SP ENERGY NETWORKS

Flexible Networks for a Low Carbon Future

BRE Client Report

Stakeholder Engagement

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Executive Summary

This report has presented the methodology, outcomes and key learning from the stakeholder engagement process developed to investigate the potential to reduce demand via energy efficiency interventions within the Industrial and Commercial (I&C) sector within three trial network areas.

The report 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 are as follows:

<u>Engagement</u>

Section 2 of the report sets out the engagement methodology adopted by BRE and SP Energy Networks (SPEN). Sections 3 and 4 provide a summary of the findings from the initial engagement and subsequent meetings or detailed discussion respectively. The engagement strategy adopted for this project consisted of initially identifying a large number of key stakeholders (by means of a desk based study) and then contacting each of them in order to develop relationships, gain customer buy-in / support and, thereafter, to progress energy efficiency opportunity identification surveys with suitably engaged stakeholders who site's appeared to offer potential. Such an approach was deemed necessary at the start of the project because very little information was known about I&C customer's energy requirements or systems and no data was available concerning the profile, or make-up, of the load in the trial areas. Key learning includes:

- 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. making use of the learning from this project and emerging programmes including the Energy Saving Opportunity Scheme (ESOS) (a mandatory energy assessment and energy saving identification scheme for organisations 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. Key reasons for this include:
    - 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.
    - Difficulties in getting to speak (/ engage with) the "correct" individuals. This was particularly an issue with medium to large organisations or national chains.
    - 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.

- Any future strategy should therefore have more clearly defined options to aid the engagement process and achieve increase 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.
- Some I&C customers were highly motivated by energy efficiency (this was particularly true for those that were largely process driven) and thus were well progressed in terms of energy efficiency at their sites. These stakeholders were amenable to working with SPEN via the project although this was predominantly only if they could see a significant direct benefit for themselves. Whilst these parties are easiest to engage with, their sites are conversely unlikely to offer maximum potential for interventions. Many smaller commercial organisations were less progressed in terms of energy efficiency.
- 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 projects.

Opportunity Identification

Section 5 of the report presents the summarised findings of targeted energy efficiency surveys undertaken at selected stakeholder's sites. It summarised the best energy efficiency measures for helping achieve peak load reduction and presents a matrix of typical energy efficiency interventions opportunities by customer / building type. Key learning includes:

- All of the organisations welcomed the engagement, surveys and provision of authoritative and independent advice provided by BRE although such an approach is clearly not sustainable in the longer term. The introduction of the ESOS Regulations[1] requiring large companies[2] to identify energy saving opportunities for all of their significant energy uses by December 2015 (and every four years thereafter); will however help overcome this barrier and will result in those

[1] The Energy Savings Opportunity Scheme Regulations 2014 – see tttp://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)

organisations bound by the new regulation to be significantly better informed as to cost effective energy opportunities at their site.

- 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 were "win-win".

- 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 report 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 progressed.

- Projects need to be low risk and present a relatively quick payback. I&C stakeholders typically required a payback on internal investment of between 2 and 5 years. In addition, the majority of stakeholders were risk averse.

- There may only be selected time windows of opportunity for installing measures. This is particularly the case for industrial and large scale commercial operations.

- A lack of in-house funding to undertake feasibility studies in to energy efficiency opportunities and/or 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 detailed investigation.

- 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

Delivery Mechanisms

Section 6 introduces a number of barriers restricting stakeholders from delivering energy efficiency projects in-house, and reports on the delivery mechanism options considered and progressed by BRE and SPEN 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.

Detailed Intervention Assessment and Delivery

Section 7 details the selection process by which selected stakeholders were chosen for detailed site assessment and presents the budget costs, annual energy saving potential, annual carbon savings potential and peak load reduction potential for a range of measures investigated at various stakeholder's sites.

- Detailed feasibility studies were completed for a range of technologies including variable speed drives (and operating various motor loads based on sensed occupancy), lighting refurbishment, lighting controls, local controls for cooling plant and mechanical ventilation. In addition, one site was investigated for the feasibility of installing trigeneration (the simultaneous production of electricity, heat and cooling from a gas fired engine) however the study concluded that trigeneration was impractical for implementation at the site.

- Approximately £430,000 worth of works was identified across 6 key sites. The scale and nature of these opportunities are considered to be typical for similar buildings owned / managed by similar I&C stakeholders. The identified works offer potential for a peak load reduction of approximately 273 kVA and an approximate annual energy saving to customers of over 2 million kilowatt-hours resulting in a simple payback of approximately 2.5 years and a CO_2 emissions reduction of approximately 641 tonnes per year.

- The measures identified ranged from £997 to £2,143 per kVA peak reduction. This assumed no customer contribution (which would make the cost effectiveness more attractive) and took no account of indirect impacts such as customer energy savings or emissions reduction. These interventions, and their costs, are not comprehensive as they are based on information from a small sample of sites that were surveyed thereby offering potential to be further developed.

The report highlights that the above findings related to sites belonging to two stakeholders for which energy efficiency was already a high priority. As a result, the findings are deemed to be more representative of a change in energy performance from "average" to "best" practice. Many sites are likely to offer potential for improving performance from a "poor" practice starting point and the report therefore recommends that any future engagement strategy focuses on identifying and engaging with these parties. More information on the likely cost effectiveness of measures applied to "poor" properties is provided in BRE Report 303592 – Energy Efficiency Business Case and Plan for Roll-out.

Section 7.2 of the report summarises the terms of agreement as developed with key stakeholders given that a limited project budget was available and that priority was applied to measures that were relatively straightforward to implement on site, offered good cost effectiveness in terms of £/kVA reduction, and offered maximum learning / replication. Key outcomes were as follows:

- A stakeholder operating multiple educational sites guaranteed that they would provide match funding to any contribution from the SPEN project. A range of variable speed drive, local cooling controls and lighting controls opportunities were agreed to be progressed offering approximately 70 kVA reduction for a total installed cost of approximately £78k. This equated to £1,126/kVA reduction when fully funded, and £563/kVA with the 50% customer contribution. SPEN are in the process of agreeing final terms and conditions with the stakeholder.

- A large hotel site offered approximately 50 kVA reduction (across a range of variable speed drives, cooling and ventilation system controls) for an installed cost of approximately £29k. This equates to £577/kVA reduction when fully funded, and £289/kVA with a 50% customer contribution. Unfortunately, this stakeholder declined to progress despite the identified measures offering a very attractive estimated energy saving of approximately £10k per annum. No clear reason was given by the stakeholder.
- A number of PV to domestic hot water system were installed in dwellings as a potential means of tackling over-voltage from distributed PV export; something that currently presents significant issue for SPEN during the summer in one of the trial areas.

Conclusions and Recommendations

Section 8 provides a summary of project conclusions and recommendations. It highlights that the stakeholder engagement process has been challenging and whilst many of the original aims and objectives have been successfully delivered the process has unfortunately not been able to deliver the magnitude of peak load savings as originally targeted. That said, despite a relatively low number of stakeholders formally engaging with the project (a number of potential factors contributing to this are raised in this report) the research was successful in identifying peak load reduction opportunities within a broad mix of I&C stakeholders sites whom presented a wide range of commercial activity / building types from which significant, and replicable, learning has be derived.

It is recommended that SPEN take cognisance of the project learning, new ESOS legislation and emerging learning from DECC’s EDR so that any future I&C stakeholder engagement strategy (and intervention measure offerings) is developed to maximise on the opportunities presented by these new initiatives e.g. this should include reviewing the interventions being progressed via EDR and the £/kVA costs being offered through that programme so that these can be used to steer the engagement and delivery strategies and help set the limits of any SPEN contributory funding of interventions in the future.

In addition the report recommends that any future engagement strategy should only focus on the most cost-effective intervention measures and that these measures be pre-selected prior to start of any engagement strategy in order to aid the engagement process, provide focus and clarity to customers, and thus help achieve increased stakeholder buy-in. In addition, any future strategy should focus on targeting specific building types and customers deemed most likely to present the best opportunities; as has been identified by this research.

Additionally, the report recommends that any SPEN energy efficiency service offering seeks to engage with customers whose current energy efficiency performance is below average, as this offers more potential and thus better cost effectiveness for implementing interventions. SPEN should look to make use of customer’s ESOS audits and opportunity identification reports as a low cost way to inform this assessment and vet opportunities.

Further considerations, and more detail in relation to ESOS and EDR, are presented in BRE Report 303592 – Energy Efficiency Business Case and Plan for Roll-out.

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1 Introduction

This report presents the methodology, findings and key learning's from the stakeholder engagement process undertaken within the SP Energy Networks' (SPEN) "Flexible Networks for a Low Carbon Future" project, under work package 2.3: Energy Efficiency.

Stakeholder engagement is the process whereby an organisation involves third parties who may be affected by the decisions it makes or who can influence the implementation of its decisions. The Flexible Networks for a Low Carbon Future project aims to investigate opportunities to increase network capacity from existing assets thereby making the network more flexible, enabling increased distributed generation connections and deferring traditional, costly, reinforcement. The project is looking specifically at three UK trial sites each of which have different but representative characteristics and customer demographics, but which are similar in that they have near-term capacity constraints due to increasing demand and an uptake of low carbon technology. When investigating opportunity for increasing network flexibility via energy efficiency it is therefore vitally important to engage with key stakeholders to better understand their current, and future, energy needs, demand profiles, energy use characteristics; as well as stakeholder's attitudes and priorities regarding energy efficiency, distributed generation, investment and funding.

BRE's main role within the stakeholder engagement process, and the focus of this report, 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 following process was adopted:

- 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
- 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.

This report presents the findings of the above stakeholder engagement process as deployed across the three trial network areas: St Andrews (Scotland), Ruabon near Wrexham (Wales) and Whitchurch (Shropshire, England).

It should be noted that an initial stakeholder interaction plan (produced in August 2012) provided an introduction to each of the three trial areas; an introduction to key stakeholders (as identified in each area via a desk based study) and set out a proposed process for initial engagement with stakeholders. This report builds on that plan and provides further information on the development of the engagement process outlined above and reports the outcomes.

2 Methodology

The following stakeholder engagement strategy was put in place to identify, engage, consult and collaborate with stakeholders. The methodology was phased, as per below, to ensure that the process remained flexible enough to adapt depending on the outcomes of the preceding phase.

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.

Phase 2: Conduct one to one meeting with key stakeholders to gain buy-in

Phase 3: Targeted site surveys at selected stakeholders: Following completion of the above, this phase included undertaking a number of technical surveys at the sites of engaged stakeholders.

Phase 4: Develop an appropriate delivery mechanism for implementation: Following completion of the above, this phase included considering appropriate delivery mechanism and procurement routes for realising the energy efficiency interventions identified during the earlier phase. This would be formulated depending on the quantity and mix of engaged stakeholders, their building types, energy efficiency opportunities available and the stakeholder’s attitudes to energy efficiency investment.

Phase 5: Intervention Assessment and Delivery

The findings relating to each of the above phases are discussed below.

3 Phase 1: Initial stakeholder identification and engagement

As outlined in the methodology section; this initial phase consisted of a number of specific tasks aimed at identifying, contacting and attempting to gain initial buy-in from suitable stakeholders. A summary of the steps undertaken and key outcomes and learning is provided below relating to each sub-task.

3.1 Sub-task 1A: Research and Identify Stakeholders

BRE conducted a desk based review of the network maps provided by SPEN (included for reference in Appendix A) in conjunction with a desk based "Google maps" review to identify prospective stakeholders. Internet based local business directories were also reviewed. A list of large sites billed half hourly (HH) was also provided by SPEN to assist.

The above sources of information were used to develop a list of prospective stakeholders on an area by area basis. The information gathered included organisation name, address, contact details and assumed property type / sector (i.e. industrial, retail, office, hotel, public authority, etc.). A summary of the stakeholder lists generated through this process are provided in Appendix B, C and D. This summary details stakeholder name, business category and whether the organisations have any sites that are metered half hourly (HH). The list includes additional information depending on whether the stakeholders formally engaged with the project, all of which is described in more detail later in this report.

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

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

Table 1: Identified stakeholder (by trial area)

3.2 Sub-task 1B: Contact Stakeholders

All 149 prospective stakeholders were then initially contacted by telephone with a view to obtaining the contact details of a relevant person and introducing the project. A relevant person was deemed to be the energy or facilities manager in larger organisation or a supervisor / general manager / technical manager for smaller business. Websites for each organisation were checked prior to making initial contact so that the caller could briefly familiarise themselves with the company, its operations as well as research key staff and their roles; in an attempt to engage with an appropriate person.

This approach gave rise to the following issues:

- Despite researchers attempting to use non-technical language during the introductory calls, many people answering the calls did not appear to fully understand the nature of the call and, as a result, were unable to direct the call to a relevant person (or, it is assumed, leave them a suitably detailed message portraying the nature of the attempted engagement).
- Many organisations did not even want to enter in to discussions as they appeared to believe that the call was a sales call even though a concise introductory statement was devised to introduce the project and the reason for the call.
- There was, in general, a reluctance to give out contact details for others in the organisation.
- Some contact details available on-line were incorrect, out of date and some companies no longer existed.
- Where local shops were part of a larger chain responses were typically “that is dealt with by head office”. In these instances head offices were duly contacted. This however typically had to be via telephoning a customer services helpline or submitting an on-line enquiry form, which were rarely acknowledged or responded to.
- Many smaller sites e.g. independent high street retails unit (as common in both St Andrews and Whitchurch) did not want to progress beyond the initial call, advising that as a tenant renting a property they would not be able to undertake many energy efficiency improvements (other than say simple lamp replacements), as deeper retrofitting of the property would be an option reserved for the landlord.
- Many sites, especially smaller retail units and small businesses, advised that energy efficiency was not high on their agenda.

Given the above difficulties in attempting to engage directly as above, a formal follow-up letter was issued by email (or post where an email address was not obtained or available) to all of the prospective stakeholders following the introductory call. This communication consisted of the following:

1. A copy of the project flyer (included in Appendix E).
2. A letter from BRE (on behalf of SPEN) introducing the project and highlighting the opportunities and benefits of engaging. This also included information on the stakeholder engagement process, introduced the BRE project team and referenced an enclosed questionnaire for interested parties to complete and return (a copy of the letter is included in Appendix F).
3. A flowchart outlining the proposed stakeholder engagement process and indicative timeline (included in appendix F), and
4. A stakeholder questionnaire (one questionnaire was produced for HH metered sites and another for non-HH). The questionnaire attempted to obtain, by return, key information relating to the site energy use and load characteristics, as well as attempt to capture any “known” or “wish-list” energy efficiency opportunities known to the organisation (a copy of the questionnaire is included in Appendix G).

3.3 Sub-task 1C: Re-contact Stakeholders

A number of follow up calls and emails were then made to all prospective stakeholders approximately one week after the initial contact to gauge interest and discuss next steps. This was done for all prospective stakeholders other than organisations who specifically asked not to be contacted again. The aim of these calls were to discuss in more detail: the aims of the project; the site energy characteristics (to determine if the organisation's site offered potential); and to confirm if the organisation wished to formally engage with the project including addressing any concerns or questions. Typical queries from interested parties included:

- Who are SP Energy Networks and BRE?
- What benefits and obligations are there for my organisation?
- Do I have to change my electricity supplier?
- What is being offered? / What type of energy efficiency upgrades is available?
- Will works be fully funded?

After approximately three failed attempts to engage no further attempts were typically made. There were exceptions to this where additional attempts were made. This included where prospective stakeholders were considered to be either significantly large consumers, key stakeholders perceived to be of significant importance (e.g. Local Authorities, large industrial users or other large commercial stakeholders who either had significant impact in the area, who operated nationally or had multiple sites – and therefore offered high potential for replicable solutions e.g. St Andrews University, Scottish Water, British Telecom). In these instances attempts were made to engage via a different route to that originally attempted e.g. by contacting a different (but still energy-related) department, researching online to obtain contact details of a suitable Director, contacting a corporate office versus a local office, etc. This approach still only had very limited success and it should also be noted that considerably more time and effort was also spent.

It should be noted that only 6 organisations returned questionnaires (2 of whom were micro-businesses).

15 stakeholders (10% of the original 149) engaged with the project at this stage. A breakdown, by area, is provided in table 2 below.

	Stakeholders			
	Identified	Engaged	Mtgs	Survey
St Andrews	60	7	4	6
Whitchurch	45	5	4	3
Ruabon	44	2	1	2
Total	**149**	**14**	**9**	**11**
		9%	6%	7%
		% of total identified stakeholders		

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

4 Phase 2: Stakeholder Meetings Summary

This section provides a summary of discussions and meetings with key stakeholders that engaged with the project during phase 1. Upon agreement with SPEN, follow-up activity, consisting of one-to-one meetings, telephone discussions and/or site surveys by BRE technical experts, were progressed with the engaged parties as detailed in table 3 below.

	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 & distribution)	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

Table 3: Engaged stakeholders & activity (by trial area)

Details of discussions during stakeholder meetings are excluded from this report in the interests of commercial confidentiality of the stakeholders.

Whilst it should be appreciated that there was a relatively small number of engaged stakeholders' (and therefore that findings may not be representative of industrial, commercial or public or charitable body customers as a whole) common finding's included:

- Significantly large I&C energy consumers (and particularly those that were largely process driven), were acutely aware of their energy consumption and appeared to appreciate the importance of network issues in terms of their long term business strategy / growth. Some were well progressed with energy efficiency and therefore presented little cost effective opportunities. These organisations were generally enthusiastic regarding energy efficiency and open to working with the DNO, however they would have to see a significant direct benefit in return.
- Some smaller commercial organisations were less progressed in terms of energy efficiency and education, resource and disruption to business activities were significant barriers.

- 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 paybacks are likely to be suitable where external funding contributes to project cost.
- 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; resource (staff) appeared to be more of an issue than availability of funds for delivery of energy projects.
- All of the organisations welcomed the engagement, free surveys and provision of authoritative advice by independent third parties although this is obviously not sustainable in the longer term. The introduction of a new regulation (the recently introduced Energy Saving Opportunity Scheme (ESOS) Regulations[3]) requiring larger companies[4] to identify energy saving opportunities for all of their significant energy uses by December 2015; will however help overcome this barrier and will result in those organisation bound by the new regulation to be significantly better informed as to cost effective energy opportunities at their site.

A number of site surveys were also completed. These are discussed in the next section.

[3] The Energy Savings Opportunity Scheme Regulations 2014 – see tttp://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)

5 Phase 3: Targeted Energy Efficiency Surveys (BRE)

5.1 Site surveys

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 whilst also providing a benefit for customers. Heat demands were generally not investigated in detail unless heating was provided using electric as the main source of energy.

Various consideration where taken in to account when selecting the sites to be surveyed. This included considering the customers electricity demand/spend, level of engagement on previous project activities, and whether sites were representative of other loads in each area; potential for maximum learning and opportunity for replication, etc. For example, whilst there are many retail outlets within the trial areas these were not prioritised because BRE's previous work in this sector has indicated that there is often limited scope for reducing energy demands. The retail sector in general has recently invested significantly in energy reduction as part of wider Corporate Social Responsibility activities and many high street retailers, including most of the major food retailers, are in the top 10% of the Carbon Reduction Commitment league table[5]). Independent retailers are most likely to be the exception to this however these tend to be relatively small units (often rented – which is another barrier) and thus there is a need to engage with a significantly large number of stakeholders in order to achieve a significant impact.

BRE completed opportunity identification surveys and/or site reviews as identified in table 3 above. This provided feedback and learning in relation to a wide range of building types, uses and mechanical and electrical energy systems e.g. commercial office type environments, industrial process, manufacturing and distribution environments, hospitality / hotel, visitor centre, schools, leisure centre, etc.

5.2 Findings

A separate report ("BRE report 283764 – Targeted Surveys and Options Assessment") provides detailed information on the methodology adopted, outcomes and learning's from the site surveys and more information on each of the identified measures. The main findings are summarised below which presents a number of opportunities identified at the surveyed sites as offering potential for reducing peak demands.

[5] 2010/2011 - CRC Performance League Table: http://crc.environment-agency.gov.uk/pplt/web/plt/public/2010-11/CRCPerformanceLeagueTable20102011

Measure	St Andrews						Whitchurch		Ruabon	
	Educational	Public Body (other)	I&C (Hotel & Accom.)	Public (Local Authority)	I&C (Sports)	Transport Depot	I&C (Food Manuf & Dist.)	I&C (Cold Store & Dist.)	I&C (Utility)	Public (Local Authority)
Voltage reduction	✓	?	?	?	?	×	?	×	×	?
ICT network power management	✓	×	×	✓	×	×	×	×	×	✓
BEMS improvements										
• Load shedding	✓	×	✓	?	✓	×	×	×	×	×
• Ventilation rates matched to occupancy	✓	×	✓	?	✓	×	×	×	×	×
• Relaxation of control setpoints	✓	×	✓	?	✓	×	✓	×	×	×
Low energy lighting								×	×	
• T12 or T8 fluorescent	✓	✓	✓	✓	✓	×	×	×	×	✓
• Tungsten halogen display lighting	✓	✓	✓	✓	?	×	×	×	×	×
• GLS	×	✓	×	×	✓	×	×	×	×	×
Temporary interruption to vending machine supplies	✓	×	×	×	×	✓	×	×	×	×
Inverter / Battery Storage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Site specific improvements	✓	✓	✓	×	✓	×	✓	✓	✓	✓

Table 4: Potential interventions by site

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.

Understandably, 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 were “win-win”. The main drivers for customers were reduced energy consumption and cost. Reduction in peak demand for customers on maximum demand tariffs could also be a benefit but opportunities may not be as widespread.

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. they get no significant cost benefit – except potentially in instances where they are on multi-rate tariffs) in most cases shifting or limiting load is likely to be detrimental to them in terms of a reduced service level, reduced output capacity, manufacturing capability, etc.

It should also be appreciated that energy savings (accumulated over the year) often do not directly correspond to the energy savings over the peak period in which the DNO is predominantly interested in so there is often no synchronous, or mutually significant, benefit to both parties during peak periods. Careful consideration must therefore be given to understanding the nature and magnitude of the customer benefits so that mutually beneficial solutions can be progressed. The table below highlights these considerations for the interventions identified from the surveys.

Measure	Benefit to DNO	Benefit to Customer	Cost	Power Saving	Energy Saving
Voltage Reduction	✓	✓	L	M	L
BEMS improvements					
• Load shedding	✓	✓	L	M	-
• Ventilation rates matched to occupancy	✓	✓	M	L	H
• Relaxation of control setpoints	✓	✓	L	M	L
Low energy lighting					
• Replacement lamps	✓	✓	L	M	M
• Replacement fittings	✓	✓	H	M	M
Temporary interruption to vending machine supplies	✓	✗	M	M	L
IT Power Management	✓	✓	M	L	H
Inverter / Battery Storage	✓	✗	M	L	L

Table 5: Potential interventions: Benefits, costs and savings

A key KPI entitled “cost effectiveness” was also developed around this point to help assess the benefit of various measures. This was calculated as the “£/kVA reduction” for a range of suitable interventions. The cost effectiveness hierarchy of interventions is explored in more detail later (and in BRE report 300776). It should however be borne in mind that the (DNO) “cost effectiveness” (as calculated in this relatively simple manner) is only a crude indicator and does not account for any of the wider benefits (e.g. energy cost savings for end-users – which is critical in terms of ensuring engagement and customer buy-in; carbon emissions reductions; etc.) or impacts (e.g. the widespread use of voltage reduction can impact on the potential to reduce supply voltage when Network Operators require to manage peak demand at national level).

Common measures typically offering the best "£/kVA reduction" were identified as:

- 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/comfort cooling controls, etc.
- Variable Speed Drives
- Lighting controls upgrades, lamp fitting replacements

5.3 Typical opportunities by customer / building type

This thinking was then expanded to consider the characteristics of other types of building for which these, or similar, interventions could apply. For example, Building Energy Management Systems (BEMS) – (with potential to fine tune control strategies) could potentially be installed in any building which has extensive or complex building services such as universities, hospitals, large office complexes, etc. Table 6 below shows how the above interventions (and others) could be applied to other building types with characteristics relevant to each intervention.

		Typical building types																
Efficiency Measure	Sub-measure	Housing	Offices - nat vent	Offices - aircon	Retail	Schools	Sports Centre	University/College	Catering	Hospital	Care homes	Hotels	Museum/Gallery	Conference facilities	Theatres/Cinemas	Library	Industrial buildings	Car parks
Low energy lighting	Lamp replacment	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Low energy lighting	Fitting replacement		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Low energy lighting	Controls - occupancy detection		•	•		•	•	•				•		•				•
Low energy lighting	Controls - daylight sensing		•	•		•		•			•	•	•	•		•		•
Low energy lighting		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Voltage reduction	3% - DNO control		•	•	•		•	•		•		•					•	
Voltage reduction	6% - transformer tap down		•	•	•		•	•		•		•					•	
Voltage reduction	9% - proprietory equipment		•	•	•		•	•		•	•	•	•	•	•	•	•	
Voltage reduction			•	•	•		•	•		•	•	•	•	•	•	•	•	
ICT power management			•	•		•		•								•		
Vending machine control							•	•		•								
Variable speed drive motors	Fans			•	•		•	•		•		•		•			•	•
Variable speed drive motors	Pumps			•	•		•	•		•		•		•			•	
Variable speed drive motors	Process loads							•									•	
Variable speed drive motors				•	•		•	•		•		•		•			•	•
BEMS / Controls upgrades	Use of time schedules		•	•			•	•		•		•	•	•	•		•	
BEMS / Controls upgrades	Load shedding							•				•		•			•	
BEMS / Controls upgrades	Occupancy based ventilation			•			•	•				•	•	•	•			
BEMS / Controls upgrades	Relaxing control set-points		•	•			•	•				•	•	•	•		•	
BEMS / Controls upgrades			•	•			•	•		•		•	•	•	•		•	
Energy Centre	CHP						•	•		•	•	•					•	
Energy Centre	Tri-generation						•	•		•							•	
Energy Centre			•	•			•	•		•	•	•	•	•	•		•	
Fabric improvements	Door seals (refrigerated spaces)			•				•	•	•		•					•	
Fabric improvements	Thermal insulation to building fabric									•	•	•					•	
Fabric improvements				•				•	•	•	•	•					•	
Time scheduling	vehicle charging (golf buggies)						•					•						
Time scheduling	vehicle charging (forklift)																•	
Time scheduling							•					•					•	
Distributed generation export to DHW		•	•	•		•	•	•	•	•	•	•		•			•	
Heating Fuel Switch	from direct heating	•								•	•	•					•	
Heating Fuel Switch	from off-peak electric heating																	
Heating Fuel Switch										•	•	•					•	

Table 6: Matrix of generic energy efficiency measures by customer

The above table presents the best energy efficiency opportunities likely to be present within a range of building types for achieving peak load reduction and network benefit.

6 Phase 4: Delivery Mechanisms

Upon completion of the initial opportunity identification and cost effectiveness evaluation, BRE and SPEN investigated a number of delivery mechanisms that offered potential to progress the on-site delivery of the identified energy efficiency measures. In doing so it was critically important to appreciate the range of common issues currently presenting barriers to stakeholders in developing and undertaking energy efficiency projects, so that the chosen delivery mechanism could appropriately overcome these barriers.

6.1 Barriers to Stakeholders

Common stakeholder related barriers included:

- A lack of in-house funding to undertake feasibility studies in to energy efficiency opportunities and/or undertake measures.
    - These initial feasibilities are required in order to undertake an initial evaluation and assessment of the potential opportunities. As a result they can be high risk (i.e. a study could be funded which does not give rise to a cost effective solution) particular where there is no or little in-house expertise or familiarity with the technologies or concepts being investigated.
    - In addition, energy projects are typically competing for in-house funding with other (non-energy related) projects that can offer other business benefits e.g. increased productivity, increased assets, etc.
- A lack of awareness of external or grant aid funding, or other financial incentives, for energy related projects.
- A lack of in-house technical expertise with the technologies being investigated.
    - Stakeholders reported being approached by number organisations attempting to sell energy saving technologies or energy efficiency services. Stakeholders often lacked knowledge in the suitability or effectiveness of various technology and/or access to impartial advice or information regarding the technologies. Lack of knowledge can restrict opportunities due to stakeholders not wanting to progress certain opportunities.
- Project feasibility needs to be undertaken to an appropriately detailed stage before stakeholders can give serious consideration or approval to proceed.
    - Feasibility studies need to be progressed 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. This can be a lengthy process and may require engagement with companies with a “design and build” capability or alternatively require a design consultant and energy installer / contractor.
- Projects need to be low risk and present a relatively quick payback.
    - Stakeholders typically required a payback of between 2 and 5 years.
    - Most stakeholders were also risk averse. As a result they required project to be low risk in terms of technology risk (i.e. they required proven and reliable technology) and disruption on operations (e.g. during initial installation as well as considering what would be the impact of a product failure post installation).

- Consideration needs to be given to the specific financial policies of individual stakeholders.
    - Stakeholders may require multiple quotes for works and/or compliance with some other means of demonstrating best value procurement.
- There may only be selected time windows of opportunity for installing measures.
    - Stakeholders may only be able to install measures during specific time in order to limit disruption, down-time, lack of production or similar. This may restrict some opportunities from proceeding unless there is good project management.
- A need to keep roles and responsibilities clearly defined and terms and conditions relatively straightforward for any projects that proceed to installation.

6.2 Delivery Mechanism Development

In addition to the barriers noted above, and even though a significant number of opportunities had been highlighted during the initial BRE "opportunity identification" surveys; feedback from individual stakeholders highlighted that they were not in a position to progress the opportunities without further support. Taking cognisance of the project learning to date, BRE and SPEN took steps to investigate potential delivery mechanisms which involved engaging with organisations who could assist in undertaking detailed feasibility, accurate cost estimation and design and installation of a range of energy efficiency measures in order to suitably progress interventions at selected stakeholder sites. It was identified that there was a need to engage with organisations that had the following capabilities:

- Suitable expertise in the wide range of energy efficiency measures and technologies being considered – this was deemed a critical requirement.
- Parties who provide "design and build" services, or similar, so that there can be an easier, quicker and less administrative transition, for the stakeholder, from (i) detailed feasibility, design, cost estimate (/ quote) stage, to (ii) installation – this was deemed a critical requirement.
- Parties who could potentially offer co-funding, innovative financing of energy measures, discounted supply of energy efficient technologies, or similar – this was deemed a beneficial requirement.

Following discussions between BRE and SPEN regarding organisations with the capabilities as identified above it was deemed beneficial for BRE to attempt to engage with Energy Retailers who offered an energy survey / solutions or energy financing / contracting function. Meetings were then progressed with EDF Energy and Scottish Power (energy retail) as detailed below, with a view to better understanding their capability and whether either offered potential to assist in delivery of the aims of the project.

EDF Energy

The reasoning for approaching EDF Energy was because they currently administer national energy procurement contracts across the UK. As a result they are a supplier to the public sector in Scotland and the Scottish Government supply contract also sees them supply energy to Further and Higher Education establishments. As a result EDF Energy was the energy supply to two stakeholders in the St. Andrews area both of whom had significant estates and energy consumption. Furthermore, should any good learning or delivery models be able to be developed then there is likely to be opportunity for replicating these elsewhere in the UK due to EDF Energy's other national procurement contracts.

Following a meeting with EDF Energy (their Energy Services team); key considerations and capability was identified as follows:

- o EDF Energy provide energy advice services to businesses however they are also a provider of Energy Performance Contracts (EnPC) and related services. These services are generally targeted at organisations with an energy spend in excess of £2m per annum and on energy projects of £500k (CAPEX) and over. EDF Energy were open to considering opportunities for EnPC with large clients.

Whilst feedback in relation to EDF Energy services was communicated to the large stakeholders engaged with the project, there was deemed to be no significant opportunity for SPEN to engage with EDF Energy to help address the above barriers and fulfil the aims of the project.

Scottish Power (energy retail)

The reasoning for approaching Scottish Power (energy retail) was because they were the historic supplier in the SPEN network area (and thus were deemed likely to have supply contracts with key stakeholders in the areas) and furthermore they have an "Energy Solutions" team who have capability in energy efficiency opportunity identification, design and delivery.

Following a meeting with Scottish Power (their Energy Solutions team); key considerations and capability was identified as follows:

- o Scottish Power provide energy advice, surveys and energy solutions to businesses including installation services. They undertake a wide range of general and specialist commercial energy efficiency projects and deliver works via specialist framework contractors who offer additional expertise in facility management, controls and Building Energy Management Systems (BEMS).
- o In addition, Scottish Power advised that if stakeholders were currently supplied by them then this offered potential to lever in additional funding for energy efficiency improvements.

The above was deemed to be suitably beneficial to overcoming the barriers and providing capability in the required areas. As a result, the support of Scottish Power - Energy Solutions was sought with a view to developing further a number of opportunities with selected stakeholders.

6.2.1 Agreed delivery mechanism

At this stage it was agreed that SPEN would arrange a number of in-depth feasibility studies to be undertaken by Scottish Power – Energy Solutions. These studies would only be undertaken at selected stakeholders' sites where significant opportunities were deemed to be available. BRE would first seek permission from the selected stakeholders before Scottish Power – Energy Solutions would progress any works. Formal letters were then issued to all stakeholders advising them of the general outcomes of the surveys and next steps (where relevant). The communications comprised as follows:

- Letters advising of general project progress and next steps (where relevant).
  - o See Appendix H - for the letter issued to stakeholder where further studies were targeted.
  - o See Appendix I – for the letter issued to stakeholders where no further works were deemed beneficial.

In both of the above instances the communication also included a number of supporting appendices as follows:

- BRE site specific feedback reports (where reviews had been completed by BRE).
  - o These reports presented a summary of the BRE survey findings and included client feedback on energy efficiency measures that could be implemented at the sites.
- A list of performance specification for energy efficiency equipment (see Appendix J).

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- These were produced as part of the project to provide information to stakeholders to assist them in developing energy efficiency projects (as may have been highlighted in the BRE survey feedback reports) or other general energy related projects in order to help them specify best practice equipment e.g. when considering replacing energy consuming equipment or undertaking a general refurbishment. Specifications were produced for a range of energy efficiency products and mechanical and electrical systems including: insulation, draught proofing, heating systems, water systems, ventilation systems, lighting, controls, pumps, air conditioning, refrigeration plant, etc. NB: the specifications were produced in December 2013.

- A list of current grant aid and other energy related financial incentive schemes (see Appendix K)
    - This list was compiled as part of the project to provide information to stakeholders regarding the range of external support mechanisms available to commercial organisations for energy efficiency products, energy efficiency refurbishment or renewable energy projects. NB: the specifications were produced in December 2013.

- A commercial lighting replacement checklist and guide (see Appendix L)
    - This checklist and guide was produced by BRE as part of the project with the aim of providing stakeholders with general information relating to options for energy efficient lighting replacements and refurbishment. The information sheet provides guidance on the types of lamps, light fittings and controls that are relevant for specific building types, works areas and tasks, and gives information as to what to consider when undertaking direct lamp replacement for more efficient fittings.
    - (NB: Direct lamp replacement with low energy fittings (e.g. LEDs) is generally a cost effective intervention in terms of kVA reduction (and it is also likely to present good energy savings to customers). Earlier in the project consideration was given to the feasibility of a direct lamp replacement roll-out for commercial customers. This was however not progressed as such an approach was deemed to give rise to a number of potential issues and liabilities which could only be overcome with a full lighting design on a case by case basis, to take appropriate account of the following:
        - The need to ensure appropriate lighting levels and colour rendering that are suitable for the building type / work area / task.
        - The need to ensure that any direct lamp replacement does not give rise to safety issues including risk of overheating and increased risk of fire.
        - The need for appropriate controls to be introduced in order to maximise the energy and power saving benefits)

Following issue of the above communication; selected stakeholder were approached with a view to having a detailed feasibility study and costed works proposal undertaken by Scottish Power – Energy Solutions. The outcomes are presented in the next section.

7 Phase 5: Intervention Assessment & Delivery

A review of the identified opportunities was undertaken and a number of detailed studies were then chosen to be progressed further. This focussed on opportunities which, in addition to providing suitable benefit to the network and energy saving potential for the stakeholders, were also measures that stakeholders were happy to consider progressing. Due to limited funds for undertaking detailed surveys only the best opportunities (i.e. opportunities that were deemed to be significantly large, cost effective, or providing high replication potential) where targeted. A summary of the proposed actions is provided below (table 7 (i) to table 7 (iii)) by network area.

Area	Stakeholder	Technology / Measure	BEMS / Controls	VSDs	Lighting	VO	Heating fuel switch	Other	Key opportunities as identified from initial surveys	Progress detailed feasibility?
St Andrews	Educational	BEMS optimisation and controls	•						various controls upgrades: • relaxation of control set-points. • load shedding control. • matching ventilation supply to occupancy (e.g. CO2 sensing within mechanically ventilated spaces). • improved (time/temp) control for selected spaces and water heating plant. • improved control of chiller plant. • opportunity for advance/delay heating/cooling/pump control to move shift loads out with peak periods.	Yes
		VSDs		•					Potential opportunities (on large pump sets) to reduce consumption and at peak periods (to manage demand).	
		Lighting Upgrades			•				Replacement of T8/T12s. Introduction of daylight/occupancy controls.	
		Voltage optimisation				•			Potential opportunity to step down at the SPEN transformer.	SPEN to investigate
		Vending Machines						•	Potential opportunity to introduce mains borne signalling control (time/presence detection over-ride), or similar, on vending machines to reduce consumption in peak periods.	No - provide feedback advice to client
		IT network management						•	Opportunity to introduce power management software on ICT network	

Table 7(i): Proposed Detailed Studies, by area (St. Andrews)

Area	Stakeholder	Technology / Measure	BEMS / Controls	VSDs	Lighting	VO	Heating fuel switch	Other	Key opportunities as identified from initial surveys	Progress detailed feasibility?
St Andrews										
	I&C (Hotel)	BEMS optimisation and controls	•						Opportunities for applying relaxation of control set-points (chillers) and matching ventilation rates matched to occupancy (e.g. CO2 sensing).	Yes
		Lighting upgrades			•				LED lighting replacement.	
		Golf buggy charging						•	Install timer on charging circuit to switch off between 16.00 and 19.00 on winter weekdays.	
	Public (other)	Lighting upgrades			•				Lighting upgrades.	Yes
	Public (LA)	Lighting upgrades			•				Lighting upgrades.	No - stakeholder progressing
		Heating fuel switch					•		Opportunity to switch space heating from electric.	No

Table 7(ii): Proposed Detailed Studies, by area (St. Andrews – contd.)

Area	Stakeholder	Technology / Measure	BEMS / Controls	VSDs	Lighting	VO	Heating fuel switch	Other	Key opportunities as identified from initial surveys	Progress detailed feasibility?
Whitchurch	I&C (cold storage & distribution)	Trigeneration	●						Potential opportunity to reduce load by introducing trigeneration (i.e. simultaneous production of electricity, heat and coolth).	Yes
		Refrigeration plant management (control optimisation)	●						Potential opportunities for improved management and/or scheduling of refrigeration plant	No - provide feedback advice to client
	I&C (food production & distribution)	Refrigeration plant operation & management	●						Opportunity to reduce consumption by introducing variable compressor head pressure that can be adjusted based on external ambient temperature.	No - provide feedback advice to client
Ruabon	Public (LA)	Lighting upgrades			●				Upgrade of lighting from T8 to T5.	No - provide feedback to client
	Housing	PV to domestic hot water						●	Opportunity to reduce amount on PV export to the grid by diverting excess power to domestic hot water	Progress without further studies

Table 7(iii): Proposed Detailed Studies, by area (Whitchurch and Ruabon)

7.1 Detailed Feasibility Outcomes

Following suitable agreement with selected stakeholders; detailed feasibility studies were progressed as highlighted above.

7.1.1 Trigeneration feasibility

A study was also progressed to examine the feasibility of installing trigeneration at a substantial cold store warehousing and distribution site. The site presented a significant refrigeration load and thus trigeneration (the simultaneous production of electricity, heat and coolth (via an adiabatic chiller) from a gas fired engine) was anticipated as being able to offer significant peak load reduction potential if a significant proportion of the, electrically driven, refrigeration load could be met from the, gas fired, trigeneration plant. Unfortunately however, the feasibility study identified that trigeneration was impractical for implementation at the site.

It should be noted that this stakeholder has subsequently investigated the potential to make use of anaerobic digestion to generate power and is now actively progressing this opportunity primarily to help provide additional security to their long term energy and company growth strategies. The stakeholder advised that the engagement process of this project had helped raise the awareness of energy security issues within the organisation and was a key factor in them undertaking this review.

7.1.2 Controls/VSDs/Lighting refurbishment feasibility

Additional feasibility studies were progressed with two other stakeholders (comprising a total of 6 sites). These studies focussed specifically on opportunities for controls improvements / upgrades, lighting replacement and controls, and variable speed drives (for air handling unit fan motors and pump motors). Significant opportunities in these areas were identified, costed and evaluated. Findings are summarised in tables 8 and 9 below for the respective stakeholders.

The following should be noted in relation to the Scottish Power Energy Retail - Energy Solutions survey findings:

- Estimates of costs are based on nameplate ratings of equipment, spot readings of consumption and information prepared by the site and supplied to Scottish Power;
- Estimated load reduction is 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.

		Figures from Scottish Power Energy Retail								
		Estimated Savings (pa)	Estimated Cost of Works	Payback Time (years)	Energy saving (kWh)	CO2 saving (Tonnes)	Peak Load Reduction (kW)		Cost effectiveness (£/kVA)	
	ALL MEASURES	£116,192	£301,988	2.6	1,448,515	463	187.0		£1,615	Grand Total
Building 1	Upgrade control strategy	£15,860	£23,645	1.5	300,655	46.4	18.7		£1,264	
Building 2	Upgrade control strategy	£14,092	£16,167	1.1	249,719	42.7	17.7		£913	
Building 3	Upgrade control strategy	£7,870	£8,960	1.1	84,090	45.5	8.2		£1,093	
Building 4	Upgrade control equipment	£2,555	£19,375	7.6	48,980	13.7	3.9		£4,968	
Building 5	Upgrade control strategy	£27,525	£28,335	1	268,555	45.6	13.5		£2,099	
	CENTRAL CONTROL STRATEGY	£67,902	£96,482	1.4	951,999	193.9	62.0		£1,556	Total
	Average	£13,580	£19,296	2.5	190,400	38.8	12.4		£2,067	Average
Building 2	Install VSD on AHU 1&2	£4,471	£11,120	2.5	47,380	25.6	12.7		£876	
Building 2	Install VSD on AHU 3	£4,086	£8,412	2.1	43,304	23.4	11.6		£725	
Building 3	Install VSD on AHU 1	£4,645	£6,870	1.5	49,620	26.8	14.8		£464	
Building 3	Install VSD on water inlet pumps	£4,595	£14,895	3.2	49,110	26.6	6.6		£2,257	
	VARIABLE SPEED DRIVES	£17,797	£41,297	2.3	189,414	102.4	45.70		£904	Total
	Average	£4,449	£10,324	2.3	47,354	26	11.43		£1,080	Average
Building 1	PIRs for Air-Con Split units	£2,645	£8,460	3.2	28,030	15.2	7.5		£1,128	
Building 5	Delta T Reset strategy on chillers	£1,210	£5,730	4.7	11,120	6	2.3		£2,491	
Building 5	Switch off 2 of 4 GEA chillers	£1,125	£690	0.6	10,335	5.6	2.1		£329	
	LOCAL COOLING CONTROLS	£4,980	£14,880	3.0	49,485	26.8	11.90		£1,250	Total
	Average	£1,660	£4,960	2.8	16,495	9	3.97		£1,186	Average
Building 1	PIRs for lift lobby & corridor lights	£2,580	£13,460	5.2	27,330	14.8	7.3		£1,844	
Building 4	PIRs on various lights	£1,530	£8,985	5.9	16,280	8.8	4.9		£1,834	
	PIR LIGHTING CONTROLS	£4,110	£22,445	5.5	43,610	23.6	12.20		£1,840	Total
	Average	£2,055	£11,223	5.6	21,805	12	6.10		£1,289	Average
Building 1	Upgrade external lighting	£675	£5,860	8.7	7,155	3.9	1.9		£3,084	
Building 2	Replace 2D fluorescent tubes	£1,963	£11,934	6.1	20,807	11.3	5.6		£2,131	
Building 3	Replace 2D fittings	£2,475	£19,220	7.8	26,450	14.3	7.9		£2,433	
Building 4	Replace Greenhouse SON lighting	£5,305	£27,440	5.2	56,390	30.5	16.9		£1,624	
Building 4	Replace corridor lighting	£1,550	£8,230	5.3	16,480	8.9	4.9		£1,680	
Building 5	Replace basement lights	£9,435	£54,200	5.7	86,725	46.9	18		£3,011	
	LIGHTING REPLACEMENT	£21,403	£126,884	5.9	214,007	115.8	55.20		£2,299	Total
	Average	£3,567	£21,147	6.5	35,668	19	9.20		£2,327	Average

Table 8: Costed Works Proposal, Education Sites (1 x owner, 5 x sites), St Andrews

		Figures from ScottishPower Energy Retail								
		Estimated Savings (pa)	Estimated Cost of Works	Payback Time (years)	Energy saving (kWh)	CO2 saving (Tonnes)	Peak Load Reduction		Cost effectiveness (£/kVA)	
	ALL MEASURES	£ 56,670	£127,820	2.3	670,440	179	86		£1,491	Grant Total
I&C (hotel) 1	Upgrade control equipment (Trend)	£ 32,025	£ 56,770	1.77268	433,395	50.7	11.8		£4,811	
	CENTRAL CONTROL STRATEGY	£32,025	£56,770	1.8	433,395	50.7	11.8		£4,811	Total
I&C (hotel) 1	Variable Speed Drives on DHW pumps	£ 2,500	£ 4,205	1.7	24,045	13	4.1		£1,026	
I&C (hotel) 1	Variable Speed Drives on pool pumps	£ 2,260	£ 7,845	3.5	21,755	11.8	3.7		£2,120	
	VARIABLE SPEED DRIVES	£ 4,760	£ 12,050	2.5	45,800	24.8	7.8		£1,545	Total
	Average	£ 2,380	£ 6,025	2.6	22,900	12.4	3.9		£1,573	Average
I&C (hotel) 1	Delta T Reset strategy on chillers	£ 2,965	£ 5,730	1.9	28,515	15.4	4.9		£1,169	
	LOCAL COOLING CONTROLS	£2,965	£5,730	1.9	28,515	15.4	4.90		£1,169	Total
I&C (hotel) 1	Kitchen extract canopy control	£2,595	£8,160	3.1	24,975	13.5	4.3		£1,898	
	LOCAL VENTILATION CONTROLS	£2,595	£8,160	3.1	24,975	13.5	4.30		£1,898	Total
I&C (hotel) 1	Replace external lamps	£4,730	£23,265	4.9	45,480	24.6	7.8		£2,983	
I&C (hotel) 1	Replace GU10 lamps	£9,595	£18,740	2.0	92,275	49.9	15.8		£1,186	
	LIGHTING REPLACEMENT	£14,325	£42,005	2.9	137,755	74.5	23.60		£1,780	Total
	Average	£7,163	£21,003	3.4	68,878	37	11.80		£2,084	Average
I&C (hotel) 1	Golf buggy charging control	£0	£3,105				33.3		£93	
	OTHER	£0	£3,105	n/a	0	0.0	33.30		£93	Total

Table 9: Costed Works Proposal, I&C (Hotel) Site (1 x owner, 1 x site), St Andrews

7.1.2.1 Summary

Table 10 below presents a combined summary of the works identified at the two sites, grouped by intervention measure.

	Data from Scot Power Energy Retail works proposals						
	Estimated Savings (pa)	**Estimated Cost of Works**	**Payback Time (years)**	**Energy saving (kWh)**	**CO2 saving (Tonnes)**	**Peak Load Reduction (kW)**	**Cost effectiveness (£/kVA)**
	£172,862	**£429,808**	**2.5**	**2,118,955**	**641**	**273**	**£1,576.12**
VARIABLE SPEED DRIVES	£22,557	£53,347	2.4	235,214	127	53.5	£997
LOCAL COOLING CONTROLS	£7,945	£20,610	2.6	78,000	42	16.8	£1,227
PIR LIGHTING CONTROLS	£4,110	£22,445	5.5	43,610	24	12.2	£1,840
LOCAL VENTILATION CONTROLS	£2,595	£8,160	3.1	24,975	14	4.3	£1,898
CENTRAL CONTROL STRATEGY	£99,927	£153,252	1.5	1,385,394	245	73.8	£2,077
LIGHTING REPLACEMENT	£35,728	£168,889	4.7	351,762	190	78.8	£2,143
OTHER	£0	£3,105	n/a	0	0	33.3	£93

Table 10: Summary of interventions identified and costed via detailed feasibility

The following was noted:

- Approximately £430,000 worth of works was identified across 6 sites (5 x educational building and 1 x commercial hotel). The scale and nature of these opportunities are considered to be typical for similar buildings owned / managed by other stakeholders. Five educational buildings were surveyed however it is highly likely that similar opportunities exist at other educational sites under the stakeholder's ownership which were not surveyed. This presents opportunities for combining similar projects across different sites to reduce costs further.

- The identified works presents an approximate peak load reduction of 273 kVA and an approximate annual energy saving to customers of over 2 million kilowatt-hours resulting in a simple payback of approximately 2.5 years and a CO_2 emissions reduction of approximately 641 tonnes per year.

- The (£/kVA) cost effectiveness of the measures identified ranged from £997 to £2,143 per kVA peak reduction. This assumes no customer contribution (which would make the cost effectiveness more attractive) and takes no account of indirect impacts such as customer energy savings or emissions reduction.

    - It is also important to note that these surveys took place at sites belonging to two stakeholders and that energy efficiency was already relatively high up the agenda of both these two parties. As a result, the project findings presented below are likely to be more representative of a change in performance from "average" to "best" practice. Many sites are likely to offer potential for improving performance from a "poor" practice starting point and thus any future engagement strategy should focus on identifying and engaging with these parties. More information on the likely cost effectiveness of measures applied to "poor" properties is provided in BRE Report 303592 – Energy Efficiency Business Case and Plan for Roll-out.

Additional analysis was undertaken to identify the minimum, maximum and average "cost effectiveness" of the measures identified by the detailed studies. The table below presents this information relative to the cost effectiveness of other interventions measures that were not investigated during the detailed studies i.e. voltage reduction and halogen to LED direct lamp replacements (for commercial sites).

The table below also presents a deemed "typical" cost effectiveness for each of the measures (that are representative of a change in performance from "average" to "best" practice) for Industrial and Commercial consumers.

	Data from work proposals (all sites)				**Deemed "Typical"**
	"Cost effectiveness" (£/kVA reduction)				
MEASURE	all measures	Average	Min	Max	(as per BRE report 300776)
6% voltage reduction (at SPEN transformer)					**18**
3% voltage reduction (at SPEN transformer)					**38**
Commercial lighting replacement (halogen to LED)	not quoted				**750**
Variable Speed Drives	997	1,245	464	2,257	**1,065**
Cooling controls	1,227	1,279	329	2,491	**1,459**
BEMS / central controls	2,077	2,525	913	4,968	**1,819**
Lighting controls (e.g. PIR)	1,840	1,839	1,834	1,844	**2,158**
Ventilation controls	1,898	1,898	n/a	n/a	n/a
6% voltage reduction (proprietary) (individual site)	not quoted				**2,200**
Commercial lighting replacement (general)	2,143	2,266	1,186	3,084	**2,691**

Table 11: Cost effectiveness (£/kVA reduction) by intervention type (from "good" to "best" practice)

- The typical (£/kVA) reduction cost effectiveness of the above measures ranged from £750 to £2,691 per kVA peak reduction (when voltage reduction at the DNO transformer is excluded). Once again, the cost effectiveness evaluation assumes no customer contribution (which would make the cost effectiveness more attractive) and takes no account of indirect impacts such as customer energy savings or emissions reduction. As noted above, more information on the likely cost effectiveness of measures applied to "poor" properties is provided in BRE Report 303592 – Energy Efficiency Business Case and Plan for Roll-out.

7.1.3 PV to Domestic Hot Water

A high percentage of distributed generation, photovoltaics (PV), was found to exist on the Ruabon network. The vast majority of PV installations are owned by the Local Authority consisting of approximately 2,000 dwellings (with an average installed capacity of 2 kW (peak) per installation) as well as a small number of larger PV installations on local authority owned commercial properties. Over-voltage can be a significant issue for SPEN when there is significant export from the PV systems. This is especially true around the middle of the day throughout summer when the PV installations are generating at their peak and at levels above the dwelling electrical demand. In an attempt to reduce the amount of exported energy it was deemed desirable to investigate devices that could be easily installed in dwellings and which could be used to increase the on-site utilisation of energy generated from the PV installation. Such a solution would benefit the customers, as it would reduce the amount of energy needed to be purchased from other sources, and the network, as it would hopefully result in less export to the network and therefore a reduction in the over-voltage issues currently being experienced.

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Following a review of various technologies it was deemed beneficial to trial a small number of a "PV to domestic hot water (PV to DHW)" diverting controller that would sense when power was being exported to the grid and divert this to an electric immersion heater installed in a domestic hot water cylinder. This type of system offered the potential to reduce customers' bills by reducing their domestic hot water energy consumption (which in this case was supplied by a gas boiler). The Local Authority was engaged and a number of properties were identified to undergo trial installation. To monitor the effectiveness of the PV to DHW systems SPEN installed smart meters to monitor the extent of export and the impact on the voltage. The PV to DHW systems were installed in Winter 2014/15. Whilst it was only a relatively small sample, the monitoring confirmed that the systems performed well over the summer 2015 period, reducing export in many cases and directly saving the local authority tenants money on their bills. Whilst PV to DHW systems are a relatively effective, and low cost, way to tackle over-voltage issues it is important to appreciate the following:

- Properties need to have a domestic hot water cylinder.
    - The Local Authority in question had a policy of installing combi-boilers which meant that less than 1% of the 2000 dwellings with PV, were suitable for the PV to DHW systems. Whilst this solution is not highly replicable in Ruabon, the trial was progressed as there was potential for useful learning that could be applied to other areas of the network where similar issues exist.
- In order to maximise the benefits of the system (i.e. maximise the reduction in exported energy and deliver maximum customer savings) the households hot water cylinder heating / charging regime is likely to need to be changed. E.g. if the hot water cylinder is already up to temperature the system will be unable to divert excess generation to the cylinder as the immersion heater thermostat (which supplies the excess power) will be satisfied. Customer education, and getting the customer to change their behaviour slightly, is therefore crucially important to ensure that the system performs at its optimum e.g. by only partially charging their hot water cylinder in the evening / early morning so that it is not fully heated up by the middle of the day as this then enables the PV to DHW system to divert excess energy to the cylinder.
- Customer education is also required to make sure that customer's don't turn off their conventional hot water heating system in the belief that the PV to DHW system can meet 100% of their hot water demands. This presents an additional concern in so much as hot water storage systems should be periodically (e.g. weekly) raised to 65 degrees centigrade to protect against the propagation of legionella bacteria.
- On the positive side, many PV to DHW systems are relatively low cost, and quick and straightforward to install (including retrofitting).
- Customers will gain more cost benefit from a PV to DHW system if they heat their water from electricity as opposed to from gas, which can be approximately three orders cheaper.

Whilst PV to DHW systems have been trialled it is important to note that there are a growing number of devices and control systems that are designed to utilise locally generated renewable power on site, and reduce export to zero. These include battery storage devices, advanced home energy control system (that, for example, can make use of local batteries or electric vehicle batteries), or storage units comprising phase change material that can provide pre-heat to domestic hot water combi-boiler systems.

It is also important to note that UK building regulations and the UK's national calculation methodologies relating to calculating the energy performance of buildings currently provides no dis-incentive to exporting power to the network.

7.2 Agree Terms with Stakeholders for Implementation

Following the completion of the detailed feasibility studies a number of meetings and telephone discussions where held with relevant stakeholders to discuss the opportunities in more detail and assess stakeholder's appetite to contribute to, and progress, key opportunities. Key outcomes are reported below:

7.2.1 Education Sites Stakeholder, St Andrews

This stakeholder was amenable to implementing a number of implementations and guaranteed that they would provide match funding to any SPEN contribution. As only a limited project budget was available priority was applied to measures that were both relatively straightforward to implement on site and which also offered good cost effectiveness in terms of £/kVA reduction. It was agreed that the following measures would be implemented.

- Variable speed drive opportunities and operating selected motor loads on a demand basis e.g. occupancy (via carbon dioxide sensing) (as identified in table 8)
- Local cooling controls (as identified in table 8)
- Lighting controls (as identified in table 8)

The above measures were estimated to offer approximately 70 kVA for a total installed cost of approximately £78k. It was agreed that measures should be prioritised in properties where the stakeholder had sub-metering, in order to assist with future monitoring and evaluation of the measures. In addition to the above measures it was agreed that the stakeholder would provide added value by investigate a number of opportunities for deferring loads and investigating opportunity for other significant lighting replacements. In addition to agreeing to progress the above measures, the stakeholder advised that they would also undertake further investigations in all of the other measures as identified during the detailed feasibility studies. The stakeholder was also particularly interested to use the learning from the detailed studies (in-house initially) to examine the potential for rolling out the recommended interventions at its other sites (which are also on the trial network).

Unfortunately the stakeholder ultimately did not take up the proposed interventions during the time scale of the project.

7.2.2 I&C (Hotel) Stakeholder, St Andrews

A meeting was progressed with this stakeholder with a view to assess the stakeholder's appetite to progress selected measures as identified from the detailed surveys. These measures comprised:

- Variable speed drive opportunities and operating selected motor loads on a demand basis e.g. occupancy (via carbon dioxide sensing) (as identified in table 9)
- Local cooling controls (as identified in table 9)
- Local ventilation controls (as identified in table 9), and
- Other; time controls on golf buggy charging ((as identified in table 9)

The above measures were estimated to offer approximately 50 kVA for a total installed cost of approximately £29k. This equates to £577/kVA reduction when fully funded, and £289/kVA with a 50% customer contribution.

Unfortunately, this stakeholder failed to respond to any communication following the meeting despite the identified measures offering a very attractive estimated energy saving of approximately £10k per annum.

7.2.3 Local Authority, PV to DHW Stakeholder

It was agreed that SPEN would fund a suitably qualified electrician to undertake installation of a number of PV to DHW systems in local authority owned dwellings. Prior to progressing with the installations the local authority had to write to the tenants selected for the trial to seek the agreement of the tenants to have the technology installed and be part of the trial. SPEN also agreed to install a smart meter in each of the dwellings in order to monitor and evaluate the PV to DHW system. Whilst it was only a relatively small sample, the monitoring confirmed that the system's perform well over the summer 2015 period, reducing export in many cases and directly saving the local authority tenants money on their bills.

8 Conclusion and recommendations

This report has presented the methodology, outcomes and key learning from the stakeholder engagement process developed to investigate the potential to reduce demand via energy efficiency interventions within the Industrial and Commercial (I&C) sector within three trial network areas.

The report 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.

The stakeholder engagement process has been challenging and whilst many of the original aims and objectives have been successfully delivered the process has unfortunately not been able to deliver the magnitude of peak load savings as originally targeted. That said, despite a relatively low number of stakeholders formally engaging with the project (a number of potential contributing factors have been raised in this report) the research was successful identifying opportunities within a broad mix of I&C stakeholders whom presented a relatively wide range of commercial activity / building types from which significant, and replicable, learning could be derived.

Key conclusions and learning are as follows:

- The engagement approach adopted in the project was time consuming and resource intensive. If starting the project today a different approach would be recommended i.e. one that would build on the learning from this project and, most importantly, capitalise on new legislation and emerging programmes including the Energy Saving Opportunity Scheme (ESOS) and DECC's Electricity Demand Reduction (ESR) pilot. The recommended approach would be to focus on selected interventions within specifically targeted user groups or building types, as opposed to a "whole-sector" engagement strategy adopted in this research which also considered a wider range of energy efficiency interventions.

- 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. Key reasons for this were deemed to be that stakeholders were generally unaware of DNO's and their role and responsibilities; there were difficulties in getting to speak to (/ engage with) relevant individuals; and, most importantly, at the early stages of the project (i.e. at initial engagement / pre-survey) it was not possible to: identify what cost effective energy efficiency opportunities were likely to exist at individual sites; clearly define what the SPEN offer to customers could be; or define how the SPEN offer would work in practice. It is therefore vitally important that any future DNO engagement strategy considers developing a number of pre-selected intervention measures as this is likely to aid the engagement process and help achieve increase early stakeholder buy-in.

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- The Larger I&C customers that engaged with the project (and in particular those that were largely process driven) were generally already motivated to reducing energy costs and thus were generally well progressed in terms of interventions at their sites. This was particularly true for low cost, easy win measures and less so for complex, high cost, interventions which were also likely to be highly disruptive to business operations. Many smaller commercial organisations were deemed more likely to be less well progressed in terms of energy efficiency and thus potentially offer increased opportunity for load reduction although being smaller the opportunities are unlikely to be at significant scale, meaning that lots of smaller companies will need to be engaged. The project team had difficulty in engaging with smaller organisations during the project. Energy efficiency was unfortunately not high on the agenda for some organisations, particularly those who rented their premises.

- All of the organisations welcomed the engagement, surveys and provision of authoritative and independent advice provided as part of the project although such an approach is clearly not sustainable in the longer term. The introduction of the ESOS Regulations[6] requiring large companies to identify energy saving opportunities for all of their significant energy uses by December 2015 (and every four years thereafter); will however help overcome this barrier and will result in those organisation bound by the new regulation to be significantly better informed as to cost effective energy opportunities at their site.

- In many cases intervention measures that can reduce peak demand will also result in a reduction in overall energy use, thereby 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 is therefore critically important to focus future engagement activities on opportunities that are “win-win”. Projects also need to be low risk and present a relatively quick payback. I&C stakeholders typically required a payback on internal investment of between 2 and 5 years.

- Common measures typically offering the best “£/kVA reduction” and good customer energy savings were identified as: (non-essential) load shedding; voltage reduction (at sub-station level); low energy lamp replacements; variable speed drives; lighting controls upgrades and light fitting and lamp replacements; and energy system controls upgrades (e.g. improved controls, occupancy linked ventilation controls, air conditioning/chiller plant controls, comfort cooling controls, etc.)

- A lack of funding to undertake feasibility studies in to energy efficiency opportunities and/or 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 detailed investigation.

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

- Detailed feasibility studies were completed at six key sites and approximately £430,000 worth of works was identified. The scale and nature of these opportunities are considered to be typical for similar buildings owned / managed by other I&C stakeholders. The identified works offered the potential for a peak load reduction of approximately 273 kVA and presented an approximate annual energy saving to customers of over 2 million kilowatt-hours resulting in a simple payback of approximately 2.5 years and a CO_2 emissions reduction of approximately 641 tonnes per year.
- The measures identified ranged from £997 to £2,143 per kVA peak reduction. This assumed no customer contribution (which would make the cost effectiveness more attractive) and took no account of indirect impacts such as customer energy savings or emissions reduction. These interventions, and their costs, are not comprehensive as they are based on information from a small sample of sites that were surveyed thereby offering potential to be further developed. The report also highlights that these findings related to sites belonging to two stakeholders for which energy efficiency was already a high priority. As a result, the findings were deemed to be more representative of a change in energy performance from “average” to “best” practice. Many sites are likely to offer potential for improving performance from a “poor” practice starting point and the report therefore recommends that any future engagement strategy focuses on identifying and engaging with these parties.
- Given that a limited project budget was available priority was applied to trialling measures that were relatively straightforward to implement on site, offered good cost effectiveness in terms of £/kVA reduction, and which offered maximum learning / replication potential.
    - A stakeholder operating multiple educational sites guaranteed that they would provide match funding towards interventions. A range of variable speed drive, local cooling controls and lighting controls opportunities were agreed to be progressed presenting approximately 70 kVA reduction for a total installed cost of approximately £78k. This equated to £1,126/kVA reduction when fully funded, and £563/kVA with the 50% customer contribution.
    - A large hotel site offered approximately 50 kVA reduction (across a range of variable speed drives, cooling and ventilation system controls) for an installed cost of approximately £29k. This equates to £577/kVA reduction when fully funded, and £289/kVA with a 50% customer contribution. Unfortunately, this stakeholder declined to progress despite a very attractive estimated energy saving of approximately £10k per annum.
    - A number of PV to domestic hot water system were also installed in dwellings as a means of combatting over-voltage from distributed PV export as this presents significant issue for SPEN during the summer in one of the trial areas.

It is recommended that:

- SPEN take cognisance of the project learning, new ESOS legislation and emerging learning from DECC’s EDR so that any future I&C stakeholder engagement strategy (and intervention measure offerings) is developed to maximise on the opportunities presented by these new initiatives e.g. this should include reviewing the interventions being progressed via EDR and the £/kVA costs being offered through that programme so that these can be used to steer the engagement and delivery strategies and help set the limits of any SPEN contributory funding of interventions in the future.

- Any future engagement strategy focusses on offering only the most cost-effective intervention measures and that these are pre-selected prior to start of any engagement strategy in order to aid the engagement process, provide clarity to customers and thus help achieve increased stakeholder buy-in. In addition, any future strategy should focus on targeting specific building types and customers deemed most likely to present the best opportunities; as has been identified by this research.
- That any SPEN energy efficiency service offering seeks to engage with customers whose current energy efficiency performance is below average, as this offers more potential and thus better cost effectiveness for implementing interventions. SPEN should look to make use of customer's ESOS audits and opportunity identification reports as a low cost way to inform this assessment and vet opportunities.

Further considerations, and more detail in relation to ESOS and EDR, are presented in BRE Report 303592 – Energy Efficiency Business Case and Plan for Roll-out.

Appendix A Network Mapping of the Trial Areas

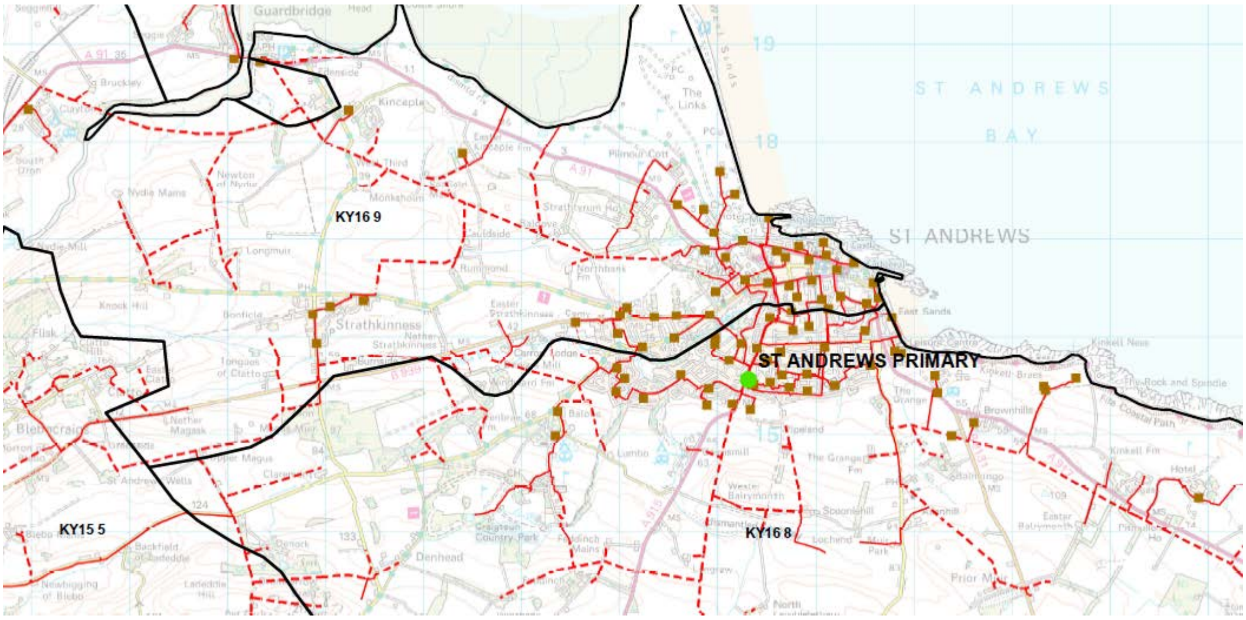
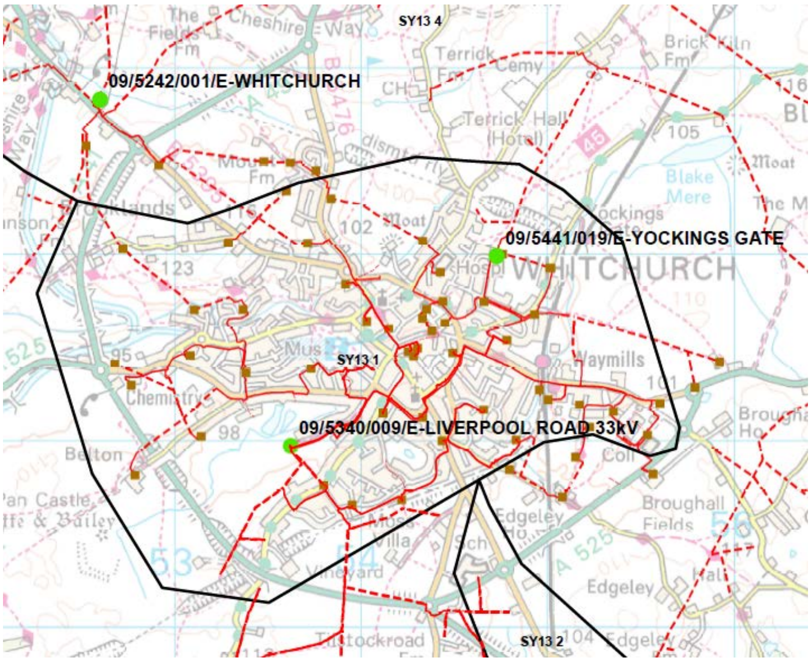


Figure A1: Network Map showing monitored secondary sub-stations - St Andrews



A2: Network Map showing monitored secondary sub-stations - Whitchurch

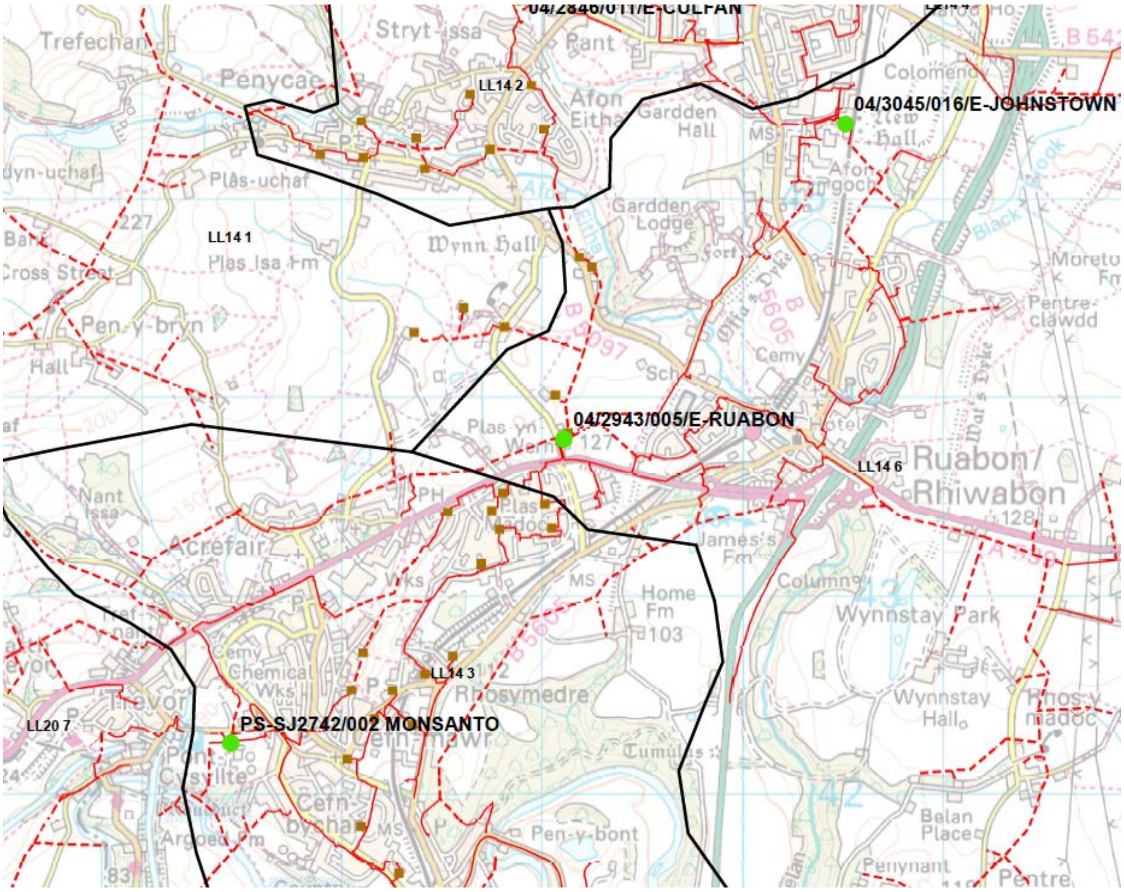


Figure A3: Network Map showing monitored secondary sub-stations - Ruabon

Appendix B Stakeholder list – St Andrews

ST. ANDREWS				10%
60	15	60	5	6
Category	**HH site**	**Contact**	**Mtg**	**Survey**
Public (LA)	y - multiple	y	y	y-multiple
Public (hospital)	y	y		
Public (other)		y		y-multiple
Public (emergency service)		y		
Educational	y - multiple	y	y	y-multiple
Educational		y		
I&C (utility)	y - multiple	y	y	
I&C (utility)	y	y		
I&C (transport depot)		y		y
I&C (transport depot)		y		
I&C (hotel / accom)	y	y	y	y
I&C (Hotel / Accom)	y	y		
I&C (Hotel / Accom)	y	y		
I&C (Hotel / Accom)	y	y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (supermarket)	y	y		
I&C (supermarket)	y	y		
I&C (supermarket)		y		
I&C (supermarket)		y		

Table B1: Stakeholder list – St Andrews (continued on next page)

Category	HH site	Contact	Mtg	Survey
I&C (retail)		y		
I&C (retail)		y		
I&C (retail)		y		
I&C (retail)		y		
I&C (retail)		y		
I&C (retail)		y		
I&C (finance)		y		
I&C (nursing home)		y		
I&C (nursing home)		y		
I&C (vetinary services)		y		
I&C (dental services)		y		
I&C (caravan park)	y	y		
I&C (caravan park)	y	y		
I&C (caravan park)		y		
I&C (caravan park)		y		
I&C (cinema)		y		
I&C (aquarium)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (sports)	y	y		y
I&C (sports)	y - multiple	y		
Place of worship		y		
Place of worship		y		
Place of worship		y		
Place of worship		y		
Place of worship		y		
Groups - Chamber of Commerce		y	y	
Groups - National Farmers Union		y		
Groups - FSB		y		

Table B1 (contd.): Stakeholder list – St Andrews

Appendix C Stakeholder list – Whitchurch

WHITCHURCH				7%
45	13	45	4	3
Category	**HH site**	**Contact**	**Mtg**	**Survey**
Public (LA)		y	y	
Public (other)		y		
Public (hospital)		y		
Public (sports)		y		
Educational	y	y		
Educational		y		
Educational		y		
Educational		y		
Educational		y		
I&C (utility)	y	y		y
I&C (food manuf. & distr.)	y	y	y	y
I&C (aluminium refinery)	y	y		
I&C (alloy production)	y	y	y	
I&C (cold storage & distribution)	y	y	y	y
I&C (manufacturing)	y	y		
I&C (manufacturing)	y	y		
I&C (recycling)		y		
I&C (supermarket)	y	y		
I&C (supermarket)		y		
I&C (supermarket)		y		
I&C (care home)	y	y		
I&C (care home)		y		
I&C (hotel / accom)	y	y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		
I&C (Hotel / Accom)		y		

Table C1: Stakeholder list – Whitchurch (continued on next page)

Category	HH site	Contact	Mtg	Survey
I&C (catering / public house)	y	not operating		
I&C (catering / public house)		y		
I&C (commerical - retail)	y	y		
I&C (commerical - service)		y		
I&C (commerical - service)		y		
I&C (commerical - service)		y		
I&C (commerical - service)		y		
I&C (commerical - retail)		y		
I&C (commerical - retail)		y		
I&C (commerical - retail)		y		
I&C (commerical - retail)		y		
I&C (commerical - retail)		y		
I&C (commerical - retail)		y		
I&C (commerical - retail)		y		
Groups - Chamber of Commerce		y		
Groups - National Farmers Union		y		
Groups - FSB		y		

Table C1 (contd.): Stakeholder list – Whitchurch

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Appendix D Stakeholder list – Ruabon

RUABON				5%
44	7	44	1	2
Category	**HH site**	**Contact**	**Mtg**	**Survey**
Public (LA)	y (multiple)	y	y	y (multiple)
Public (healthcare	y	y		
Public (other)		y		
Hous Assoc		y		
Hous Assoc (care home)		y		
I&C (utility)	y	y		y
I&C (manuf)	y	y		
I&C (manuf)	y	y		
I&C (waste management)	y	y		
I&C (sports)	y	y		
I&C (supermarket)		y		
I&C (care home)		y		
Educational		y		
I&C (hotel / accom)		y		
I&C (hotel / accom)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		
I&C (catering / public house)		y		

Table D1: Stakeholder list – Ruabon (continued on next page)

Category	HH site	Contact	Mtg	Survey
I&C (commerical - service)		y		
I&C (commerical - retail)		y		
I&C (commerical - service)		y		
I&C (Commerical)		y		
I&C (Commerical)		y		
I&C (commerical - retail)		y		
I&C (Commerical)		y		
I&C (commerical - service)		y		
I&C (commerical - service)		y		
I&C (commerical - service)		y		
I&C (Commerical)		y		
I&C (commerical - retail)		y		
I&C (Commerical)		y		
I&C (Commerical)		y		
I&C (Commerical)		y		
I&C (Commerical)		y		
I&C (commerical - service)		y		
I&C (Commerical)		y		
Place of worship		y		
Place of worship		y		
Place of worship		y		
Groups - Chamber of Commerce		y		
Groups - National Farmers Union		y		
Groups - FSB		y		

Table D1 (contd.): Stakeholder list – Ruabon

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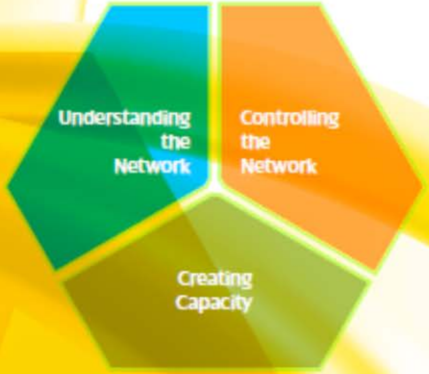
Appendix E Stakeholder communications – Project Flyer

SP ENERGY NETWORKS

Flexible Networks

Tier 2



As the UK embraces Low Carbon Technologies, more and more demands are placed on electricity networks. ScottishPower's Flexible Networks Project aims to find a more practical alternative than simply building new assets, to exploit and increase the existing network capacity.

How can we do this?

- **Determine** more accurately the capacity headroom by enhanced network monitoring.
- **Provide** incremental increases in headroom when required through a flexible and dynamic network.
- **Engage** stakeholders to establish how that headroom could be utilised in a safe, reliable and cost-effective manner.

What is the plan?

1. **Establish** a baseline to improve understanding of network usage and demands.
2. **Deploy** innovative network technology to improve network use, operation and control.
3. **Review** of outcomes, implementation and dissemination of learning.

The Trial Sites

Three sites have been identified with specific network issues reflecting the demands that may be placed on the network if there is an uptake of Low Carbon technologies, e.g. Electric Vehicles, Heat pumps, Photovoltaic panels, Wind or Combined Heat & Power microgeneration.

- St Andrews, Scotland - Growing load and generation requests in St Andrews are a significant area of concern with the lack of capacity available in the distribution network.

- Whitchurch, England - the economic development in this area is connecting additional demand on the network.

- Wrexham, Wales - Wrexham Council is installing over 3000 of their social housing stock with PV, giving rise to dispersed microgen issues on the network.

bre

The project goal

To create headroom of up to 20% at each of the three trial sites, which may defer further network investment for a significant number of years.

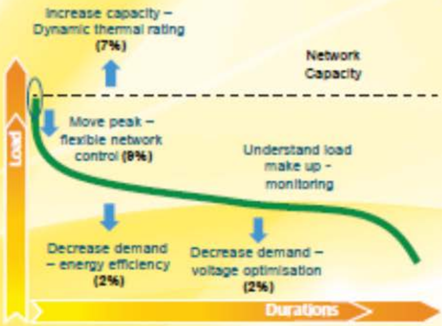
The 20% being achieved is based on the following build-up:

Flexible network control - 9% of peak load can be redistributed on the network at appropriate times.

Dynamic rating - 7% increase in capacity following site specific assessments.

Voltage optimisation - 2% reduction in demand by reducing voltage where appropriate.

Energy Efficiency - 2% reduction by reducing overall demand.



Project duration Jan 2012 to Dec 2014

Project value £6.4M (£3.6M LCNF funding)

Project Manager Martin Hill

Project Lead Engineers Dr A Collinson, Martin Wright, Kevin Smith

The Project partners

ScottishPower has teamed up with 4 partner companies who are supporting the aims of the project with their expertise in various fields.

nortech – *Supporting the monitoring data communications, storage and retrieval.*

University of Strathclyde Glasgow – *Supporting the development of analysis tools & software. Providing academic direction & review of the trials & learning.*

bre – *Providing the expert knowledge & experience for customer energy use and efficiency measures.*

tnei enterprise with energy – *Own IPSA power. Supporting the data analysis & development of software tools for future network modelling.*

spenergynetworks.com/innovation
SPInnovation@spenergynetworks.com

SP ENERGY NETWORKS

Appendix F Stakeholder communications – Introductory Letter

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June 2013

Our Ref. CT0591/CS

Dear Prospective Stakeholder

SP Energy Networks - 'Flexible networks for a Low Carbon Future' Project

Further to our recent telephone conversation I now provide further background information to formally introduce the 'Flexible Networks for a Low Carbon Future' project as well as details regarding next steps should you wish to engage with SP Energy Networks [1] and BRE Scotland[2] on this exciting, Government initiated, research project which could help realise significant advantages and savings in the way your organisation uses electrical energy and engages with the distribution network operator (DNO), SP Energy Networks.

Project Summary

The 'Flexible Networks for a Low Carbon Future' project is part of a £500m Government initiated Low Carbon Networks Fund[3] which aims to encourage electricity network operators to trial innovative new technologies, operating practices and commercial arrangements in order to improve their electricity distribution networks and inform them of changes that need to be made as Great Britain moves to a low carbon economy. The project aims to find a more practical alternative than simply building new assets; that is to exploit and increase the existing network capacity.

We are asking for your participation in this important trial as you have been identified as either a large consumer, or a targeted focus group, and are therefore an important stakeholder in one of the three exclusive trial areas, each of which present their own unique network constraint issues.

[1] http://www.spenergynetworks.co.uk/

[2] http://www.bre.co.uk

[3] http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/Pages/lcnf.aspx

BRE's Quality Management System is approved to BS EN ISO9001:2008, certificate number LRQ 4001063.

INVESTOR IN PEOPLE

A project flyer which provides more information on the Flexible Networks project and the inherent issues can be viewed here:
http://www.spenergynetworks.co.uk/innovation/documents/Flyer_FlexibleNetworks.pdf

What are the benefits to my organisation?
The aim of the study is to help provide the network operators with economic solutions to increase and enhance the capability of the networks via a combination of: flexible network control; dynamic ratings; voltage optimisation and energy efficiency. The following opportunities therefore exist for a significant number of key stakeholders (exact numbers to be determined as the process develops):

- Opportunity to engage with the network operator and be at the forefront of leading network supply solutions;
- Reduce the need for expensive infrastructure upgrades to enable new connections or increase in load capacity of existing connections.
- Enable increased generation requests (i.e. for small scale renewable energy generators including photovoltaics) without significant network strengthening.
- Opportunity to have a free site energy audit evaluation completed by BRE experts.
- Potential to have some of the identified opportunities (energy efficiency improvement measures, load management opportunities, smart/flexible control opportunities etc.) to be implemented in practice and/or specialist advice provided to customers on these opportunities including signposting to relevant grant schemes, low interest loans or other available incentive measures.

In addition, the project learning is aimed to better inform the network operator about the network, the buildings and systems served by it and their future needs. This knowledge will, in turn, enable the operator to develop 'flexible' control of the network that will allow its existing capacity to be used more effectively. As noted above, this will enable growing load and generations requests to be facilitated and will also help offset the need for significant strengthening of the network which is currently restricting wider economic growth and development in the trial areas.

Who are BRE Scotland and what it their role?
BRE Scotland is a project partner to SP Energy Networks. BRE is an internationally recognised centre of expertise in all aspects of the built environment with a long history of top quality research and consultancy. BRE Scotland is responsible for engaging with stakeholders as well as the assessment of building related improvement and energy efficiency measures.

Key members of the BRE Scotland delivery team are as follows:
- Laura Birrell, Director of Operations, BRE Scotland – Project Director
- Colin Sinclair, Senior Consultant, BRE Scotland – Project Manager / delivery
- Niall McClelland, Katy Hunter, Adam Duff, Consultants, BRE Scotland – Project delivery

What do I need to do/contribute to take part?
The success of the project depends upon the team obtaining consumer insight into the network and any potential future issues. It is also vitally important that BRE obtain information on the nature, type and size of loads being managed by customers so that we can better understand customer's specific issues, and opportunities, as well as develop an understanding of the overall network performance.

We would therefore ask stakeholders to provide some basic information regarding the buildings/loads served from the network in order for us to assess energy demand and supply profiles, future energy requirements and discuss potential interaction measures. We offer a number of ways in which BRE Scotland can interact with you to complete this process and this ranges from telephone consultations, postal questionnaires or face-to-face interviews (for large consumers / multi-building or site / half hourly metered consumers only). Further information on this process, and next steps, is provided in the enclosed information sheet titled 'Flexible Networks for a Low Carbon Future – outline process'.

Any data obtained as part of this process will be held by BRE and treated in accordance with BRE's data protection policy, a copy of which is available upon request.

Next Steps

If you are being provided with this letter then you should have already been contacted by BRE Scotland, in which case we would now like to confirm your acceptance to engaging with the project by asking you to providing some feedback information using the supplied questionnaire (please note that there are two different questionnaires; one for consumers and one dedicated to targeted focus group representatives – however you will have been provided with the one which suits your situation).

We wish that you can take the time to complete the questionnaire to help inform this important research project. The questionnaires and telephone discussions will also allow BRE to initially assess the extent of any opportunities that may exist at your site.

Completed questionnaires should be returned via any of the mediums below:

Scanned copies by email to:	e: eastkilbride@bre.co.uk
Faxed to:	f: 01355 576210
Or by posting to:	BRE Scotland Orion House Bramah Avenue East Kilbride Glasgow G75 0RD

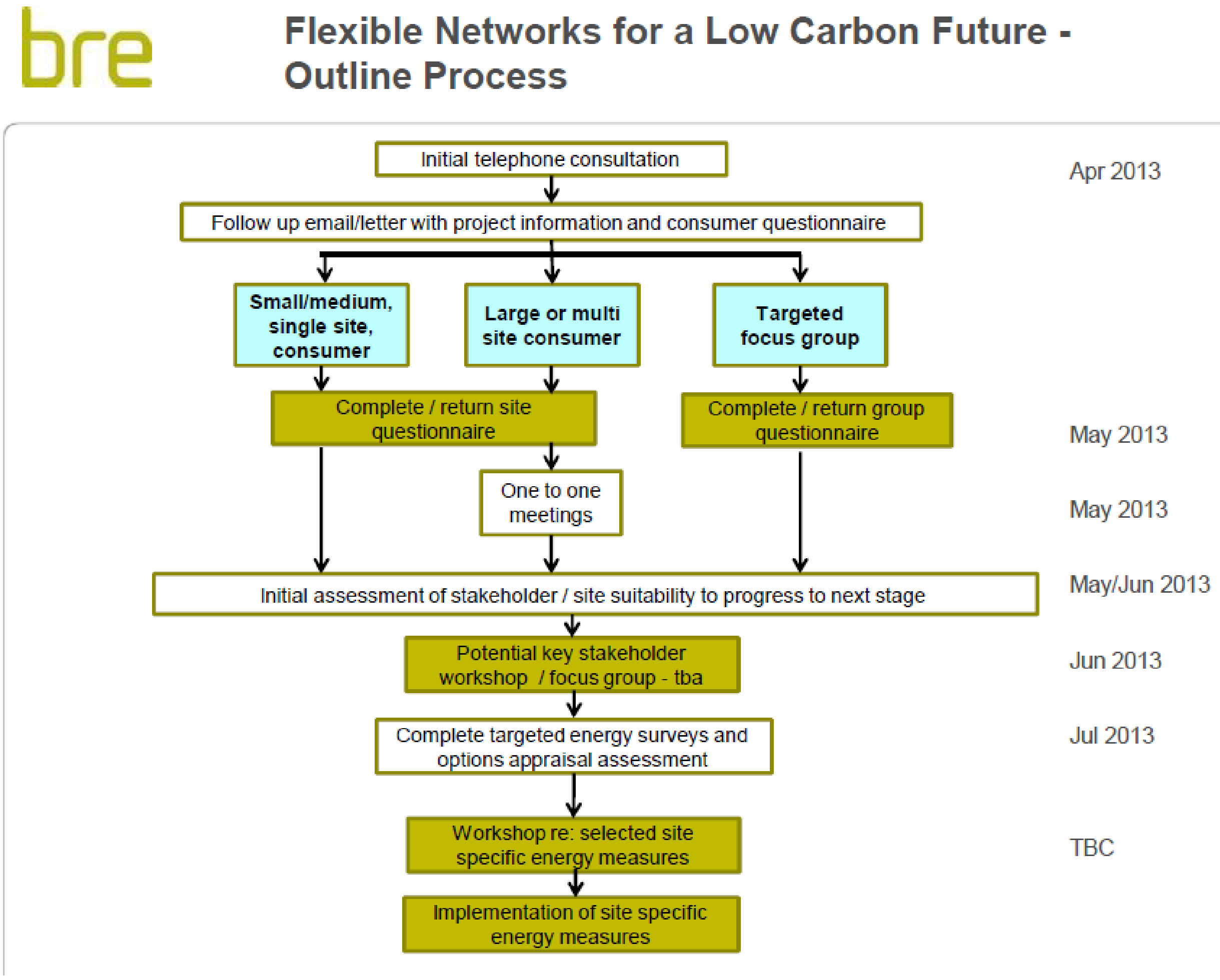
If you are unable to answer all questions on please do not worry however should you have any difficulties or would like to raise any other specific issues that you feel would like to raise to our attention please either discuss these with the BRE representative that completed your initial consultation or direct them to myself at the details below.

BRE Scotland would like to thank you in anticipation of your contribution to this exciting research project. We hope that you see the benefits that this project can bring and please do not hesitate to contact a member of the project team should you have any queries.

Yours sincerely

C. Sinclair

Colin Sinclair
Senior Consultant
For and on behalf of BRE
Telephone: +44 (0) 01463 667349
Email: sinclairc@bre.co.uk


Flexible Networks for a Low Carbon Future - Outline Process
Initial telephone consultation
Apr 2013
Follow up email/letter with project information and consumer questionnaire
Small/medium, single site, consumer
Large or multi site consumer
Targeted focus group
Complete / return site questionnaire
Complete / return group questionnaire
May 2013
One to one meetings
May 2013
Initial assessment of stakeholder / site suitability to progress to next stage
May/Jun 2013
Potential key stakeholder workshop / focus group - tba
Jun 2013
Complete targeted energy surveys and options appraisal assessment
Jul 2013
Workshop re: selected site specific energy measures
TBC
Implementation of site specific energy measures

Appendix G Stakeholder communications – Questionnaire

Flexible Networks for a Low Carbon Future - Questionnaire

(please complete a separate questionnaire for each supply connection)

Contact Name   Company

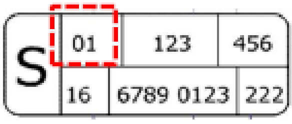
Contact Telephone

Site details   Address   Site Postcode

Building Type:
Please insert either your Standard Indiustrial Classification (SIC) code: [ ]
and / or
The CIBSE building type reference (from page 3): [ ]

Total Floor Area (m2) [ ] m2   Number of Staff [ ]

Building Load Profile Class? - please circle
01   02   03   04   05   06   07   08
(NB: load profile class is detailed on the Meter Point Administration Number (MPAN)
i.e.



Location / name of sub-station (if known):

Consumption Data   Y/N
Is electrical consumption data freely available to inform the study / identification of upgrade opportunities? [ ]

Key Performance Indicators (12 months)
ELEC: kWh/annum
or
ELEC: kWh/m2/annum   please provide total floor area above
or
ELEC: kWh/person/annum   please provide number of staff above

Which of these electrical loads are on site?   General time of use?

	on -site	09:00-17.30	07:00-18.00	00:00-23.59	Other (please state)
Lighting					
Small Power					
Heavy Power					
Elec Htg-Storage					
Elec Htg-direct					
Cooling					
Process					
Other -please state					

Do these loads vary significantly with season

	Y/N	increased in summer	increased in winter	other-please give details
Lighting				
Small Power				
Heavy Power				
Elec Htg-Storage				
Elec Htg-direct				
Cooling				
Process				
Other -please state				

How are these loads expected to change over the next 2-5 years

	largely constant	% increase 0-10	10-25	other-state	% decrease 0-10	10-25	other-state
Lighting							
Small Power							
Heavy Power							
Elec Htg-Storage							
Elec Htg-direct							
Cooling							
Process							
Other -please state							

Are there opportunities for load management of interruptable / non-essential loads?

	interuptable? Y	non-interuptable? Y	unsure? Y	details
Lighting				
Small Power				
Heavy Power				
Elec Htg-Storage				
Elec Htg-direct				
Cooling				
Process				
Other -please state				

Is there a large thermal capacity on site (e.g. thermal store, large domestic hot water cylinder)?

Are there any on-site renewables?	Y	Capacity (kW)	Not currently but are considering in the futur
PV			
Wind turbine(s)			
CHP			
Heat pump			
Solar thermal			
Biomass			

Are there an electric vehicles on site?	Y	Qty	General time of charge / other details

Please provide details of any (i) planned or (ii) known / "wishlist" efficiency improved measures not yet implemented .

Please provide any other details which you think may be relevant

Thank you for your time. Please return completed questionnaires to:

Scanned copies by email to: eastkilbride@bre.co.uk

By Fax to: 01355 576210

By post to: BRE Scotland, Orion House, Bramah Avenue
East Kilbride, Glasgow, G75 0RD

Chartered Institution of Building Services Engineers (CIBSE) - Building Classifications

Please insert the associated reference number in to the appropriate cell on p1 of the questionnaire

		REF
Catering:	— fast food restaurants	1
	— public houses	2
	— restaurants (with bar)	3
	— restaurants (in public houses)	4
Entertainment	— theatres	5
	— cinemas	6
	—social clubs	7
	— bingo clubs	8
Education (further and higher)	— catering, bar restaurant	9
	— catering, fast food	10
	— lecture room, arts	11
	— lecture room, science	12
	— library, air conditioned	13
	— library, naturally ventilated	14
	— residential, halls of residence	15
	— residential, self catering/flats	16
	— science laboratory	17
Education (schools)	— primary	18
	— secondary	19
	— secondary (with swimming pool)	20
Hospitals:	— teaching and specialist	21
	— acute and maternity	22
	— cottage	23
	— long stay	24
Hotels:	— holiday	25
	— luxury	26
	— small	27
Industrial buildings:	— post-1995; £ 5000 m2	28
	— post-1995; >5000 m2	29
	— pre-1995; £5000 m2	30
	— pre-1995; >5000m2	31
Local authority buildings:	— car park (open)	32
	— car park (enclosed)	33
	— community centres	34
	— day centres	35
	— depots	36
	— sheltered housing	37
	— residential care homes	38
	— temporary homeless units	39
	— town hall (see also offices)	40
Ministry of Defence (MoD) buildings:	— aircraft hangars (heated)	41
	— junior mess	42
	— motor transport facilities	43
	— multi-occupancy accommodation	44
	— officers' mess	45
	— stores/warehouses (occupied)	46
	— stores/warehouses (unoccupied)	47
	— workshops	48
Offices:	— air conditioned, standard	49
	— air conditioned, prestige	50
	— naturally ventilated, cellular	51
	— naturally ventilated, open plan	52
Primary health care (general practitioners' surgeries and dental practices)		53

		REF
Public buildings:	— ambulance stations	54
	— churches	55
	— courts (Magistrates)	56
	— courts (County)	57
	— courts (Crown)	58
	— courts (combined County/Crown)	59
	— fire stations	60
	— libraries	61
	— museums and art galleries	62
	— police stations	63
	— prisons	64
	— prisons (high security)	65
Residential and nursing homes		66
Retail:	— banks and building societies	67
	— banks and building societies (all electric)	68
	— book stores (all electric)	69
	— catalogue stores	70
	— catalogue stores (all electric)	71
	— clothes shops	72
	— clothes shops (all electric)	73
	— department stores	74
	— department stores (all electric)	75
	— distribution warehouses	76
	— distribution warehouses (all electric)	77
	— DIY stores	78
	— electrical goods rental	79
	— electrical goods retail	80
	— frozen food centres	81
	— high street agencies	82
	— high street agencies (all electric)	83
	— meat butchers (all electric)	84
	— off licences (all electric)	85
	— supermarket (all electric)	86
	— post offices	87
	— post office (all electric)	88
	— shoe shops (all electric)	89
	— small food shops	90
	— small food shops (all electric)	91
	— supermarket	92
Sports and recreation:	— combined centre	93
	— dry sports centre (local)	94
	— fitness centre	95
	— ice rink	96
	— leisure pool centre	97
	— sports ground changing facility	98
	— swimming pool (25 m) centr	99
Light manufacturing		100
Storage and Distribution		101

bre

Appendix H Stakeholder communications – Follow up letter (for further investigation)

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bre

June 2014

Our Ref. CT0591/CS

Dear Sir / Madam

"Flexible Networks for a Low Carbon Future" project – An update

The aim of this letter is to update you on progress regarding the above project (being delivered by your local electricity Distribution Network Operator; **SP Energy Networks**), provide information on next steps, and formal feedback with respect to any surveys that the Building Research Establishment (BRE) may have undertaken on your site as part of the project activities.

The BRE surveys aimed to identify opportunities for energy efficiency measures that could help address the aims of the project (i.e. to increase headroom capacity within the existing electricity network infrastructure at peak times) whilst also offer potential for stakeholders to reduce their energy consumption, save costs, or benefit in some other useful way. Surveys have been completed in each of the three UK trial areas and a number of opportunities have been identified. We are pleased to advise that opportunities have been identified at your site which, with your continued engagement, we would now like to investigate progressing further. With this in mind SP Energy Networks and BRE have developed a process (as outlined below) to further investigate the feasibility of implementing measures at your site.

We also take this opportunity to enclose the following documents for more information:

- BRE Site Specific Feedback Report (if applicable)
- Appendix A: a list of current grant and/or low cost/interest free loan schemes and other energy efficiency initiatives
- Appendix B: a list of energy efficient performance specifications covering a range of common products and systems as highlighted during the surveys

…

BRE's Quality Management System is approved to BS EN ISO9001:2008, certificate number LRQ 4001797.

INVESTOR IN PEOPLE

As noted above, opportunities have been identified at your site which we would like to investigate further and ideally realise. The process for the next step is as follows:

- BRE will contact all stakeholders to discuss the findings of the Site Specific Feedback Report.
- BRE will seek permission from you (the stakeholder) for (i) your contact details and (ii) the BRE Site Specific Feedback Report to be provided to a selected Energy Supplier (i.e. an Energy Retailer) who offer specialist energy related technical services (including specialist feasibility, design and installation capabilities), to enable a specialist survey, design and costed feasibility study to be prepared which focusses on the opportunities identified at your site. The cost of this study will be borne by SP Energy Networks.
- Once the specialist, costed, feasibility study is completed a copy will be made available to you, BRE and SP Energy Networks. Thereafter, SP Energy Networks may be able to contribute funding to help install measures although this will be assessed on the relative cost effectiveness of the whole range of measures being investigated across the project.
- The Energy Supplier is likely to be able to undertake the installation works however there will be no obligation on you (the stakeholder) to progress the works with the Energy Supplier. If however SP Energy Networks offer a financial contribution to installing of measures then the works will need to be carried out by the Energy Supplier.

NB: The Energy Supplier does not have to be your current supplier and progressing with the specialist survey and/or installation works does not mean that you have to change your supplier. The survey and works can be completed independently of any existing supply arrangement that you may already have in place with your current supplier. However, should the Energy Supplier be your current supplier, then this may enable additional benefits such as opportunities for alternative funding mechanisms (e.g. funding/part funding of measures being able to be spread across electricity bills over time) or additional co-funding potentially being available via your supplier. Further information on these opportunities will be identified in the Energy Supplier specialist feedback report where relevant.

The range of measures being investigated within the project includes, but is not restricted to, the following:

- Optimisation of Building Energy Management Systems (BEMS)
- Optimisation of refrigeration plant controls, operation and management
- Optimisation of building and system controls
- Voltage optimisation
- Variable speed drives
- Lighting replacements and upgrades

We will shortly be contacting stakeholder to discuss the above in more detail and to seek your express permission to pass relevant details to a relevant Energy Supplier. In the meantime, should you have any queries please do not hesitate to contact me.

Yours sincerely

C. Sinclair

Colin Sinclair
Senior Consultant
For and on behalf of BRE
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Appendix I Stakeholder communications – Follow up letter (unsuccessful)

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W www.bre.co.uk

14 October 2014

Our Ref. CT0591/CS

Dear Sir / Madam

"Flexible Networks for a Low Carbon Future" project – An update

The aim of this letter is to update you on progress regarding the above project (being delivered by your local electricity Distribution Network Operator; **SP Energy Networks**) and provide feedback with respect to any surveys that the Building Research Establishment (**BRE**) may have undertaken on your site as part of the project activities.

The BRE surveys aimed to identify opportunities for energy efficiency measures that could help address the aims of the project (i.e. to increase headroom capacity within the existing electricity network infrastructure at peak times) whilst also offering potential for stakeholders to reduce energy consumption, save costs, or benefit in some other useful way. Surveys have been completed in each of the three UK trial areas and some opportunities have been identified for further investigation. Your site has not been selected for further investigation. Only limited funds were available to investigate and fund opportunities therefore we are only able to progress the most cost effective opportunities.; Whilst it has not been possible to progress with all sites as part of the Flexible Networks project, we have identified good opportunities for energy efficiency in a number of areas and would encourage you to consider these further.

The following documents are enclosed for more information:

- BRE Site Specific Feedback Report (if BRE conducted a survey at your site)
- Appendix A:
    - a list of energy efficient performance specifications covering a range of common products and systems, as either highlighted during the surveys, or which are likely to be relevant to a number of stakeholders.

...

BRE's Quality Management System is approved to BS EN ISO9001:2008, certificate number LRQ 4001797.

INVESTOR IN PEOPLE

- Appendix B:
  - a list of current grant and/or low cost/interest free loan schemes and other energy efficiency initiatives that will hopefully serve as a useful reference document when considering developing any of the opportunities listed in the BRE feedback report or any other energy efficiency opportunity that may exist at your site.
- Appendix C:
  - An energy efficiency lighting refurbishment checklist that will hopefully serve as a useful reference document when considering undertaking lamp replacements, lighting refurbishment or controls upgrades.

For your information the following opportunities are being further investigated and developed, at selected sites, in subsequent stages of the project:

- Optimisation of Building Energy Management Systems (BEMS)
- Optimisation of building and system controls
- Trigeneration (combined cooling, heating and power generation)
- Voltage optimisation
- Variable speed drives
- Lighting replacements and upgrades
- Control systems to maximise on-site use of renewable energy generation

Further information on the overall outcomes of the study will be published in due course. You can keep up to date with developments on the Flexible Networks for a Low Carbon Future website:
http://www.spenergynetworks.co.uk/pages/flexible_networks_for_a_low_carbon_future.asp

On behalf of **SP Energy Networks** and BRE we would like to thank you for participating in the project. We hope that you find this information useful and hope that you have found your involvement in the project to be worthwhile.

Should you have any queries in connection with this letter please do not hesitate to contact me.

Yours sincerely

C. Sinclair

Colin Sinclair
Senior Consultant
For and on behalf of BRE
Telephone: +44 (0)1355 576200
Email: sinclairc@bre.co.uk

Appendix J Follow up communication – supporting information 1: "Appendix A: Performance Specifications for Energy Efficient Equipment"

(NB: these specification were produced in December 2013)

Heating

Electric Water Boilers

New electric water boilers or electric Combined Primary Storage Unit (CPSU) should be installed in a suitable cupboard, such as an airing cupboard in which the householder's hot water cylinder is located, with sufficient circulation space to allow for installation of pressurisation tanks, pumps, mixing valve, temperature relief valves, discharge pipe and the pipework and its insulation. Further, there must be ease of access for maintenance in accordance with the manufacturers written instructions.

Systems may be:

- an unvented, partially or fully sealed, electric water boiler, with associated mixing valve, pump and pressurisation tanks provided separately by the manufacturer and installed on site, or
- a sealed electric Combined Primary Storage Unit (CPSU) which will be complete with all operating, safety and commissioning controls, expansion vessel, pumps, mixing valve, backflow prevention valve and pressure regulator. Some CPSUs have a permanent facility for the automatic filling of the appliance and sealed heating system.

Boilers must be suitable for minimum cold water pressure measurements taken at the dwelling prior to, and on installation. If the minimum water pressure is deemed to be unsuitable for an electric water storage boiler or electric CPSU, then a standard electric storage heating system with a direct hot water cylinder may be offered as an alternative. In such circumstances, the system must adhere to performance specification for Electric Storage Heating Systems.

The electric water boiler or electric CPSU should have a sufficient kilowatt output to meet the above design temperatures when the external temperature is -1^{o}C. The boiler must be sized in consideration with the capacity of thermal storage provided so that satisfactory heating and hot water performance is obtained using Economy 10 hour or 24 hour off peak tariff.

Electric water storage boilers or electric CPSU systems should be designed to accept teleswitching.

All specified electric water boiler or electric CPSU units must meet the criteria set out below, be approved by the Water Research Council, carry the European Approval mark (CE) and have a current and comprehensive Quality Management System covering the manufacturing process, distribution and customer care. The electric water storage boiler or electric CPSU units must be installed in accordance with all relevant legislation, regulations, and in particular, the relevant current Building Regulations/Standards, BSI standards, good practice and manufacturers' written instructions.

Efficient Heating Controls

Non-domestic buildings

As the output of the boiler increases, the controls requirement increases.

A boiler of less than 100kW should be installed with timing and temperature controls (in zones where the building area is greater than 150m^2) and weather compensation (except where constant temperature supply is required).

A larger boiler of less than 500kW should be fitted with optimal start/stop controls with night set-back (or frost protection outside occupied periods) and two-stage high/low firing facility (or multiple boilers with sequence controllers).

Individual boilers larger than 500kW require fully modular burner controls rather than two stage firing.

Dwellings

Controls for a fossil-fuel fired wet heating system:

- Boiler Interlock (so that boilers and pumps do not operate when there is no demand for heat);
- Time and temperature control of space heating;
- Separate zoning for heating and hot water each of which must serve an area of no more than 150m^2;
- Separate time control of hot water (other than where provided by instantaneous heaters);
- Temperature control of hot water.

Controls for electric storage heaters:

- Manual charge control – adjusted by user;
- Automatic charge control – using internal or external temperature sensors;

Heating System Circulators

Circulators (for both domestic and non-domestic installations) should be labelled for energy efficiency in accordance with the Europump[7] labelling scheme and have a rating in the range A-G. Motors rated at more than 750W should be fitted with or controlled by an appropriate variable speed controller.

Heat Pumps

Performance levels for heat pump systems should be tested in accordance with the requirements set out within the following standards:

Air Source Heat Pumps (ASHP)	BS EN 14511 – Air conditionedrs, liquid chilling packages and heat pumps with elevctrically driven compressors for heating and cooling: test methods
Ground Source Heat Pumps (GSHP)	IDO13256-2 – Water source heat pumps – testing and rating for performance - water-to-water and brine-to-water heat pumps

[7] Further information is available from www.bpma.org.uk

The Seasonal Performance Factor (SPF) for all heat pump systems shall be assessed in accordance with the standard conditions within BS EN 15450 Tables C1 and C3.

Additional guidance on the design of heat pump systems is provided in BS EN 15450: Heating systems in buildings – design of heat pump systems.

Air Source Heat Pumps

Air source heat pumps use an electrically driven refrigeration system to transfer heat from outside air into a heating system. They can be used to provide space heating in a wide range of buildings, and some products also are able to provide cooling by reversing the refrigerant flows around the product.

Products should meet the performance criteria set out in the table below for:

- Coefficient of Performance (COP) across the range of connected capacities and including 100% (full) load in heating mode.
- Energy Efficiency Ratio (EER) across the range of connected capacities and including 100% (full) load in cooling mode, where the product is designed to provide cooling.

Performance thresholds for:	**Heating mode (COP)**	**Cooling mode (EER)**
Air to water heat pumps: Heating Capacity <= 20kW	> 4.00	> 3.10
Air to water heat pumps: Heating Capacity > 20kW	> 3.80	> 3.00
Air source: packaged heat pumps	>3.20	>2.80
Single-split heat pump driven air curtains	>2.80	>2.80
Heat pump driven air curtain units for multi-split (including VRF) heat pumps	>3.00	>3.00

Water Source Heat Pumps

Water source heat pumps use an electrically driven refrigeration system to transfer heat from an internal water loop into the air within the space to be heated. They can be used to provide space heating in a wide range of buildings, and some products also are able to provide cooling by reversing the refrigerant flows around the product.

Products should meet the performance criteria set out in the table below for:

- Coefficient of Performance (COP) across the range of connected capacities and including 100% (full) load in heating mode.
- Energy Efficiency Ratio (EER) across the range of connected capacities and including 100% (full) load in cooling mode, where the product is designed to provide cooling.

Performance thresholds for:	**Heating mode (COP)**	**Cooling mode (EER)**
Water source: single/dual/multi- split (non-VRF) heat pumps	>3.70	>3.30
Water source: split and multi-split variable refrigerant flow (VRF) heat pumps	>4.10	>3.50

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Lighting

Replacing old lighting with modern fittings that include high-frequency electronic ballasts, high-efficiency tubes and high-efficacy reflectors can significantly reduce energy consumption.

Lighting ballasts is the generic term for electrical or electronic components that are required to control the current passing through fluorescent discharge tubes. These ballasts dissipate energy themselves and can affect the light output efficiency of the tube itself.

These measures are particularly relevant to non-domestic installations, although low-output fluorescent lamps can be used successfully in domestic situations, with the lamps lasting up to 12 times longer than the equivalent standard incandescent lamp. Low-energy lamps such as compact fluorescents generally have an average light output equivalent to five times their power consumption, e.g. a low-energy lamp consuming 15W of power will have a light output in the region of 75W.

<u>Dwellings</u>

Low energy light fittings should have lamps with a luminous efficacy greater than 45 lamp lumens per circuit-watt and a total output greater than 400 lamp lumens (excluding light fittings whose supplied power is less than 5 circuit-watts).

External lighting for dwellings should be either:

- Lamp capacity not greater than 100 lamp-watts per fitting and automatically controlled by daylight sensors and occupancy detection, or
- Where manually operated, lamp efficacy greater than 45 lumens per circuit-watt and automatically controlled by daylight sensors

<u>Non-dwellings - general lighting</u>

Average initial efficacy should be not less than 55 luminaire lumens per circuit-watt for internal lighting, not less than 22 lamp lumens per circuit-watt for external lighting.

The various types of lighting for non-domestic buildings are:

Lighting products should:

- Have a luminaire efficacy (i.e. lighting efficiency) that is greater than, or equal to, the thresholds set out in the tables below, when tested after 100 hours of continuous operation.
- Have a power factor that is greater than, or equal to, 0.7 at all levels of product light output.

Category (high efficiency lighting units with CRI>=80 OR with lamp rated power less than 200 Watts per lamp)	**Minimum luminaire efficacy (in luminaire lumens per circuit watt)**	
	With dimmer and photocell control	Without dimmer and photocell control
Amenity, accent and display lighting units	>= 60	>= 60
General interior lighting units using downlighting (DLOR/LOR>=0.9)	>= 60	>= 65
General interior lighting units using uplighting (DLOR/LOR<0.1)	>= 75	>= 80
General interior lighting units using combined up and down lighting (DLOR/LOR>=0.1 and<0.9)	>= 75 – (15 x DLOR/LOR)	>= 80 – (15 x DLOR/LOR)
Exterior area lighting units	>= 65	>= 65

Exterior floodlighting units	>= 65	>= 65

Category (high efficiency lighting units with CRI<80 AND with lamp rated power greater than or equal to 200 watts per lamp)	**Minimum luminaire efficacy (in luminaire lumens per circuit watt)**	
	Lamp Watts >= 200 and < 500 per lamp	Lamp Watts >= 500 per lamp
General interior lighting units using downlighting (DLOR/LOR>=0.9)	>= 85	>= 105
General interior lighting units using uplighting (DLOR/LOR<0.1)	>= 105	>= 130
interior lighting units using combined up and down lighting (DLOR/LOR>=0.1 and <0.9)	>= 105 – (20 x DLOR/LOR)	>= 130 – (25 x DLOR/LOR)
Exterior area lighting units	>= 85	>= 105
Exterior floodlighting units	>= 85	>= 105

(NOTE: The Light Output Ratio (LOR) is the ratio of the light emitted by the unit to that emitted by the bare lamp(s). The Downward Light Output Ratio (DLOR) is the ratio of the light emitted by the unit in a downward direction to that emitted by the bare lamp(s) in any direction. Thus for this type of lighting, upward light emitted by the unit does not count towards its light output)

Replacement Lamps

Replacement lamps for existing installations shall have a lamp luminous efficacy equal to or greater than the minimum efficacy of the relevant energy class given in the table below:

Type of lamp	**Relevant energy class**
Tungsten halogen lamps	C
Compact fluorescent lamps without integral ballast	B
Globe shaped, pear shaped, reflector type or chandelier type compact fluorescent lamps with integral ballast	B
All lamps other than halogen lamps with colour rendering index Ra>=90	B
All other compact fluorescent lamps with integral ballast	A
15W T8 tubular fluorescent lamps, and miniature tubular fluorescent lamps	B
Circular lamps	B
Other tubular fluorescent lamps	A
All other lamps including LEDs and discharge lamps	A

The latest definition of energy efficiency class should be used. Energy efficiency is currently defined in Annex IV to Commission Directive 98/11/EC.

Installed Lighting Loads (type of building)

Where lighting is to be installed throughout a building, the maximum lighting power consumed in the whole building, divided by its total floor area, must not exceed the following values:

Type of building	**Lighting power density W/m^2**
Car park	2.5
Court	14
Exhibition space, museum	9
Fire station	12
Further education	13
Hospital	12
Library	12
Office (mainly cellular)	13
Office (mainly open plan)	11
Police station	14
Post office	14
Prison	9
Public hall	9
Residential	11
Residential (communal spaces only)	6
School	8
Sports centre	9
Town hall	13

A calculation provided by the lighting designer showing the total power consumed by the lighting, including lamps, ballasts, sensors and controls, divided by the total floor area of all the indoor spaces in the building. The lighting designer should also show that the lighting meets the relevant performance standards in EN 12464-1, equivalent national standards or best practice guides, or those set by the public authority. Depending on the type of space and its requirements, these may include illuminance, uniformity, control of glare, colour rendering and colour appearance.

Installed Lighting Loads (type of space)

Where lighting is to be installed in an individual space or part of the building, the maximum lighting power consumed in the space, divided by its total floor area and by its illuminance in units of 100 lux, must not exceed the following values:

Type of space	Normalised lighting power Density (W/m^2/100 lux)
Bedrooms	7.5
Canteens	3.5
Car parks	2.2
Circulation inc lifts, stairs	3.2
Conference rooms	2.8
Gyms	2.8
Halls	2.8
Hospital wards and examination rooms	4
Kitchens (domestic)	5
Kitchens (restaurants)	2.8
Laboratories	2.8
Libraries	3.2
Lounges – large area	6
Lounges – small area	7.5
Offices (open plan)	2.3
Offices (cellular)	3
Plant rooms	3.2
Post rooms/ switchboards	3.2
Prison cells	4
Reception	4
Rest rooms, toilets, bathrooms	5
Retail	3.5
School classrooms	2.3
Store rooms	3.2
Waiting rooms	3.2

Lighting in infrequently occupied spaces to be controlled by occupancy sensors which turn off the lighting after the space becomes unoccupied, unless this would endanger safety or security.

Lighting in spaces which are unoccupied at night or at weekends, and where the lighting could be left on by mistake, to be fitted with either time switches or occupancy sensors to switch off the lighting after the space becomes unoccupied at night or at weekends.

Lighting in spaces with side windows to be controlled in rows parallel to the windows, so that rows nearer to the windows can be switched off separately.

Lighting in offices, conference rooms, school classrooms and laboratories to be controllable by the occupants using accessible switches in convenient locations.

Lighting in daylit circulation areas and reception areas to be controlled by automatic daylight linked control (either switching or dimming).

The lighting designer shall provide a schedule showing the lighting controls to be installed in each space, with product descriptions or manufacturers' datasheets showing their operation.

The lighting designer shall provide a calculation showing the installed lighting power of the entire installation (including that consumed by lamps, ballasts, sensors and controls) when those parts of the lighting that can be dimmed are fully dimmed, divided by the installed lighting power when all lamps are at full light output.

Lighting Controls

Lighting controls switch lighting on and off and enable electric lighting levels within specific areas to be adjusted, as and when required by changes in daylight or occupancy, or individual activities.

A wide variety of lighting control products are available, and these range from simple manual switches to fully automatic control systems that adjust electric lighting levels to reflect planned operating hours, occupation levels and the availability of daylight in specific areas.

The main categories of lighting controls are:

> **Time controllers** that automatically switch off lighting, or dim it down, at predetermined times. These should automatically switch the lighting off, or dim it down, at predetermined times of the day or week, or after a predefined interval. Where automatic dimming controls are used, they must be capable of reducing the power consumption of the controlled lamps by at least 50%[8].
>
> **Presence detectors** with associated switching controllers that monitor occupancy or movement of personnel, and automatically switch off lighting, or dim it down, when the area is unoccupied. These should automatically switch off the lighting, or dim it down, after the area has become unoccupied. Where automatic dimming controls are used, they must be capable of reducing the power consumption of the controlled lamps by at least 50%[1].
>
> **Daylight detectors with associated switching controllers** that monitor daylight availability, and automatically switch off lighting when daylight is sufficient to illuminate the area. These should monitor the availability of daylight and automatically switch the lighting off when sufficient daylight is available to illuminate the area[1].

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[8] Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballast and electronic control gear.

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They may also:

- Automatically switch on the lighting when daylight has fallen below the required level. Alternatively local users could be allowed to switch on the lighting manually, when daylight has fallen below the required level.
- Incorporate the facility for local users to manually override daylight detector/controller and switch the lights off at any particular instance.

Daylight detectors with associated dimming controllers that monitor daylight availability, and automatically dim lighting, by reducing its power consumption, to the level needed to sufficiently illuminate the area. These should monitor the availability of daylight and automatically dim the electric lighting to the level just needed to sufficiently illuminate the area, and be able to reduce the power consumption of the lamps being controlled by at least 50% through dimming[1].

Central control units that provide the facility to manage the overall operation of electric lighting installations that include some or all of the categories of lighting controls above.

The above categories of lighting controls may be installed either individually or in combination.

Reasonable provision is to locate lighting controls where they would encourage occupiers to switch off lighting when there is sufficient daylight or the space is not in use. Local controls should be no more than 6m away from the luminaire (or a distance of twice the luminaire height from the floor if this is greater). Dimming should be by reduction (and not diversion) of the power supply.

Ventilation Systems

Dwellings

Ventilations systems in dwellings include:

Background ventilators and intermittent extract fans
Passive stack ventilation
Continuous mechanical extract
Continuous mechanical supply and extract with heat recovery (MVHR)

Where mechanical ventilation systems are installed in dwellings these should:

- Follow the guidance in GPG268[i] and CLG publication*: Domestic ventilation compliance guide*[ii]
- Meet the minimum standards set out in Table 32 of the Domestic Building Services Compliance Guide, reproduced below

Minimum provisions for mechanical ventilations systems		
	Standards for new and replacement systems	Supplementary Information
Fan power	Mechanical ventilation systems should be designed to minimise electric fan power. Specific fan power (SFP) should not be worse than: I. 0.5 W/l/s for intermittent extract ventilation systems; II. 0.7 W/l/s for continuous extract ventilation systems; III. 0.5 W/l/s for continuous supply ventilation systems; IV. 1.5 W/l/s for continuous supply and extract with heat recovery ventilation systems.	
Heat	The heat recovery efficiency of balanced mechanical	

recovery efficiency	ventilation systems incorporating heat recovery should not be worse than 70%.	
Controls	Intermittent mechanical extract ventilation systems should be operated by local manual switches or automatically by a presence sensor. All other mechanical ventilation systems should have manual or automatic control of the boost facility.	***British Standards*** *BS EN 15232:2007 "Energy performance of buildings – Impact of building automation, controls and building management".*

Non domestic buildings

As a general rule, specific fan power (a measure of efficiency) should be as low as possible (below 2W/litre second is good practice in offices[iii]). The following table contains values for maximum specific fan power for a range of ventilation systems in new and existing buildings:

System Type	**SFP (W/l/s)**	
	new	**existing**
Central mechanical ventilation providing heating and cooling	1.8	2.2
Central mechanical ventilation system providing heating only	1.6	1.8
All other central mechanical ventilation systems	1.4	1.6
Zonal supply system where the fan is remote from the zone, such as ceiling void or roof-mounted units	1.2	1.5
Zonal supply system where the fan is remote from the zone	0.6	0.6
Zonal supply and extract system such as ceiling void or roof-mounted units serving a single room or zone with heating and heat recovery	2.0	2.0
Local supply and extract system such as wall/roof units serving a single area with heat recovery	1.8	1.8
Local supply and extract system such as window/wall/roof units serving a single area (e.g. toilet extract)	0.4	0.5
Other local ventilations units	0.6	0.6
Fan assisted terminal VAV unit	1.2	1.2
Fan coil units (weighted average)	0.6	0.6

Ductwork should have minimal leakage. A way of achieving this is to fabricate the ducts to the specifications given in HVCA DW144[iv]. SBEM gives better results for calculations if leak tests for ductwork and air-handling units meet the CEN classifications.

Ventilation systems should have effective controls, and as a minimum should meet the requirements set out in the following table:

System Type		Controls
Zonal system	Air flow control at room level	On/off time control
	Air flow control at air handler level	No control
	Supply temperature	No control
Local system	Air flow control at room level	On/off
	Air flow control at air handler level	No control
	Supply temperature	No control

Air Conditioning Systems

Dwellings

Fixed air-conditioning units for use in dwellings are required to be labelled with an energy efficiency classification graded from A to G[v]. A represents the most energy efficient and G the least.

For room air conditioners, the efficiency is indicated by the energy efficiency ratio (**EER**) which is the ratio of the cooling to its power consumption. The higher the EER rating, the more efficient the air conditioner. Minimum standards for new and replacement air conditioners should be as follows:

- Air-cooled air conditioners: EER>2.4 when operating in cooling mode
- Water-cooled air conditioners: EER>2.5 when operating in cooling mode
- Fixed air conditioners: energy efficiency classification equal to or better than class C[vi]

The installation should be carried out by a competent refrigeration and air conditioning engineer with a valid refrigerant handling certificate and the installer should be approved by the manufacturer or supplier of the equipment.

Pipes as well as ducts carrying treated air should be insulated, and enclosed in protective trunking where it is potentially subject to limit accidental damage.

Non-domestic Buildings

The initial emphasis is on reducing internal and external heat gains to minimise the requirement for air conditioning by reducing heat gains to cooling equipment, reducing air leakage from buildings, reducing air leakage from ductwork and providing suitable controls, appropriate commissioning and operating systems/instructions to enable energy-efficient operation of the building.

The minimum energy efficiency ratio (EER) for comfort cooling should meet the following minimum standards for the relevant system:

Type	Full load EER
Packaged air conditioners	2.5
Split and multi-split air conditioners	2.5
Variable refrigerant flow systems	2.5

Vapour compression chillers, water cooled, < 750kW	3.85
Vapour compression chillers, water cooled, > 750kW	4.65
Vapour compression chillers, air cooled, < 750kW	2.5
Vapour compression chillers, air cooled, > 750kW	2.6
Water loop heat pump	3.2
Absorption cycle chillers	0.7
Gas engine driven variable refrigerant flow	1.0

Controls for comfort cooling:

- Each terminal unit capable of providing cooling should be capable of time and temperature control either by its own or by remote controls.
- In any given zone simultaneous heating and cooling should be prevented by a suitable interlock

Design

Each zone (defined by activity, internal or external thermal gains or independent conditioning system) should be considered independently.

Improvements can be made in energy performance by using one or more of the following approaches:

- Consider the use of heat recovery systems;
- The system itself should not be overdesigned and should be optimised for each zone;
- The design should take into account ease of access for repairs and replacements of plant and the controls;
- Efficiency is optimised by use of variable speed driven primary and secondary pumps;
- Provide energy metering on newly installed plant;
- Primary pipes containing conditioned fluid should be as short as possible and well insulated to avoid heat gain of coolant;
- Consider increasing temperatures and differential temperatures (to reduce unwanted heat gain) and reducing flow rates (this reduces the energy used by pumps);
- Consider improving air flow in (less resistance) duct work (to reduce fan energy).

Controls

Individual cooling modules should be provided with controls that provide the most efficient operation of combined plant, and that the cooling systems are capable of time and temperature control at each terminal (either through integral or remote controls) and prevent simultaneous heating and cooling at each terminal.

- The system controls should be readily accessible so that they can be easily over-ridden and should run the plant only when it is required.
- Consider the use of refrigerant loss monitors; note that an annual check will be required when there is more than 3kg of refrigerant in the system.
- Table 2 of Part L2A gives beneficial adjustment factors for carbon dioxide emissions if automatic monitoring systems with alarms are incorporated into the design.

Commissioning

- Ductwork on systems served by fans with a design flow rate greater than $1m^3/s$ (and also ducts designed for BER to have leak rates lower than standard) should be tested for leakage (paragraph 5.19b of Part L2A) in accordance with procedures set out in HVA DW/143 and by a suitably competent person (e.g. a member of the HVCA Specialist Ductwork Group or a member of the Association of Ductwork Contractors and Allied Services).
- A log book should be provided in accordance with paragraph 6.2 of Part L2A (a way of showing compliance is using CIBSE TM 31 *Building Logbook Toolkit*). The log book must include the information used to calculate TER and BER.
- For existing buildings under Part L2B, a new or updated log book should be provided that should include details of newly provided services, their operation and maintenance and any newly installed energy meters (see Appendix 6.18).

Operation and maintenance

Instructions should include:

- Regular calibration of controls;
- Regular cleaning of dirty filters – and clearing dust from fins;
- Regular inspection of ductwork to ensure insulation and airtightness are maintained.

These checks aim to avoid too much deterioration in the energy performance of the system.

Variable Speed Drives

A variable speed drive is essentially an electronic power converter that generates a multi-phase, variable frequency output that can be used to drive a standard ac induction motor, or permanent magnet synchronous motor, and to modulate and control the motor's speed, torque and mechanical power output.

Variable speed drives may be purchased either as a stand-alone product or purchased as part of another item of plant or machinery.
Products should:

- Incorporate an electronic VSD that generates a controlled variable frequency, variable voltage, 3 phase power output (with each phase displaced by approximately 120 degrees) that is suitable for operating a 3 phase motor.
- Provide an adjustable variable-voltage, variable-frequency output that can be matched to the torque-speed characteristic of the load (being driven by the motor), including both loads with a quadratic torque-speed and linear torque-speed characteristics. The relationship between the voltage and frequency of the product's output must either be:

  a) Predefined prior to sale to match a number of specific motor loads, which can be selected during commissioning; or

  b) Programmed into the product during installation using a multi-point approximation or parametric motor model as part of a clearly defined commissioning procedure; or

  c) Determined during commissioning by a self-tuning or automatic model identification algorithm that automatically minimises the energy consumption of the drive; or

d) Automatically adjusted during operation as part of a vector control algorithm in a manner that ensures the product's output matches the characteristics of the motor and its load and minimises energy consumption of the drive; or

e) Any combination of the above.

- Be able to automatically vary, in response to an external control signal, the frequency of its output between 5% (or less) and 100% (or greater) of the frequency of its alternating current supply.
- Be designed to make smooth controlled transitions between speed changes by the use of predefined, programmable, or automatically adjusted, acceleration and deceleration ramps.
- Be CE Marked, or otherwise demonstrate conformity with the requirements of the EU EMC Directive 89/336/EEC, or its replacement EU EMC Directive 2004/108/EC.

Loft Insulations

Loft space of existing domestic dwellings should be insulated to a minimum thickness of 270 mm where the level of loft insulation does not meet prescribed minimum standard of more than 150 mm of loft insulation.

All eligible materials are to meet the relevant British Standard, that is, BS 5803 Part 1: 1985 for man-made mineral fibre thermal insulation mats; BS 5803 Part 2: 1985 for man-made mineral fibre thermal insulation in pellet or granular form for application by blowing; and BS 5803 Part 3: 1985 for cellulose thermal fibre insulation for application by blowing; or be approved by the British Board of Agrément (BBA) for the purpose of insulating the loft spaces of domestic dwellings in the UK. The installation of either man-made mineral fibre or cellulose thermal fibre insulation is covered by BS 5803 Part 5: 1985

All materials will have a maximum thermal conductivity of 0.045 W/mK or lower.

As far as is practical the following thicknesses should be applied:

Existing Level of Insulation	Proposed Standard
None	at least 300mm in total with 100-150mm rolled out between joists and between 100 and 200mm crossed laid over the joists, or butted above the joist so there are no cold bridges caused by the loft joists
50mm or less	at least300 mm in total with 100-150mm rolled out between joists and between 150 and 200mm crossed laid over the joists or butted above the joist so there are no cold bridges caused by the loft joists
more than 50mm up to and including 100mm	A minimum of 200mm up to a maximum of 250mm to be added, to achieve at least 300mm overall. This may be entirely crossed laid over joists on top of the existing loft insulation or butted above the joist so there are no cold bridges caused by the loft joists. Alternatively, it may be split so that some is laid between the joists on top of the existing insulation up to the height of the joists and the rest crossed laid over the joists or butted above the joist so there are no cold bridges caused by the loft joists.
More than 100mm up to and including 150mm	A minimum of 150mm up to a maximum of 200mm to be added, to achieve at least 300mm overall. This may be entirely crossed laid

	over joists on top of the existing loft insulation or butted above the joist so there are no cold bridges caused by the loft joists. Alternatively, it may be split so that some is laid between the joists on top of the existing insulation up to the height of the joists and the rest crossed laid over the joists or butted above the joist so there are no cold bridges caused by the loft joists.

The total thickness of all loft insulation when the job is completed will be at least 300 mm of insulation in the loft space and achieve a maximum U-value of 0.15 W/m^2K. If, because of standard thicknesses of the loft insulation materials available, the total insulation thickness would result in either more than 300mm or less than 300mm, then the presumption should be to install the thicker insulation to achieve more than 300mm, rather than leave the loft with less than 300mm of insulation.

All practical steps must be undertaken to minimise the risks of condensation occurring within the roof space on completion of works. The roof should be ventilated to the outside air in accordance with BS 5250. Ventilation at eaves ridges gables, or sagging sarking felt should not be obstructed. Any ventilation apertures should be covered with mesh to prevent entry of insects. All holes at ceiling level, such as service penetrations, must be filled to block air paths.

The loft hatch must be draughtproofed with an appropriate material and securing catches fitted to ensure a compression seal.

Pipes rising from the bathroom and linen cupboard and ventilation ducts within the roof space should also be insulated.

All electrical cables give off heat. Cables should be routed where they can dissipate heat, (i.e. above insulation). This is particularly important for cables serving electric shower units and cookers (See BRE Thermal Insulation Avoiding Risks).

Cold bridges should be avoided as far as is practical. Cold bridges occur at roof-wall junctions and at uncovered ceiling joists. Where practical these should be covered in accordance with the BRE Document Thermal Insulation Avoiding Risks.

As far as is practical, pipes should be located below the loft insulation. Where pipes sit above the loft insulation they should be insulated to standards for indoor standards as set out in BS 5422: 1990, BS 3958 and BS 6700: 1987, where appropriate. Care must be taken to ensure that no part of the pipes particularly at elbows, and entry and exit points to tanks are left exposed. Where existing pipework insulation meets BS 5422: 1990 and is fitted to ensure no pipes or part of pipes are left exposed and where no evidence exist of pipes being wet or saturated, no additional insulation should be fitted. No works should commence on pipes if is it considered that such action will result in damage to these pipes.

Cold water cisterns and tanks located in the loft space must also be insulated in strict accordance with British Standard BS 5422: 1990, BS 3958 and BS 6700: 1987, and guidance given in the BRE documents Thermal Insulation Avoiding Risks. Also:

All tanks should have appropriate fitting lids;

Cold water cisterns and tanks located 300mm or more above the ceiling joists shall be completely enclosed and insulated, with the insulation applied under the cold water cistern or tank; and,

tanks located less than 300mm above the ceiling joists must be completely enclosed and insulated with the exception of the base which must have no insulation. There must be no loft insulation at ceiling level immediately beneath the tank. Loft insulation should be turned up to surround the gap below the tanks up to a height of at least 300mm so that there is a continuous barrier around this area.

Material used to insulated cold water tanks should be fit for the purpose and meet the appropriate standards.

Where there is a cold water tank or cistern in the existing loft space, and the loft does not have fixed walk boards then these must be installed, and be fully secured to the existing joists.

Where existing recessed lighting installations are present, these provide a number of technical challenges all combined into one. Each of these fittings will need to be provided with sufficient space to allow them to dissipate heat, which in turn means that there will be a discontinuity within the insulation layer between the ceiling joists. Additionally, these fittings will most likely be inadequately draughtproofed, and this could provide a route for moist air to enter into the roof void leading to potential problems from condensation. Guidance on how to deal with these technical challenges is provided in the Energy Saving Trust publication: ‘Refurbishment of existing dwellings – an introduction to improving energy and water efficiency, and reducing waste’.

Cavity Wall Insulation

Blown mineral fibre or poly bead materials should be used. All such materials are to be the subject of a current British Board of Agrément (BBA) Certificate or British Standards Institute (BSI) Licence for the purpose of insulating existing cavity walls of domestic dwellings in the UK.

The BBA Certificate or BSI Licence will cover not only the material, but also the pre-installation surveys, approved drilling patterns, procedures on site, post-installation works, the qualifications of operatives, and the necessary paperwork to be retained with regard every job, as well as contra-indications and other restrictions covering situations when cavity wall insulation must not be carried out on a dwelling.

All materials are to be installed in accordance with the conditions, procedures, and other requirements as set out in their BBA Certificates or BSI Licence.

The installation of cavity wall insulation shall be undertaken only by an organisation which is currently approved by the BBA or BSI for the system of cavity wall insulation that is applied to the property.

Drill-hole patterns to be in accordance with recognised standards and good practice, and in keeping with the BBA certificate of approval. All holes are to be filled and made good following installation of the cavity wall insulation and, as far as is practical, match the wall existing finish both in material and colour rendering.

A pre-installation inspection of the cavities of the proposed walls to be insulated should be completed prior to the installation of any cavity wall insulation materials. The purpose of this pre-installation survey is to establish the suitability of the cavity to receive blown fibre insulation in keeping with the BBA certificate of approval. This survey must include an internal, external and cavity inspection, and an assessment of the exposure rating of the walls to wind driven rain.

At the time of the survey, the wall or the cavity may be unsuitable for cavity wall insulation due to the presence of;

- Mortar or other debris within the cavity;
- Dampness on the external wall (whether, rising, falling, penetrating, or related to condensation);
- Defective pointing of the wall;
- Cracks in the external through building movement, subsidence; or,
- Other cause or other circumstances prescribed in the cavity wall insulation system's BBA certificate

Where such circumstances occur, the installer should advise the householder of such problems, the unsuitability of the wall for cavity wall insulation in its current state, and the need for the problem to be remedied or rectified before the cavity wall insulation works can take place. The remedy of such defects is not covered by the grant.

If wiring is found within the cavity then reference must be made to the latest IEE regulations to ensure there is no risk of wiring overheating.

Draught Proofing

A wide range of specialised materials are available to draughtstrip doors and windows which currently have no draught-proofing. These include foams, brushes, sealant strips.

All materials used should be tested and approved to the relevant British Standard for the actual material, and also to BS 7386: 1997. Installers are responsible for ensuring that the correct material type is chosen for each application and ensure that the installation is in accordance with BS 7880: 1997.

External Windows - Materials selected should be appropriate for the type of window, e.g. timber sash, timber casement, metal casement, louvre types. Windows in rooms with combustible appliances should only be draught proofed if, and only if, the ventilation through air-bricks or other vents meet the current Building Regulations.

Doors - All external doors, including doors to a draught lobby, should be draught proofed. No internal doors to rooms with combustible open flued appliances should be draught proofed unless the ventilation to the outside air provision within that compartment meets the current requirements as set out in the Building Regulations.

Loft Hatch - Loft hatches should be draught proofed with appropriate materials and securing catches should be attached to ensure a compression seal.

Letter box openings - Letter boxes should be fitted with an appropriate cover.

Hot Water

'Economy 7' water heating controllers enable householders to take advantage of appropriate off-peak tariffs.

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If the existing electric immersion heater is inoperable, unsafe or faulty, it is to be replaced. To be considered safe, the replacement must not only include safe wiring and a working thermostat, but must also be fitted with a re-settable safety cut-out device that complies with BS EN 60335-2-73 and has a BEAB approval mark to prevent the water from boiling, to provide the occupants with protection against being scalded. The thermostat should be set at 60^{o}C prior to the contractor signing off the job as complete.

If an existing electric immersion heater does not have a re-settable safety cut-out device that complies with BS EN 60335-2-73 and has a BEAB approval mark to prevent the water from boiling, then one must be fitted.

Where a new electric storage system is being fitted there should have been an alternative form of heating hot water within the dwelling. However, where replacement or upgrade of an existing heating system would leave the household without any method for providing or storing hot water within the dwelling, then a new electric immersion heater and hot water cylinder should be fitted. The electric immersion heater must be fitted with thermostat, and fitted with a re-settable safety cut-out device that complies with BS EN 60335-2-73 and has a BEAB approval mark to prevent the water from boiling.

If there is an existing cold water feed tank / cistern to supply the hot water cylinder that is being retained, the installer must inspect the cold water feed tank / cistern that there is no evidence of any cracks in the tank, and that the vent pipe, the service valves, the float operated valves, and the overflow pipes are in good working order. These tanks / cisterns are to fully supported and insulated and should be fitted with a warning / overflow pipe. These installations must comply with the guidance as appropriate set out in BS 6700:2006 which covers the specification for the design, installation, testing and maintenance of services supplying water for domestic use with buildings and their cartilages, and with the Water Regulations Guide and the Water Byelaws 2000 (Scotland).

If the cold water feed tank / cistern does not comply with these standards it is to be replaced with one that does.

Hot Water Cylinders

A correctly sized insulating jacket tested and approved to the British Standard BS 5615:1985 should be fitted to the hot water storage cylinder.

As far as practical an 80mm thick jacket should be applied where the tank is to remain in use and the existing hot water cylinder has;

- No BSI approved insulating jacket; or,
- An insulating jacket of 25mm thickness or less; or,
- An insulating jacket in a bad state of repair.

If the hot water cylinder is not accessible, i.e. it is sited in an enclosure that is permanently closed, or it is fitted in a compartment which cannot accommodate the full jacket, then the hot water cylinder should not be insulated unless it can be guaranteed that re-instating the property to the condition it was before works commenced.

In circumstances where a standard jacket cannot be used installers may use alternatives subject to the materials specified are in accordance with Clause 4 of BS 5615:1985.

The insulating material should have a thermal resistance of at least 2.0m^{2}k/W (that is, the equivalent of 80mm thickness for typical mineral fibre insulation material) when tested in accordance with the test method for thermal properties of BS 5803:1985.

An insulating jacket should not be left behind on the assumption that the householder will fit it at some future date

Pipe Insulation

General

The type of insulation will depend on the range of operating temperatures for the circuit and the location of the equipment, i.e. whether it is internal or external or above or below ground.

For small to medium bore pipes (domestic or small commercial installations), a one-piece pre-formed insulation is usually appropriate. Examples of this may be wool, felt, cork, flexible rubber or fibreglass. Larger bore pipes over 250mm diameter will require a quilted material secured with metal bands or adhesive tape with taped joints.

Rectangular ducts and tanks should have rigid or semi-rigid slab insulation, cut to fit with overlaps at angles and bonded as recommended by the manufacturer. Duct insulation should be covered with an impermeable finish to provide protection and shed condensation. In external situations, this should be a sheet metal protection for additional strength.

Cylinders can be insulated using the same method as tanks, although both tanks and cylinders in domestic situations can be fitted with a quilted jacket. New domestic cylinders are usually insulated with foam before they are installed.

Dwellings

Primary circulation pipes should be insulated whenever they pass outside the heated living space, domestic hot water pipes should be insulated throughout their length (except where impractical – say through joists) and all pipes connected to hot water storage vessels should be insulated for 1m from their point of connection to the cylinder (or to where they become concealed). Lesser standards are acceptable for replacement systems where access is unavailable. Buried community heating pipes tend to be pre-insulated to EN 253[vii], but variable volume controls assist by maintaining low return temperatures (and correspondingly lower rates of heat loss).

Pipes should be insulated to comply with the maximum heat loss indicated in the table below for various external pipe diameters (used on new and replacement gas-, oil-, electric boiler-, solid fuel-fired and community central heating systems). Standardised conditions should be assumed for calculating heat loss (horizontal pipe at 60°c in air at 15°) – further information on the relationship between heat loss and insulation thickness is available from TIMSA[viii].

Pipe diameter (external)	(maximum heat loss)
8 mm	7.06 W/m
10 mm	7.23 W/m
12 mm	7.35 W/m
15 mm	7.89 W/m
22 mm	9.12 W/m
28 mm	10.07 W/m
35 mm	11.08 W/m
42 mm	12.19 W/m
54 mm	14.12 W/m

All that all primary circuit pipes should be insulated for solar hot water systems throughout their length.

Non-domestic buildings

Pipes and ducts are insulated to avoid heat loss in heating systems and heat gain in cooling systems.

Other than where heat loss only occurs where ‘it is useful, pipes should be insulated to comply with the maximum heat loss indicated in the table below for various external pipe diameters (used on new and replacement gas-, oil-, electric boiler-, solid fuel-fired and community central heating systems).

External pipe diameter (mm)	Heat loss (W/m)			
	Hot water	Low temperature hot water (<95°C)	Medium temperature hot water (96-120°C)	High temperature hot water (121-150°C)
17.2	6.60	8.90	13.34	17.92
21.3	7.13	9.28	13.56	18.32
26.9	7.83	10.06	13.83	18.70
33.7	8.62	11.07	14.39	19.02
42.4	9.72	12.30	15.66	19.25
48.3	10.21	12.94	16.67	20.17
60.3	11.57	14.45	18.25	21.96
76.1	13.09	16.35	20.42	24.21
88.9	14.58	17.91	22.09	25.99
114.3	17.20	20.77	25.31	29.32
139.7	19.65	23.71	28.23	32.47
168.3	22.31	26.89	31.61	36.04

The cooling load to compensate for heat gain in distribution pipework should be less than 5% of the total load.

Refrigeration Equipment

Packaged chillers

Packaged chillers generate chilled water that can be used to provide space cooling in summer in large air-conditioned buildings. They can also be used to generate chilled water or other fluids for industrial process cooling. Reverse cycle packaged chillers are able to heat fluids and can be used to provide space heating in winter, or for industrial process heating. Some air cooled packaged chillers also incorporate free cooling mechanisms that can be used to reduce the amount of electricity needed by the product to provide cooling at lower ambient temperatures.

Packaged chillers are available in a wide range of different designs and efficiencies.

Equipment should:

- Incorporate the following items of equipment:
  - a) One or more electrically powered compressors.
  - b) One or more air-cooled or water-cooled condensers.

c) One or more evaporators.

d) A control system that ensures the safe, reliable and efficient operation of the product.

- Be CE Marked.

Where the product incorporates an integral free-cooling mechanism, it must be:

- Fully integrated into the packaged chiller unit during product manufacturing.
- Directly controlled by the product's control system in a manner that maximises the use of free cooling for outside air, dry bulb temperatures between 2.0 and 15.0°C.
- Able to provide a cooling capacity at an outside air, dry bulb temperature of 2.0°C and an outlet water temperature of 7.0°C that is at least (=>) 50% of the cooling capacity obtained at the standard rating condition specified in the table below.

Product Category		**Cooling Capacity (kW)**	**Performance thresholds**	
			Cooling EER	**Heating COP**
Air-cooled packaged chillers that provide cooling only.	**without** integral free cooling mechanism.	<=100kW	>= 2.80	-
		101-500 kW	>= 2.80	-
		501-750 kW	>= 2.90	-
		751-1,500 kW	>= 2.90	-
	with integral free cooling mechanism.	<=100kW	>= 2.70	-
		101-500 kW	>= 2.70	-
		501-750 kW	>= 2.80	-
		751-1,500 kW	>= 2.80	-
Air-cooled, reverse cycle, packaged chillers that provide heating and cooling.		<= 100kW	>= 2.70	>= 2.70
		101-500 kW	>= 2.80	>= 2.80
		501-750 kW	>= 2.90	>= 3.10
Water-cooled packaged chillers that provide cooling only.		<= 100kW	>= 4.20	-
		101-500 kW	>= 4.20	-
		501-750 kW	>= 5.00	-
		751-2,000 kW	>= 5.10	-
Water-cooled, reverse cycle, packaged chillers that provide heating and cooling.		<= 100kW	>= 4.20	>= 3.90
		101-500 kW	>= 4.30	>= 3.90
		501-750 kW	>= 5.00	>= 4.70
		751-2,000 kW	>= 5.10	>= 4.70

Where:

EER = net cooling capacity (kW) / effective power input (kW) in cooling mode.

COP = net heating capacity (kW) / effective power input (kW) in heating mode.

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Air-cooled Condensing Units

An air-cooled condensing unit is a factory-assembled, packaged unit that consists of a refrigeration compressor, an air-cooled condenser and various ancillary components. This packaged unit does not contain a complete refrigeration system, but is designed to provide a convenient method for cooling a cold room or other equipment fitted with an evaporator that is controlled by an expansion valve.

Air-cooled condensing units are available in a range of different designs and efficiencies, and are used in a variety of commercial and industrial cooling applications, including cold rooms, refrigerated display cabinets, back-bar equipment, temperature controlled food preparation areas, and for air conditioning systems.

Products should:

- Be designed to operate with one or more clearly identified standard refrigerants.
- Be a factory assembled unit that incorporates at least the following components:

  a) Air-cooled refrigerant condenser.

  b) One or more electrically driven refrigeration compressors.

  c) A control system that controls the product's compressor(s) and cooling fan(s).

- Conform to the requirements of the Pressure Equipment Directive 97/23/EC in respect of their design, manufacture and testing procedures.
- Have CoPs greater than those shown in the table below:

Temperature Category	Evaporating temperature (Dew Point)	Ambient (condenser air-on) temperature	Compressor suction gas temperature	COP threshold
High temperature units	+5°C	20°C	20°C	>=3.9
Medium temperature units	-10°C	20°C	20°C	>=2.8
Low temperature units	-35°C	20°C	20°C	>=1.6

Air Blast Coolers

Air blast coolers normally consist of a finned tube heat exchanger and a cooling fan(s). The cooling fan is used to force air over the heat exchanger and to cool water and other process liquids as they passed through the heat exchanger. Air blast coolers can be used to reduce the load on refrigeration systems by cooling water and other process liquids, prior to their transfer into the refrigeration system.

Products should:

- Incorporate a heat exchanger designed to cool water or other process liquids.
- Incorporate a fan(s) which forces air over the heat exchanger.
- Conform with the requirements of the EU Pressure Equipment Directive PED 97/23/EC in respect of its design, manufacture and testing procedures, or be CE Marked.
- Incorporate a series of control valves (or "by-pass mechanism") that re-direct the water or other process liquid around the pre-cooler in response to a control signal, **and** a controller that operates the by-pass mechanism and turns off the cooling fan at times when the ambient air temperature is higher than the water/process liquid inlet temperature.

- Incorporate a variable speed drive which reduces the duty of the cooling fan as the cooling demand decreases, or as the ambient air temperature decreases
- **P**roducts must have a minimum energy efficiency rating (EER) that, at 10K approach temperature difference, is greater than or equal to (>=) 10.0 (where EER = net cooling capacity (kW) / effective power input (kW)).

Refrigeration Compressors

Refrigeration compressors are products that are specifically designed to raise the pressure, temperature and energy level of a refrigerant vapour by mechanical means as part of a "vapour-compression, economised vapour compression or transcritical CO2 refrigeration cycle. They range in size from those used in refrigerated display cabinets used in shops and supermarkets, to those used in large industrial refrigeration systems in breweries.

Refrigeration compressors are available in a range of different designs and efficiencies, and can be manufactured as fully hermetic, semi-hermetic or open products.

Products should:

- Incorporate a positive displacement type, hermetic or semi hermetic compressor (with integral electric motor).
- Be subject to quality assurance procedures that ensure consistency of performance between one production item and any other.
- Have a coefficient of performance (COP) that is greater than the values shown in the table below:

Category	**Evaporating temperature (Dew Point)**	**Condensing temperature (Dew Point)**	**Compressor suction gas temperature**	**Liquid sub-cooling**	**COP threshold**
High temperature with HFC or HC refrigerant	+5°C	35°C	20°C	0K	>5.20
Medium Temperature with HFC or HC refrigerant	-10°C	30°C	20°C	0K	>3.50
Low Temperature with HFC or HC refrigerant	-35°C	25°C	20°C	0K	>2.00
Medium temperature transcritical/subcritical with R744 refrigerant	-10°C	15°C	0°C	0K	> 4.20
Low temperature transcritical/subcritical with R744 refrigerant	-35°C	15°C	-25°C	0K	> 1.80
Low Temperature Subcritical with R744	-35°C	-5°C	-25°C	0K	> 3.20

Refrigeration Leak Detection Systems

Refrigerant leak detection systems continuously monitor the atmosphere in the vicinity of refrigeration equipment, and other components or pipework that contain refrigerant. They provide an early warning of refrigerant leaks, to allow their early repair, and thus improve the energy efficiency of the refrigeration system and reduce carbon emissions.
The detection system is permanently fixed in place at the site of the refrigeration equipment.

Products should:

- Continuously monitor the refrigeration system for refrigerant leakage.
- Detect the presence of one or more refrigerants (which must be clearly named in the information supporting the application) and raise an audible alarm when a pre-set level of refrigerant is reached.
- Have fittings to allow permanent fixing to the wall or floor.
- Be able to operate in conditions of between 0°C to 50°C and humidities of up to 90%.
- Be CE marked.
- Generate an alarm signal when the level of refrigerant in the atmosphere exceeds the relevant threshold set out in the table below, and have a measurement accuracy of +/- 20 ppm and be able to detect a change of 10 ppm in the level of refrigerant in the atmosphere at refrigerant concentrations up to the relevant alarm threshold.

Refrigerant	**Alarm signal threshold** (parts per million, ppm)
HCFC, HFC, HFO or HC	>=100
CO2	>=1,500

High Speed Hand Air Dryers

Hand air dryers are widely used in washrooms to dry hands after washing, as an alternative to paper or linen hand towels. They use an electric blower to produce one or more jets of air that are used to dry hands placed under, or into, the hand air dryer unit. Some models heat the air jets prior to use with electrical heating elements or by passing it over the electric motor that drives the blower.

Hand air dryers are available with a wide range of efficiencies.

Products must use less than 6.9 kWh of electricity per 1,000 standard drying cycles in its normal mode of operation, determined in accordance with the procedures and test conditions set out in: Sections 5.3 and 6.3, NSF Protocol P335, “Hygienic Commercial Hand Dryers”, May 2007.

Uninterruptible Power Supplies (UPS)

Uninterruptible power supplies are used to allow electrical equipment to continue operating when the mains power supply is interrupted for a period, or the quality of the power supply deteriorates. They are widely used throughout industry and commerce to maintain the safety critical and business critical systems located in process control stations, computer rooms, data centres and server areas.

Uninterruptible power supplies are available with a wide range of different efficiencies.

There are two main categories of product:

Static uninterruptible power supply units or packages that use one or more electronic dc. to a.c. converters to generate their output voltage when operating without mains input power.

Rotary uninterruptible power supply units or packages that use one or more rotating electrical machines (i.e. ac generators) to generate their output voltage when operating without mains input power

Products should:

- Be either:

  a) A static uninterruptible power supply as defined in BS EN 62040-3:2011 (or IEC 62040-3: 2011).

b) A rotary uninterruptible power supply as defined in BS EN 88528-11:2004 (or IEC 88528-11: 2004).

- Include the following components (within the unit or package):

  a) An electronic control system that controls the operation of the product.

  b) Voltage inverter and rectifier devices (required for static uninterruptible power supplies, optional for rotary uninterruptible power supplies).

  c) One or more energy storage devices (for example: batteries, flywheels, etc.).

  d) One or more power supply filters.

  e) A bypass switch (where required)

  f) A motor generator set or alternator (for rotary uninterruptible power supplies only).
- Be designed to be connected to, and to provide electrical power backup to, a three-phase electricity supply of nominally fixed frequency and voltage.
- Be CE Marked.
- Meet or exceed the minimum efficiencies at full and part load conditions set out for the relevant product category in the table below.
- Have an input power factor that is greater than or equal to (i.e. >=) 0.93 at 25%, 50%, 75% and 100% of rated maximum power output.
- Have an input total harmonic distortion (THD) that is less than or equal to (i.e. <=) 5% at 100% of rated maximum power output.

Product Category	**Power range (kVA)**	**% rated maximum power (i.e. % full load)**			
		25%	**50%**	**75%**	**100%**
Static uninterruptible power supply units or packages	>=10 and <= 200	>=93.0	>=94.0	>=94.5	>=94.5
	>200	>=90.9	>=93.5	>=94.3	>=94.0
Rotary uninterruptible power supply units or packages	>100	>=89.0	>=93.0	>=95.0	>=96.0

Voltage Reduction Devices (VRDs)

The statutory supply voltage in the UK is 230 +10%, -10% as a result of EC harmonisation, giving a voltage range of 207 – 253 volts and a requirement that any equipment sold in the UK must operate satisfactorily at the lower end of this range.

There are currently no BS or EN standards associated with VRDs. Due to the different operating principles behind the types available (the technology usually comprises a ‘black box’ controller based on either magnetic / transformer based devices or power electronic devices using thyristors or triacs.), any standards would need to be carefully constructed. The key issues relate to the need to ensure nominal voltage to prevent loss of performance and limits on harmonics production:

- Harmonic content should be within the limits described in EN50160 for power quality in public supply systems
- Devices should not reduce the output voltage to lower than 230 volts single phase nominal by more than 2% to ensure satisfactory operation of lighting.

Most devices aim for a nominal output around 220V – i.e. a ‘tap down’ of around 8 -10% on nominal. Systems are usually fitted at the distribution board, to service lighting loads or the entire building, depending on the power rating of the device selected, although other devices are available that are designed to be fitted in individual appliances or luminaires.

The lighting industry is concerned with the use of these devices but concedes that in the case of high grid voltage at night, savings should be possible on magnetic-ballast fittings, with little or no performance loss, *provided the voltage does not fall significantly below nominal*. The concerns include:

- reduced lumen levels with devices that aim to reduce below 230 volts
- no savings are achieved with devices with high frequency (HF) ballasts
- Much greater energy savings are possible by replacing magnetic ballast luminaires with new HF ballast fittings
- A voltage reduction may cause lamp instability and starting problems, leading to excessive electrode wear, ‘black-ending’ and shortened lamp life
- Full voltage may be needed at the start of long circuits to ensure suitable voltages for fittings at the end due to volt drop
- Any manufacturers’ warranty is likely to be voided
- Concerns over harmonic content produced by switching technology devices and subsequent increase in capacitor failure

Further details are in LIF Technical statement 3, published by The Lighting Industry Federation.

[i] GPG268, Energy efficient ventilation in dwellings – a guide for installers, EST, 2006

[ii] Domestic Ventilation Compliance Guide, CLG, 2010

[iii] Energy Efficient Ventilation and Air Conditioning, Inside Energy CPD Programme Module 6, Jones, P (Sep 2003)

[iv] HVCA DW144 Specifications for Sheet Metal Ductwork (1998)

[v] The Energy Information (Household Air Conditioners) (No. 2) Regulations, SI 2005/1726

[vi] As defined in Schedule 3 of the labelling scheme adopted under The Energy Information (Household Air Conditioners) (No. 2) Regulations, SI2005/1726 – see www.legislation.gov.uk/uksi/2005/1726/schedule/3/made

[vii] BS EN 253:2003, District heating pipes. Pre-insulated bonded pipe systems for directly buried hot water networks. Pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene". (2003)

[viii] HVAC Guidance for achieving compliance with Part L of Building Regulations, TIMSA, 2000 – see www.timsa.org.uk/TIMSAHVACGuidance.pdf

Appendix K Follow up communication – supporting information 2: "Appendix B: Incentive Schemes"

Grant, Incentives and Low Interest Loan Schemes for Energy Efficiency and Renewable Energy

Name	**Scheme Type**	**Scheme Operator**	**Eligibility**	**Information**
UK Non Domestic Schemes				
Carbon Reduction Funding	Funding	EMSc (UK)	This scheme is aimed at companies who are keen to implement energy efficient technologies that are able to return an investment in 5 years.	
Green Retrofit Investment Programme	Investment	BRE and Sustainable Development Capital.	Non Domestic: It is open to projects worth £2 million plus.	This is a new scheme introduced in 2013 to provide investment to non-domestic energy efficient retrofit projects in the UK. £100 million investment opportunity provided from the Government's Green Investment Bank. The return on investment will come from savings in energy bills.
Enhanced Capital Allowance	Allowance (Grant)	Government	Businesses	This scheme was introduced to enable businesses to claim 100% first year capital allowance on certain investments (listed in their ETL database) in energy saving equipment, against the taxable profits of the company).

RHI (Renewable Heat Incentive)	Incentive	Government/ Ofgem	Industrial, commercial, public and non-for-profit sectors	The Renewable Heat Incentive (RHI) is a UK Government scheme set up to encourage uptake of renewable heat technologies among householders, communities and businesses through the provision of financial incentives. The UK Government expects the RHI to make a significant contribution towards their 2020 ambition of having 12% of heating coming from renewable sources. The Renewable Heat Incentive is the first of its kind in the world.
The Green Deal	Financing Scheme	UK Government	Building Owners.	An innovative financing mechanism that lets people pay for energy-efficiency improvements through savings on their energy bills. The process involves an assessment of the home or business by a Green Deal Advisor who will identify areas which could be improved if connections to Green Deal Providers were to occur.
Plug-in Van Grant	Car	Department for Transport.	This grant is available to individuals and businesses in the UK, although the vehicle must be pre-approved and registered in the UK.	A grant to reduce the cost of eligible electric, plug-in hybrid and hydrogen vans in the United Kingdom.
Enhanced Capital Allowances (ECA's)	Tax Relief	DEFRA & HM Revenue	This scheme is available to companies that meet certain criteria. The criteria is assessed every year and a full list can be viewed here: https://etl.decc.gov.uk/etl/site/criteria.html	This ECA scheme enables businesses to claim a 100% first year capital on investments in certain energy saving equipment against the taxable profits of the period of investment. Father investment may continue a relief in tax.
UK Domestic Schemes				

RHI (Renewable Heat Incentive)	Incentive	Government/ Ofgem	This scheme is available to anyone who has installed an eligible technology since 2009. It is targeted at, but not limited to, off gas grid houses. The scheme will cover single domestic dwellings and will be open to owner-occupiers, private landlords, Registered Providers of Social Housing, third party owners of heating systems and self-builders. It will not be open to new build properties other than self-build.	The Renewable Heat Incentive (RHI) is a UK Government scheme set up to encourage uptake of renewable heat technologies among householders, communities and businesses through the provision of financial incentives. The UK Government expects the RHI to make a significant contribution towards their 2020 ambition of having 12 per cent of heating coming from renewable sources. The Renewable Heat Incentive is the first of its kind in the world. To help improve performance of renewable heating systems, there will be an extra incentive for applicants who install metering and monitoring service packages, of £230 per year for heat pumps and £200 per year for biomass boilers. Applicants are required to complete a Green Deal Assessment (GDA) before applying and to ensure they meet minimum energy efficiency requirements of loft and cavity insulation where required by the GDA.
ECO (The Energy Companies Obligation)	Funding			This has replaced CERT (Carbon Emissions Reduction Target) and CESP (Community Energy Saving Programme) It places a legal obligation on large energy suppliers to deliver energy measures to the domestic energy market.
Affordable Warmth Obligation	Grant	Government (Energy Suppliers)	Low-income and vulnerable households. (Social tenants are not eligible)	It is a scheme which has been introduced by the government to ensure that big energy companies aid those who are less fortunate to insulate their home sufficiently to enable them warmth.
Carbon Saving Obligations	Funding	Government	Hard to treat areas and cavity walls.	This funding incentive can provide insulation for solid walled properties
The Green Deal	Financing Scheme.	UK Government	Building owners, occupants, tenants.	Covering over 45 areas this scheme is an innovative financing mechanism that lets people pay for energy-efficiency improvements through savings on their energy bills. The process involves an assessment of the home or business by a Green Deal Advisor who

				will identify areas which could be improved if connections to Green Deal Providers were to occur.
UK Government Feed-in Tariff	Cash Back Incentive	UK Government/Ofgem	This scheme is aimed at a wide spread of home owners who may have installed an electricity-generating technology from a renewable or low carbon source: i.e. P.V. or Wind turbines.	The scheme involves the home owner to benefit from the electricity to power their own home, but to also benefit from the surplus energy by feeding it back to the grid and being paid for it. To qualify for this scheme your product and installer of the product must be certified under the "Microgeneration Certification Scheme" (MCS), and also an EPC (Energy Performance Certificate) must be produced so that a tariff is determined for the products used.
Enhancing Communities	Funding	SITA Trust	This programme is available for non-profit organisations, community groups, parish councils, local authorities and charities.	The scheme has been brought about to benefit local communities so that they can make physical improvements to their community with regards to regenerating leisure facilities and historic buildings and structures. There are various sums of grants available up to £60,000 for not-for-profit organisations whose projects equate up to £250,000.
EON Sustainable Fund	Funding	EON	This funding is only eligible for projects that follow the 'Project Eligibility' section which is found on the E-on website.	The funding programme has been set up as eon's commitment to helping communities to better manage their energy consumption. They have targeted local community centres that need to improve on consumption and wish to make a change.
Energy Efficiency Financing Scheme	Finance	Siemens	The scheme is available to all kinds of businesses and organisations, from sole traders and partnerships through to large corporate enterprises, local authorities, charities and public sector organisations	Funding for UK businesses to invest in cost effective energy efficiency equipment and other low carbon technologies, such as new efficient lighting and biomass heating.

Scottish Domestic Schemes				
Green Homes Cashback Scheme.	Cash Back Incentive.	Scottish Government	Owner occupiers, private and social tenants and private sector landlords.	The Government are offering the sector the opportunity to claim up to £1,200 towards energy efficiency measures.
Landlord Green Appliance Scheme.	Cash Back Incentive.	Scottish Government	Landlords who own rented properties. The Scottish Government is offering private sector landlords up to £500 toward replacing old and inefficient appliances in their rented property.	
Home Energy Scotland renewables loan scheme.	Loan	Scottish Government.	This is available to everyone in Scotland to invest in renewable systems - interest free loans of up to £10,000 for owner occupiers in Scotland for installations of renewable electricity and heat technologies and connections to renewably-fired district heating schemes. The amount of money that is on offer, to borrow, depends on the technologies that are being installed, and can be seen on the website.	

The Warm Homes Fund	Loan	Scottish Government	This is available for RSL's (Registered Social Landlords) and also local authorities can apply. Community groups undertaking renewable energy projects may also apply in certain circumstances.	The scheme is a £50 million initiative whose aim is to provide loan funding for renewable energy projects to support communities in fuel poverty. Funding is said to be provided to a group who is targeting an area with proof of fuel poverty. This scheme will run until 2017.
The District Heating Loan Fund	Loan	Scottish Government/Energy Saving Trust	This has been made available to businesses and communities using innovative green energy schemes.	The fund can be up to £400,000. The loan type scheme has been put in place to aid small businesses to improve their district heating problems.
Affordable Warmth Scheme	Funding	Scottish Government/ 'The big 6'	This scheme is aimed at various types of energy users: A homeowner, a tenant, a private sector landlord, and various others that can be seen on the website provided. Although it is mainly for the domestic dwelling.	Running alongside the Government's Green Deal Scheme, this initiative pushes the 'big six' energy companies to provide funding in order for the homeowner to have more efficient products - lower cost and lower energy. To qualify for this scheme there are some dependants: You must: Live in your own home or a privately rented one; You must receive state benefits; have an inefficient, faulty central heating boiler; have poorly insulated walls or roofs. In order to further explore the opportunities that the tenant has it is recommended that they phone a provider of the service.
Energy Assistance Scheme	Grants	Scottish Government	This scheme is available to/for a homeowner or tenant of a private sector rented home who also must either be, or have a partner, who is over the age of 60 or whose home is poorly energy inefficient and are qualifying benefits or are in receipt of the 'Carers' Allowance'	This scheme is a finance package that aids the resident with money so that they can purchase /install/repair various technologies in the home (Central Heating Systems, Boilers, Air Source Heat Pumps, Draught Proofing, Insulation and providing thermostats/heating controls).

Climate Change Fund	Funding	Keeping Scotland Beautiful	The funding is used for two different reasons: for communities to educate various other groups of the community in order to improve their local environment. (Keep Scotland Beautiful); and to improve community owned buildings in order to also improve their energy efficiency.	
Creative Scotland Sustainable Development Fund	Funding	Creative Scotland	Arts Organisations.	This is a programme that has been set up to help support Art organisations in Scotland to improve their long term financial and environmental sustainability. Those who are not eligible are schemes that have already started or which will start before a decision is made on application.
Green Homes Cashback Scheme	Cash Back Incentive	Energy Saving Trust	To be eligible for the scheme landlords must: • be private landlords, registered with the relevant local authority, • be undertaking work that is recommended in either their Energy Performance Certificate (EPC) or Green Deal assessment, and • they must ensure receipt of the rebate will not result in them receiving illegal state aid.	This scheme involves the private sector landlords up to £1,200 towards energy efficiency measurements that are recommended in the EPC or the Green Deal assessment for their dwelling/property. This £1,200 comprises of up to £500 got insulation, up to £400 for a boiler and £300 for glazing/LED and heating.

Croft House Grant Scheme - (CHGS) - New House Grant	Grant	Scottish Government Agriculture and Rural Development	The scheme is open to: • crofting tenants; • owner-occupiers of crofts, which were acquired from the landlord within the last seven years; • cottars; and • Kyles crofters.	This scheme involves a financial assistance to crofter and cottars in the former crofting countries of Scotland for costs associated with erecting new dwelling houses. The support comes in three different priority areas: Low priority- max of 11,500, standard priority-17,000 and high priority £22,000. Grant award will require compliance with the following conditions for 20 years: • The house must be occupied by the applicant's family.
Home Energy Efficiency Programmes for Scotland - Gas Infill	Loan Packages	Greener Scotland	The programme is available to owner-occupiers and private and social tenants, as long as they have landlord's permission. Homes must be situated in an area where a gas connection project is planned or has been completed within the last 5 years.	The gas infill programme provides loan funding of up to £5,000 for individuals, aggregators, and local authority fund managers who need support with gas infill projects. The loan is for gas infill projects to connect groups of owner occupiers housed within the existing gas grid but who aren't currently connected. The loan can also be used for gas grid extension projects, where groups of houses located close to the existing gas grid to be connected at a reasonable cost.
Home Energy Efficiency Programmes for Scotland Affordable Warmth	Loan Packages	Greener Scotland	For those having trouble paying energy bills or keeping their home warm. If owners or those who rent privately may be eligible for support via Affordable Warmth. If there are persons in receipt of Child Tax Credit (threshold £15,860) or in receipt of State Pension Credit within your household then they may apply.	Insulation and heating packages are available to qualifying low income and vulnerable households if you own your home or rent privately.
Assisted Connections Scotland	Funding	Scotia	Only available to existing dwellings.	

Scottish Non Domestic Schemes				
Renewable energy relief	The Scottish Government	Funding	-	
Homes Energy Efficient Programmes for Scotland: Energy Assistance Scheme.	Funding	Scottish Government	This is aimed at the following group: Pregnant, Over 60s, household with children, reliant on care, or terminally ill.	This is a Scottish scheme aimed at the most vulnerable groups to reduce energy and fuel poverty by installing energy efficient products (i.e. Air Source Heat Pumps, Insulation etc. etc.) with the hope that in the long run they can make a return.
Resource Efficient Scotland SME loans	Loan	Scottish Government	Scottish businesses that fall within the EC definition of Small and Medium-sized Enterprise (SME), private sector landlords, not-for-profit organisations and charities. Private sector landlords will be eligible to apply for loans if they are registered as a private landlord with their local authority or if they are able to demonstrate that they are exempt from	This is aimed at Scottish businesses that fall into the category of "Small and Medium-sized Enterprises, Private sector landlords, not-for-profit organisations and also charities. This scheme is available to those who carry out a green deal assessment. This is a scheme that provides loans between £1,000 and £100,000 to help support businesses in reducing costs and efficiently managing their energy, water and resources use. They point out that there are benefits to using their system such as: • No set up charges • An immediate and on-going reduction in costs • Significant savings compared to other forms of finance

			registration.	• Investment can be set against capital allowances
District Heating Loan Fund	Loan	Energy Saving trust	The scheme is open to registered social landlords, local authorities, small and medium-sized enterprises (SMEs) and energy service companies (ESCos)	Loans offered on a commercial basis for both renewable and low carbon, low emission technologies in Scotland, for heating distributed through a network of pipes to provide space and water heating in homes or offices.
Welsh Domestic Schemes				
NEST	Grant	Welsh Assembly	Replaces the HEES scheme. This scheme is aimed at the over 60 age group, disabled or chronically ill, pregnant, or household with children.	This scheme involves the assessor taking into account the energy rating of the house, and in doing so installing/upgrading or renovating, with the use of renewables to tackle fuel poverty in deprived areas.
Welsh Non Domestic Schemes				

The Wood Energy Business Scheme	Grant	Forestry Commission	This is a scheme aimed at businesses that use woodfuel heating systems and processing equipment, with the aim of broadening the renewable heat market across Wales.	Closing this year, the scheme is a £17 million pound capital grant scheme that target projects that support: Wood Fuel Heating Systems, Small scales electricity generation (CHP), and wood fuel supplying businesses.

NB: The above list is not exhaustive.

Appendix L Follow up communication – supporting information 3: “Lighting Checklist”

Options for direct lamp replacement

Existing lamp technology	Replacement option	Remarks
Tungsten filament	Plug-in compact fluorescent	Use appropriate colour temperature.
	White LED	Not in enclosed luminaires. Use appropriate colour temperature and colour rendering index.
Tungsten filament with reflector	Plug-in compact fluorescent	Use appropriate beam angle and colour temperature.
	White LED	Not in enclosed luminaires. Use appropriate beam angle, colour temperature and colour rendering index.
Tungsten halogen	White LED	Not in enclosed luminaires. Use appropriate beam angle, colour temperature and colour rendering index.
T8 fluorescent	T8 LED tubes *	Not in enclosed luminaires. Use appropriate colour temperature and colour rendering index.
T5 fluorescent	-	-
T12 fluorescent	T8 fluorescent	Use appropriate colour temperature.
Plug-in compact fluorescent	White LED	Not in enclosed luminaires. Use appropriate colour temperature and colour rendering index.
Pin-base compact fluorescent	-	-
Metal halide	-	-
Compact metal halide	-	-
Induction	-	-
High pressure mercury	Metal halide	Use appropriate colour temperature.

	White LED	Not in enclosed luminaires. Use appropriate colour temperature and colour rendering index.
High pressure sodium	Metal halide *	Use appropriate colour temperature.
	White LED *	Not in enclosed luminaires. Use appropriate colour temperature and colour rendering index.
White LED	-	-
Coloured LED	-	-

***** *May not be cost-effective*

General remarks

- In all cases of direct lamp replacement, it must be ensured that the correct quantity and quality of the light are provided, in accordance with relevant standards and codes. Spot readings of illuminance levels may be helpful in assessing light quantity before and after lamp replacement.
- Where dimming controls are used, replacement lamps should be dimmable and compatible with existing dimmers.
- For presence/absence detection, LED replacement lamps are preferable as fluorescent and HID discharge technologies are affected by frequent switching.
- Wherever applicable, magnetic ballasts should be replaced with equivalent electronic ballasts.
- Wherever LED replacement lamps are used, the correct light distribution pattern should be used.

Checklist for refurbishment

Area	What to look for	What to do
General retail areas	Lighting more than 15 years old. Fluorescent tubes with bayonet cap connections. Badly discoloured plastic diffusers.	High priority for replacement of entire lighting system. Get an expert lighting survey carried out.
	38 mm (1.5 in) diameter T12 fluorescent tubes in switch-start fittings.	Fit 26 mm (1 in) diameter T8 fluorescent tubes as direct replacements in open fittings, or replace enclosed fittings with new fittings using 16 mm (5/8 in) diameter T5 lamps.
	26 mm (1 in) diameter T8 fluorescent tubes in enclosed fittings.	Consider replacing with new T5 fluorescent fittings.
	600 mm square fittings with 55W CFLs.	Replace with modern reflector or high-performance prismatic lens fittings using T5 fluorescent lamps or LED fittings.
	PAR 38 sealed-beam reflector lamps. Tungsten halogen lighting.	Replace with metal halide discharge lighting or LED lighting.
'Warehouse' type retail premises	High-pressure mercury lamps. Old 8 ft 125 W fluorescent fittings.	For most high-bay applications, replace with metal halide lighting. For low mounting heights, replace with modern T5 fluorescent or LED lighting.
Lighting controls	Large areas controlled by a switch near the door. Lighting on outside normal working hours. Potential for increased use of daylighting.	Install appropriate lighting controls to enable lighting to be switched off when not needed, or dimmed in daylit areas.
External lighting	Tungsten halogen lamps. Signboard, security or car park lighting on during hours of daylight.	Install new lighting using metal halide or LED lamps. Install automatic time and/or daylight-linking controls.
Floodlighting	High-wattage tungsten halogen floodlights.	Replace with metal halide or LED lighting.
Staffrooms, stockrooms	Check lights not left on when	Post reminder notices near switches and on noticeboards. Appoint

and utility rooms	unoccupied.	member of staff with responsibility for checking. Consider installation of automatic lighting controls using time switches and/or occupancy sensors to vary light outputs according to use.
Good housekeeping	Are lamps and luminaires clean and unobstructed? Are the staff aware of the need for energy efficiency?	Ensure maintenance schedule includes regular lamp and fitting cleaning routines. Instigate information and energy awareness campaign among staff.