**Community Flex**

# Flexibility and energy efficiency catalogue


NEA Action for Warm Homes

Scottish & Southern Electricity Networks

NAVIGANT A Guidehouse Company

## About this brochure

Our use of electricity to light and heat homes, and power our cars is increasing. This can be partly offset by the continuously improving energy efficiency of appliances. This creates a challenge for network operators like Scottish & Southern Electricity Networks (SSEN) that are responsible for distributing electricity to their customers. Instead of simply reinforcing the power grid, network operators are increasingly looking for energy efficiency and flexibility as cost-effective alternatives to guarantee the delivery of power, now and in the future. This brochure provides an overview of measures that businesses and communities can take to support this, and remuneration that is available from SSEN and other sources. that are responsible for distributing electricity to their customers. Instead of simply reinforcing the power grid, network operators are increasingly looking for energy efficiency and flexibility as cost-effective alternatives to guarantee the delivery of power, now and in the future. This brochure provides an overview of measures that businesses and communities can take to support this, and remuneration that is available from SSEN and other sources.

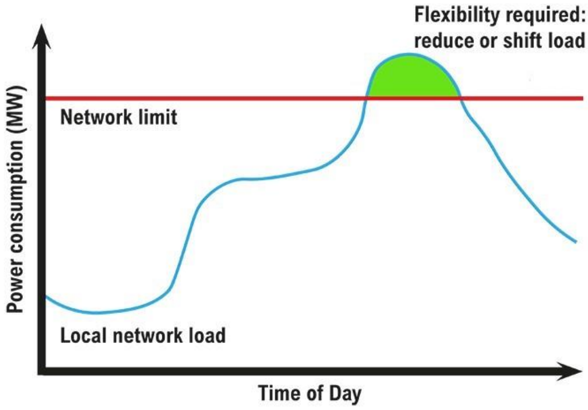
## Our energy system is changing

Our energy system is undergoing monumental changes, primarily as a result of the need to strongly reduce emissions to limit climate change, which is already being felt around the globe, and to curb air pollution. As most renewable energy is generated in the form of electricity, the decarbonisation of the energy system is to a large extent electrification. The advent of electric vehicles (EVs) is one of the more visible indicators of this. Also, all new-build properties are planned to be fitted with heat pumps (instead of gas boilers) within a few years. The increasing demand for electricity has strong implications for the electricity distribution grid.

Historically, the electricity distribution network operator (DNO) has applied a predict-and-provide strategy for users – providing secure supply, whatever consumers demand, at whatever time. The cost of this is increasing, due to the large number of infrastructure upgrades required to cover peak loads, while network capacity is under-utilised for the rest of the day. Ofgem suggest that reducing peak electricity load by 10% would save between £550 million and £1.2 billion per year on national infrastructure costs. Factoring in the increase in electric vehicle and heat pump deployment, and the distributed generation outputs of domestic PV and batteries - the benefits are likely to be much higher. An approach that focuses on energy efficiency and savings, and exploits flexibility in the system by rewarding behaviour change, is expected to be a more cost-effective approach that benefits customers and the climate, and that SSEN is keen to explore.

## Constraint Management and Community Flex

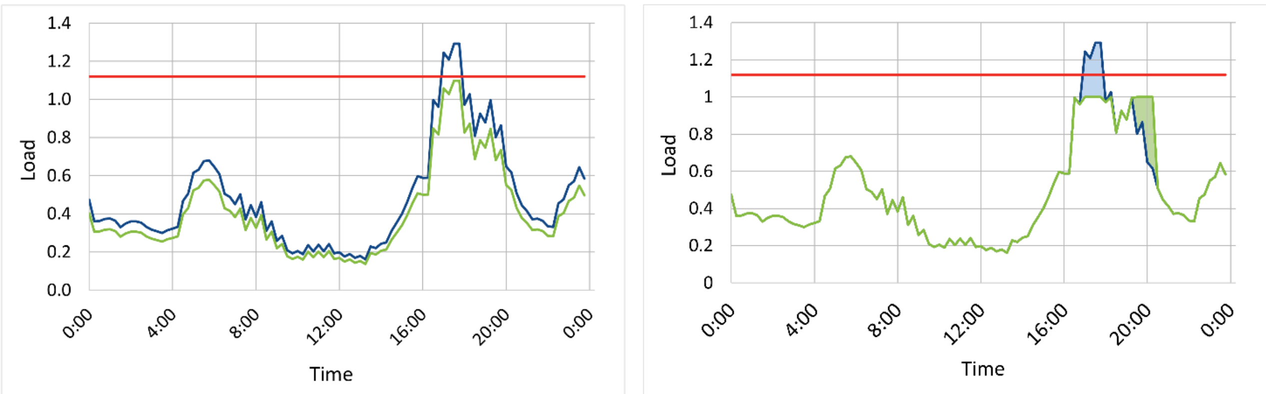
Some parts of the local electricity network may approach maximum capacity when there is high (and increasing) electricity demand or supply. This may be due to an increase in numbers of homes, businesses, electrical heating, electric vehicle charging or renewable generation. The times of peak events where there is high demand are traditionally on winter evenings between around 16:00 and 19:00 hours, while events from over-supply of solar generation are more likely to occur at midday in summer. The times of events will vary across the network, being influenced by the level of local industry, housing and renewable generation. The graph below illustrates the problem where demand is forecast to exceed the network's design limits.




SSEN constantly monitors its network, and where the electricity network in an area is projected to become overloaded, that area may be designated a Constraint Managed Zone (CMZ). Here contracts are negotiated with commercial organisations to lower demand or provide on-site generation – known as “flexibility” – at times of peak demand, or constraint, in a local area.

Social Constraint Managed Zones (SCMZs) aim to unlock **Community Flex** by providing financial rewards to local community organisation and businesses to encourage them to develop community-based projects that provide flexibility and energy saving. These projects thereby help address the network issues whilst benefitting those communities. Benefits extend beyond financial rewards as many projects also improve building quality and living comfort.

SSEN welcome proposals for any project which would lower demand at peak periods of electricity demand / consumption in an area. There are many examples of projects which may do this, and this brochure aims to highlight a few of these methods, but projects may be a mixture of approaches. The charts which follow illustrate 3 different approaches to reducing peak demand in a community, and their effects on energy use. Peak reduction reduces energy use (or generates electricity locally) at the peak time. Load-shifting does not reduce total electricity use but moves it to a non-peak time when the network can better meet the demand, whereas load reduction improves efficiency, reducing consumption over the daily profile. This is illustrated in the figure below.



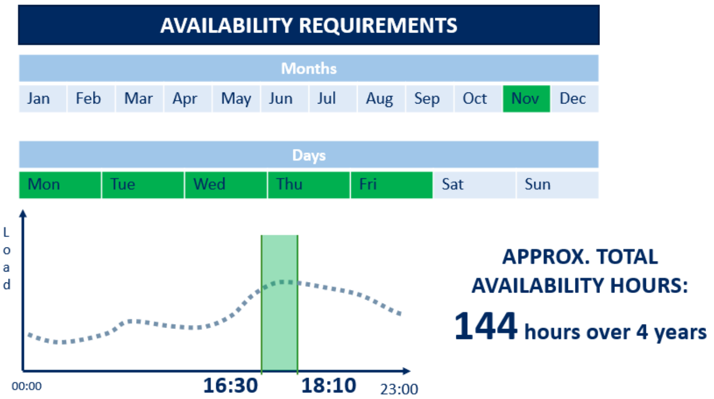

*Examples of load reduction (left panel) through energy saving and load shifting (right panel) though demand response. Without community flex the load would temporary exceed the network limits. The expected load without any measures (blue lines) is adjusted using Community Flex to stay within the network limits (green lines).*

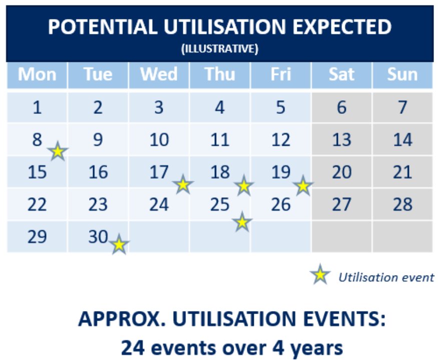
It is hoped that this brochure will assist prospective community partners to develop ideas for projects. The examples included are not an exhaustive list - other ideas, to help reduce consumption or move electricity use out of peak times, are also welcomed.

## Contracts & Payment

SSEN can predict the level of flexibility needed and the times when it might be required for an area of the electricity distribution network under consideration, up to 24 months ahead of time. Projects and locations for Community Flex will be sourced based on this estimated need for load reduction.

For example, in the Drayton zone, up to 5MW of flexibility needs to be available on weekdays in November between 16:30 and 18:10. There are a few days per year when this flexibility will be utilised. The network operator can predict these in advance and notify flexibility providers about when they will be required – this can be through smart technology, or by emails or text messages. Usually constraint events would be on weekdays, so **all assessments in this brochure have been made based on weekdays only**. Flexibility need, timings and payments will vary between constraint zones and exact values would be calculated by SSEN . and payments will vary between constraint zones and exact values would be calculated by SSEN.




Contracts for Community Flex are currently for 4 years[1], and are covered by 3 different contract types:

1. **Utilisation only**:
    - The provider is paid on a per-event basis when the flexibility is required and provided.
    - This type of contract may be best suited to projects where energy demand is reduced, or energy generation turned on, in response to a signal from the electricity network operator.
2. **Availability only**:
    - Payments are made for flexibility during the tendered time-window (whether or not a specific network constraint event occurs).
    - This is best suited to efficiency projects which permanently reduce electricity use, including through the constraint time-period.
3. **Traditional mix** – both Availability and Utilisation:
    - Here payments are made both during the specific network overload / constraint event (utilisation), AND for the periods when flexibility is normally required.
    - This could be suited to traditional electricity generation projects (which includes batteries) which generate & reduce capacity network constraints during the critical hours on an ongoing basis.

The table below shows payment levels for contracts for 2 example Community Flex zones. Payment levels may be quite different between zones so the amounts below serve as an indication only. It is necessary to consult the payment levels for the zone in question when estimating levels of payment for your project.

| Type of contract | Payment levels for Drayton zone | Payment levels for Coxmoor Wood |
|---|---|---|
| Utilisation Only | £868/MWh for 1.6h events | £638/MWh for 4.5h events |
| Availability Only | £33 per kW available | £69 per kW available |

[1] Contract values and durations may vary significantly across CMZ sites



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| | | |
|---|---|---|
| Traditional Mix | Utilisation: £4963/MWh<br>Availability: £150/MW/h | Utilisation: £140/MWh<br>Availability: £38/MW/h |

**How to participate**

SSEN welcomes proposals for lowering peak demand from interested parties. It should be noted though that all projects and Community Flex areas are quite different. SSEN's engineers will evaluate and cost every proposal on its individual merits, factoring in the electrical load saving required, the times of day and the number of times per year that the reductions are forecast to be required, compared to the cost of upgrade works which would be required if SSEN replaced the equipment in the traditional way now. This will allow partners to see anticipated funding available to community organisations to develop a project.

Those wishing to offer flexibility services need to complete a Pre-qualification Questionnaire (Initial Procurement document) followed by the Invitation to Tender (Full procurement document). Applicants must register on a procurement system called Achilles. This only needs to be done at Supplier Registration System (SRS) level (no fee), and allows SSEN to set flexibility providers up on their Emptoris tendering system. The tenders will be assessed based on a number of technical, economic and social criteria.

SSEN must be sure that the project will deliver the electricity savings or flexibility required, and that they can be relied upon for several years. The examples in this brochure give organisations an introduction of what may be considered, how payments may be calculated, and possible funding levels.

## How to use the brochure

This brochure includes a series of example measures or interventions which could provide flexibility. It is intended this should be used to provide guidelines to SME and community-based groups to build a virtual 'shopping cart' of initiative's they may wish to consider under a community flex scheme. This can then be used to estimate initial kW and kWh load-reductions and resultant community flex payments to aid in initial business case development and the commercial benefits of participating in a community flex programme.

**Types of measures**

The types of measures can be energy efficiency, indirect demand response or direct demand response.

- **Energy savings & energy efficiency** measures aim at reducing the energy consumption of participants by either upgrading appliances to more energy efficient ones.
- **Indirect demand response** provides time-dependent incentives to customers, encouraging them to shift electricity consumption in general to periods of lower demand.
- With **direct demand response**, the network operator rewards customers for agreeing to respond to specific requests (perhaps via email, SMS, or an app) to adjust their load or generation profile to manage potential constraint situations.

**Attractiveness to network and customer benefits**

Each measure is scored between 1 and 3 on its attractiveness to the network. This has been assessed by taking into account the amount of savings or flexibility that the measure might provide, the security of the supply of the flexibility, the expected longevity of the impact and the maturity of the technology.

The consumer benefits are also assessed with a score of between 1 and 3. This is based on the cost of the measure or intervention, the convenience of operation, the personal benefits provided by the measure (e.g. thermal comfort) and the impact on the climate.

### Savings potential and example payments

There is a description of the measure and a discussion of its savings potential which includes a graph. Savings in kilowatts (kW) from the measures shown in the graph can be used to estimate the payments from Community Flex using the contract payment levels.

For example, in the Drayton zone, the availability window for constraint events occurs during late afternoons in November. The payment for an availability-only contract is £33 per kW over the duration of the contract. Information in the measures section (below) shows that a saving of approximately 95kW could be achieved by replacing 1000 sodium streetlights with LED equivalents. This means the payment over the contract is £33/kW x 95kW = £3,135.

### Value stacking and sources of funding

One Community Flex project can provide services, and thus value, to multiple parties in the energy system. This is called value stacking. Value stacking should always be considered for measures during the project planning stages, where the measure provides multiple incomes, to improve the return on investment. For example, a battery could provide power grid support services to National Grid much of the time and occasionally also be used to support an electricity distribution network constraint event. At times a measure can achieve the aims of several services at the same time.

Also discussed are additional sources of funding towards measures. These are likely to be the main source of funding towards installing a new measure, with Community Flex contract payments providing an additional top-up to help improve the business case.

## List of example technologies and measures

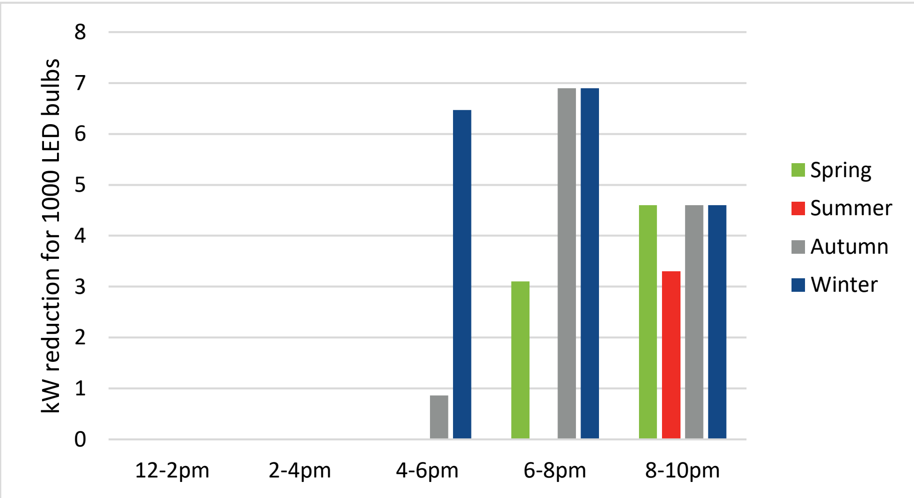
## Domestic LED lighting

| | |
|---|---|
| Type of measure: | Energy Saving |
| Attractiveness to network: |  |
| Customer benefits: |  |
| Type of contract: | Availability only |

Replacing incandescent or halogen bulbs with LED bulbs can typically reduce consumption by between 80 and 90%. This can include B22 bayonet bulbs consuming 40 to 100W or GU10 or GU5.3 downlights, rated at 50W or 35W. A halogen bulb may have a lifespan of up to 2,000 hours, whereas an LED is expected to last 25,000 hours.

### Savings potential

If a 50W Halogen bulb is replaced by a 4W LED, the saving per bulb would be 46W. Therefore if 1000 bulbs were replaced and they were all running, the saving would be 46kW. In practice not all the bulbs would be running at the same time, so taking this into account, the saving is projected to be 6.9kW during peak hours (4-8pm) and 4.6kW after 8pm. An assessment of the savings expected at different times of year is shown below, taking into account the changing time of sunset.




### Example payment

For illustration purposes, an estimate of the payments for an example contract is shown. Note that the constraint times and contract values will differ considerably between different Community Flex zones. Example calculations for other measures are provided in the Appendix. Payments will vary between constraint zones and exact values would be calculated by SSEN.

Events at the Coxmoor Wood zone occur in winter between 3.50pm and 8.20pm. It is possible to estimate the average kW reduction from installing 1000 LED bulbs to replace old incandescent or halogen ones by averaging the reduction in winter for the time periods 4-6pm and 6-8pm.

- Average kW saving during event = 0.5 x (6.5 + 6.9) = 6.7kW
- Payment (total) over 4-year contract at Coxmoor Wood = 6.7kW x £69/kW = £462



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## LED street lighting

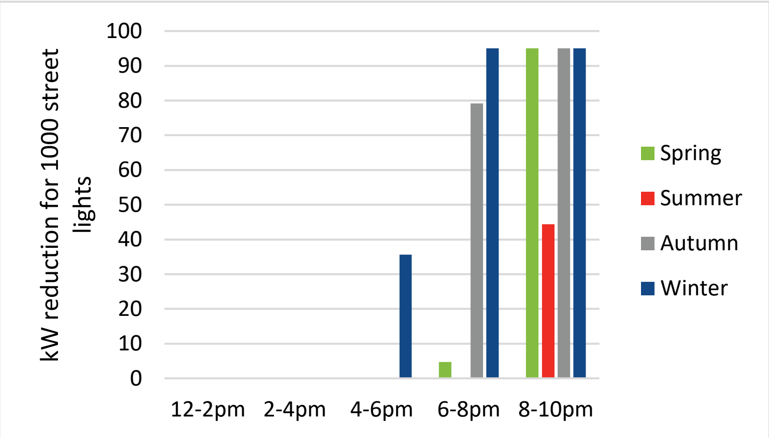
| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: | 👍👍👍 |
| Customer benefits: | 👍👍👍 |
| Type of contract: | Availability only |

The power consumption from street lighting may be from 35W to 400W per unit. Savings can be made by upgrading lighting, including replacing old sodium street lighting units with LED, and reducing excess lighting so that only town centres and main roads have the highest lighting intensity, whilst reducing light pollution. There is also potential for further financial savings by dimming, timer control, selective switching or presence detection to be used, though these solutions are usually only used outside peak hours so not at times when they would attract Community Flex payments.

### Savings potential

This example considers replacing old 90W SOX sodium street lighting with modern 35W LED units. On average, due to the power consumption of the control and ballast equipment for the light, 90W units actually consume around 130W[2]. This results in a saving of 95W per unit. In addition, LED lamps have an estimated lifetime of 10 years, compared to a 3 to 4-year lifetime for sodium bulbs.

The savings from replacing 1000 SOX sodium streetlights is therefore 95kW during operation. The variation of these savings with time of year is shown below, as sunset time changes.




### Sources of funding

Salix Finance Ltd[3] provides interest-free Government funding to the public sector to improve energy efficiency and reduce carbon emissions. Street lighting is one of the measures which are eligible. For local authorities, the loan is usually repaid from energy savings within a 5-year period.

### Example payment

For Coxmoor Wood zone, peak events occur in winter between 3.50pm and 8.20pm. An estimate of the average kW reduction from 1000 LED streetlight installations is made by averaging the reduction in winter for the time periods 4-6pm and 6-8pm: Average kW saving during event = 0.5 x (35 + 95) = 65kW

The total payment over a 4-year contract would therefore be approx. 65kW x £69/kW = £4,485. Contracts and payment levels for Community Flex will vary between different constraint zones. Payments will vary between constraint zones and exact values would be calculated by SSEN.

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[2] Street Lighting Load Research Report, elexon.co.uk/wp-content/uploads/2012/03/Street_Lighting_Load_Research_SOX_SON_2012.pdf, [Accessed 5/9/2019]

Office / commercial LED lighting

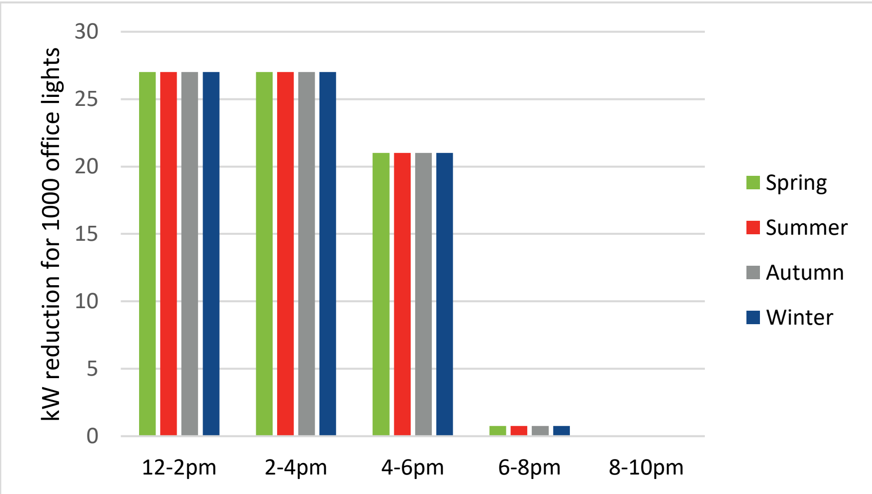
| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: | |
| Customer benefits: | |
| Type of contract: | Availability only |

Office lighting is often used consistently during the day, and savings can be made by replacing fluorescent tubes with LED panel lights. LEDs have an estimated lifespan of around 10 years, compared to under 6 years for fluorescent tubes. Other benefits are that the new LED fittings use “daylight” wavelength (less blue than original LEDs), reported to be a healthier light wavelength for an office or commercial space. Additional savings can be achieved by zoning circuits to enable lights to be turned off in areas which are not being used, and use of passive infrared sensors (PIR sensors), which can work as occupancy detectors.

## Savings potential

Many offices have recessed lighting fittings in the ceiling which contain 3 x T8 fluorescent tubes and these can be replaced by LED panels. The savings per light fitting are about 30W and so replacing 3000 T8 tubes with 1000 LED fittings could save 30kW.

| Scenario | Bulb type | Demand |
|---|---|---|
| Baseline | Fluorescent T8 tubes (2 foot) | 3 x 25W = 75W |
| Energy efficient | LED panel replacement | 45W |
| | **Saving per lighting unit** | **30W** |




In practice, not all lights will be used during the whole day: it is assumed that 90% of lights are used during office hours (9am-4pm), 70% are used as staff enter and leave the office (8am-9am and 4pm-6pm) while only 5% are used from 6pm-7pm when staff rarely use the office. The lights are used throughout the year and so this leads to a variation with time and month as shown.

## Value stacking and sources of funding

Again, Salix Finance could be a suitable source of interest-free funding for an installation in the public sector. Eligible public sector buildings include council offices, libraries, sports centres, museums, schools, colleges and hospitals.

## Example payment

The payment level for replacing 1000 office light fittings with LEDs was estimated to be £693 for the Drayton zone and £752 for Coxmoor Wood. These calculations are shown in the Appendix. Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Domestic solar PV

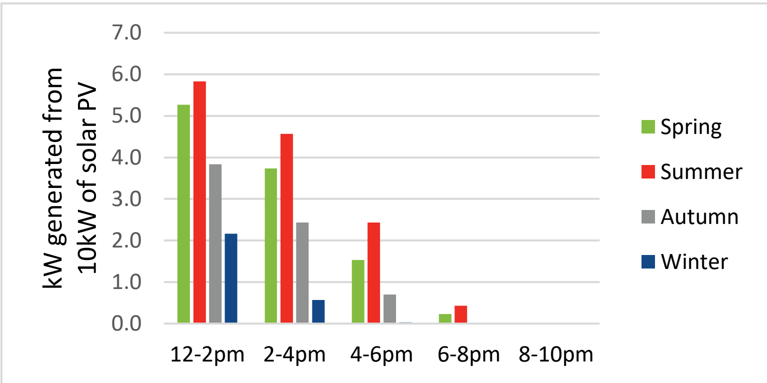
| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: | 👍👍 |
| Customer benefits: | 👍👍👍 |
| Type of contract: | Availability only |

Solar photovoltaic (PV) panels generate electricity which can be used in the home (or business) or exported to the electricity grid. As well as powering domestic appliances, it can be used with a solar immersion device to heat water, or to charge a battery or electric vehicle. When adopted at scale, there can be issues due to significant levels of PV export unless the systems have been coupled with local storage.

The generation from a PV system is influenced by the: system size, location, tilt, orientation and shading. A PV system will generate less electricity in winter when the days are shorter, and the sun is lower in the sky. Higher levels of generation occur between March and October.

### Savings potential

Simulations of the average hourly PV output were made for 10kW of solar PV facing south at an angle of 35 degrees. The graph shows how the average power output of a PV system varies with time of day and season. There is little or no PV generation in the late afternoon / early evening in winter. For many areas where the electricity network is constrained, maximum demand occurs on winter evenings between about 4pm and 8pm. A solar PV system on its own would therefore be of little benefit in reducing electricity demand on a winter evening and is therefore only likely to be encouraged in a Community Flex scheme where a constraint issue occurred at a non-standard time of day e.g. due to industrial use.




However, if a battery were also installed, this might be charged up earlier in the day, to power the home or business later in the afternoon / evening when constraint events are more likely to occur. Such a scenario is calculated later in this catalogue.

### Value stacking and sources of funding

The feed-in tariff (FiT) scheme for solar PV closed for new installations in March 2019. Installations that do not receive the FiT are eligible for the Smart Export Guarantee (SEG) from 2020. ECO3 can also provide funding towards solar PV in electrically heated homes for eligible households. Battery storage combines well with solar PV, maximising self-consumption and potentially offering grid services.

### Example payment

No payment is likely to be achieved for installing solar panels in a Community Flex zone where the constraint period occurs on winter evenings, as a negligible solar generation is seen at this time. Payments would only be received by installation - as value stacking - in conjunction with a battery.

## Loft insulation

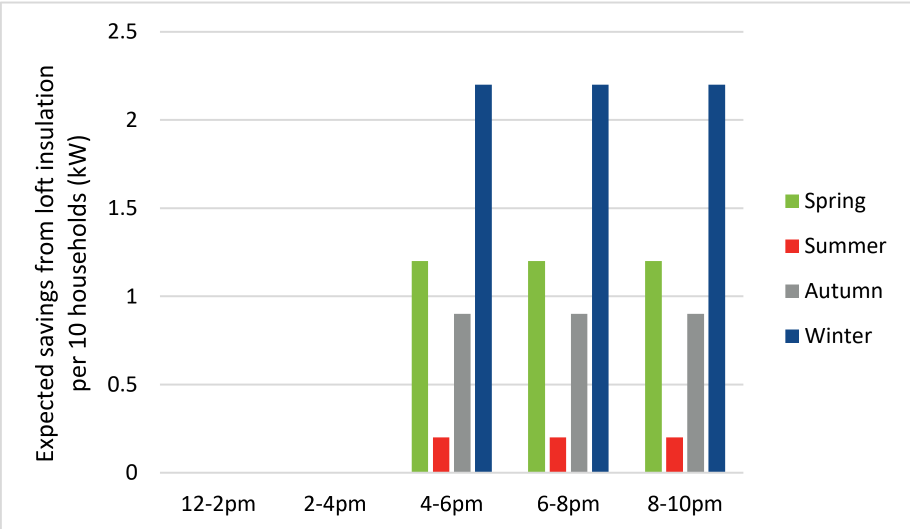
| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: | 👍👍👍 |
| Customer benefits: | 👍👍👍 |
| Type of contract: | Availability only |

Insulating a loft reduces the energy consumed to heat a house. If the house is heated by **peak-rate electric heaters**, this will lead to a reduction in electricity consumption. Although insulating properties heated by other fuels will save energy, it will not save electricity at the critical times.

Most lofts are insulated by laying mineral wool along the joists as this is the cheapest solution, and the current standard thickness is at least 270mm. More expensive alternatives are fitting insulation board or using spray foam insulation at rafter level (ventilation of rafters via the eaves is still required). This has the advantage of allowing use of the loft space for storage.

### Savings potential

The annual savings due to loft insulation is estimated to be 450kWh for a home heated by peak-rate electric heaters. This is an average across all property types. Using degree day data to assess heating need, and assuming that heaters run for 9 hours per day during the week and 16 hours per day during at the weekend, the below estimates of kW saving in electricity consumption were made.




### Sources of funding

The latest round of the Energy Company Obligation, ECO3 runs until 31 March 2022. Loft insulation can be funded for low income and vulnerable households who meet certain criteria or those who live in social housing with Energy Performance Certificates of band E or below. There may be other local sources of funding available in a locality – check with the local council for any schemes in the area.

### Example payment

The total payment level for the 4-year contract of insulating the lofts of 10 households was estimated to be £152 for the Coxmoor Wood zone using a saving of 2.2kW in winter (see the Appendix). Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Cavity wall insulation

| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: |  |
| Customer benefits: |  |
| Type of contract: | Availability only |

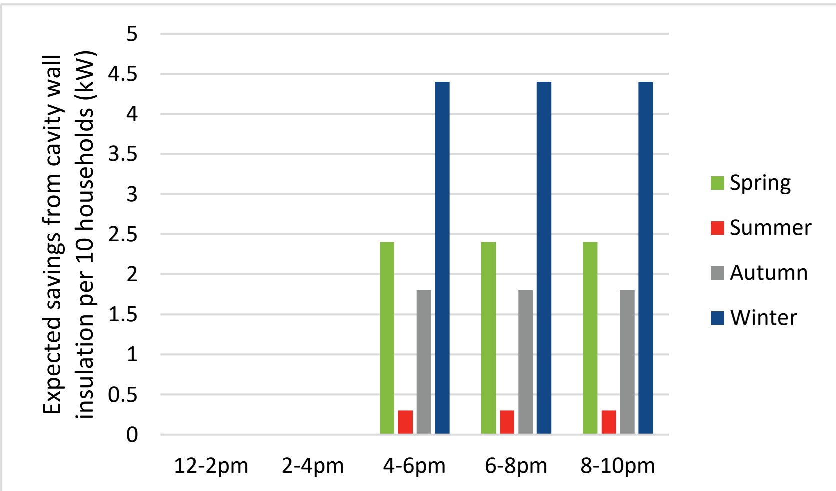
Homes built after the 1920s typically have a cavity between the inner and outer wall, which was originally aimed to reduce water penetration. The brick pattern for cavity walls has rows of bricks laid with their length exposed. Some properties with a cavity wall may however have a rendered outer surface.

After a tightening of Building Regulations in 1985, it became normal practice to fit insulation in the cavity for new-build homes. Older properties with uninsulated cavities can have insulation retrofitted. This involves drilling regular holes in the external wall and injecting insulating material such as fibre, cellulose, polystyrene beads or polyurethane foam.

Although cavity wall insulation will have limited impact on the electricity consumption of gas-heated homes, those which use **peak-rate electric heaters** will see an impact.

### Savings potential

The annual electricity savings due to loft insulation is estimated to be 900kWh for a home heated by peak-rate electric heaters. Using degree day data and assuming the heaters run for 9 hours per day during the week and 16 hours per day during at the weekend, the below estimates of kW saving in electricity consumption were made. These are shown for weekdays for each month.




### Sources of funding

Under ECO3, which runs until 31 March 2022, cavity wall insulation can be funded for households, owner-occupiers or those who are privately renting who are in receipt of qualifying benefits. Funding is also available for cavity wall insulation for social housing properties with EPC ratings of E, F or G.

### Example payment

The total payment level over the 4-year contract for insulating the cavity walls of 10 households was estimated to be £304 for the Coxmoor Wood zone using a saving of 4.4kW in winter (see the Appendix). Payments will vary between constraint zones and exact values would be calculated by SSEN.

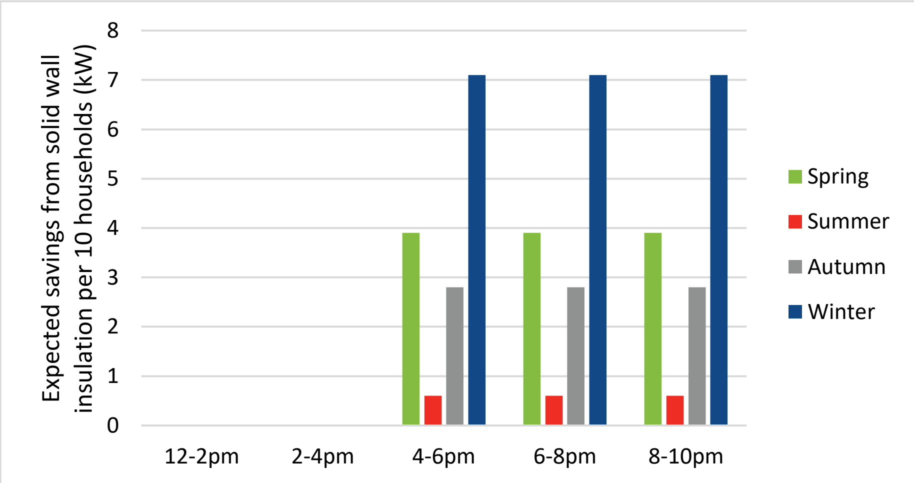
## Solid wall insulation

| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: | |
| Customer benefits: | |
| Type of contract: | Availability only |

Brick walls of properties before the 1920-30s typically did not have cavities, so are described as "solid". Ends of bricks can be seen in the brick pattern, which go straight through the thickness of the wall. These walls can be insulated by external or internal wall insulation.

### Savings potential

Although solid wall insulation is significantly more expensive than cavity wall insulation, the savings are higher. The estimated annual electricity saving for an average home heated by peak-rate electric heaters is 1,440kWh. Degree day data and the standard times for heating used for Energy Performance Certificates were used to estimate the kW savings below for different months.




### Sources of funding

Funding towards solid wall insulation is available under ECO3 for those who are owner-occupiers or those privately renting who are in receipt of eligible benefits. There is also funding available towards solid wall insulation for social rented properties in EPC bands E, F or G. The level of funding will depend on factors such as the property detachment and size.  Electrically-heated properties receive higher levels of funding than those heated by other fuels. Some local authorities can provide additional funding under Flexible Eligibility for ECO3, widening the eligibility or increasing the support – check with the local council for the area.

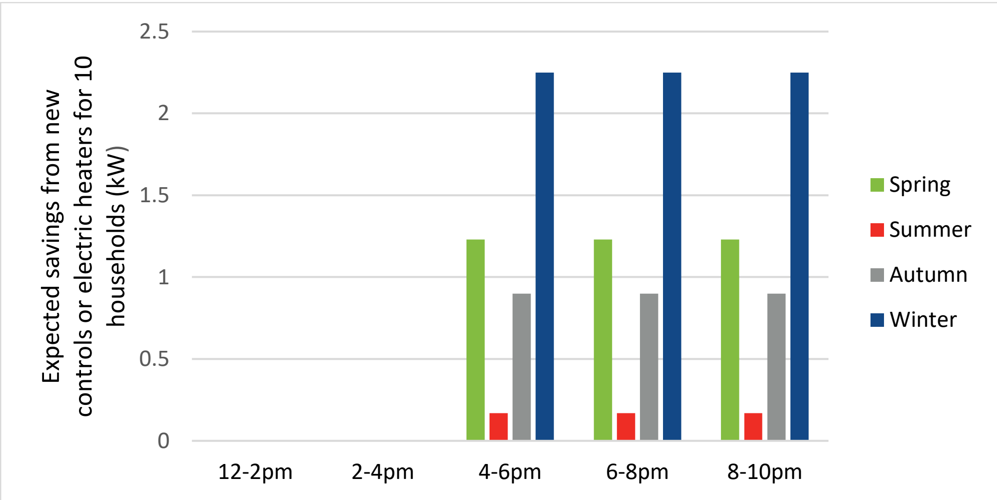
### Example payment

The estimated saving on a winter evening from insulating the solid walls of 10 households is 7.1kW. For the Coxmoor Wood zone, this would result in a total payment of £490 over the 4-year contract. Payments will vary between constraint zones and exact values would be calculated by SSEN .

## New heating controls or peak-rate heaters


| | |
|---|---|
| Type of measure: | Energy Efficiency |
| Attractiveness to network: | |
| Customer benefits: | |
| Type of contract: | Availability only |

An improvement in the energy efficiency of homes using peak-rate electric heaters can be achieved by installing more advanced heating controls to existing electric heaters, or replacing old electric heaters with modern versions which have improved temperature control. Heaters manufactured after 1st Jan 2018 must comply with Lot 20 of the EU EcoDesign Directive which requires better control and efficiency.  Smart heating controls can include presence detection, weather compensation or remote control either via web or smartphone app.




### Savings potential

The annual heating demand for a standard 3-bed semi-detached home in the South East is about 13,000kWh. It is assumed that properties have a standard heating pattern of 9 hours per weekday and 16 hours at the weekend as used when producing an Energy Performance Certificate.

The evening heating period is assumed to be 4pm to 10pm. The average saving per year is estimated to be 5%, but a [diversity] factor of 70% is applied to deal with the variability of heating use in a community. The savings over different seasons were calculated using outdoor temperature [Degree Day] data.

### Value stacking and sources of funding

Funding is available for some heating controls under ECO3 or ECO3 innovation. Greater energy and cost savings at peak periods would be achieved by replacing peak-rate electric heaters by modern high heat-retention storage heaters on a time-of-use tariff (a scenario calculated next in this catalogue).

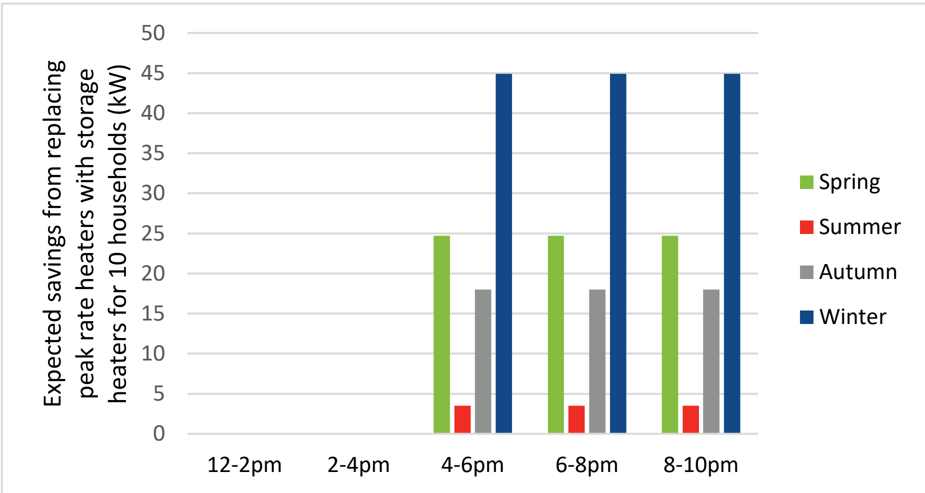
### Example payment

For the Coxmoor Wood zone, the payment over the full 4-year contract is estimated to be £155 when 10 households have new better heating controls on their peak-rate electric heaters installed, or new peak-rate heaters fitted which have better controls built in. Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Replacing peak-rate electric heaters with storage heaters

| | |
|---|---|
| Type of measure: | Energy Saving |
| Attractiveness to network: | |
| Customer benefits: | |
| Type of contract: | Availability only |

Some homes which are not connected to the mains gas grid may have their space heating provided by peak-rate electric panel heaters or electric radiators. These are costly to run for the residents and have a high electricity consumption during times when grid constraints are likely to occur. A potential solution may be to replace these peak-rate heaters with modern storage heaters (which have heating time and temperature control). Consumption of electricity would be shifted from peak periods to overnight, so benefiting the electricity network. The household could switch to an Economy 7 tariff and save money on the electric heating. The Dimplex Quantum is one model of modern storage heater which has a high heat-retention and so limits heat loss during the middle of the day when the home may not need heating. It also has a digital timer and thermostat.




### Savings potential

For a semi-detached home in the South East, the annual heating demand is 13,000kWh. It is assumed there is some under-heating of homes using peak-rate heaters, as well as heating outside the normal heating times. A diversity factor of 70% is used to account for this. Consumption per month was estimated using Degree Day data and that consumption assumed to be distributed across standard heating hours. The savings by time and season are shown for replacing peak-rate electric heaters with off-peak storage heaters in 10 households.

### Value stacking and sources of funding

Grants may be available to provide funding towards new storage heaters. However, many have been focused only on households with faulty storage heaters rather than peak-rate heaters. While switching to Economy 7 for the storage heaters, there is also potential for off-peak water heating and fitting of a mixer shower. Replacing peak-rate heaters with modern storage heaters will lead to cost savings for the residents.

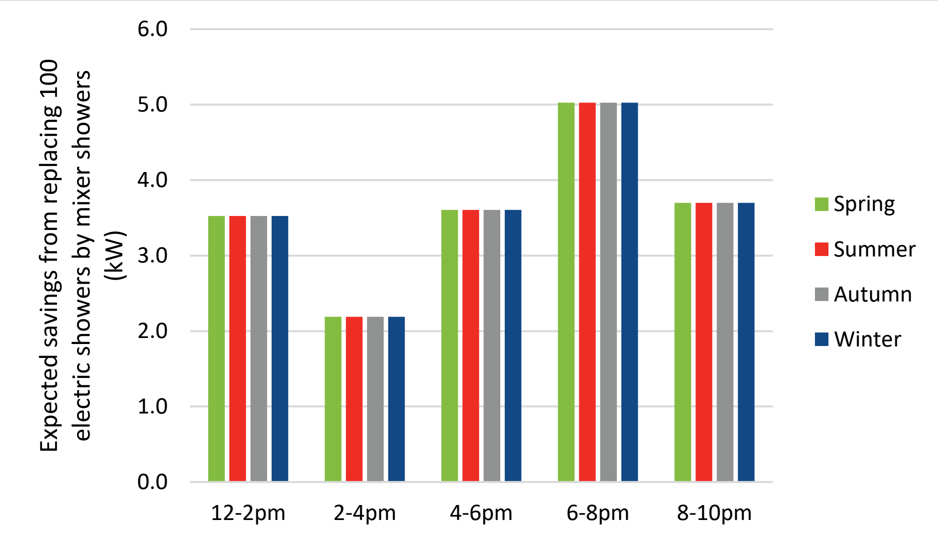
### Example payments

The payment for replacing peak-rate electric heaters with storage heaters in 10 households is estimated to be £3,104 for the Coxmoor Wood constraint zone over the 4-year contract. For the Drayton zone, it is estimated to be about £594. Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Replacing electric showers

| | |
|---|---|
| Type of measure: | Indirect Demand Response and Energy Saving |
| Attractiveness to network: | |
| Customer benefits: | |
| Type of contract: | Availability only or Traditional Mix |

Electric showers are more common in homes which are not on the mains gas grid. They are normally rated at between 7.5kW and 10.5kW. If a landlord were planning bathroom upgrades - particularly if they coincide with heating system / plumbing alterations - they may consider replacing an electric shower with a mixer shower using the domestic hot water. For a property which is not on the gas grid, water for a mixer shower could be heated by an immersion cylinder on a time-of-use electricity tariff, or renewable heating.




### Savings potential

Savings from removing electric showers and replacing with off-peak electrically-heated mains mixer showers in 100 properties would result in the savings (kW) below. Switching to a heat pump could make these same savings during peak hours (4-8pm) only, if water was heated outside these times.

### Value Stacking

There is potential for value stacking when homes with peak-rate electric heaters have them replaced with a heat pump which could – for best savings - also supply water for the mixer shower. Water heating by the heat pump could be carried out outside of peaks in electricity consumption. If the house had solar PV, this could supply power for a heat pump, or a solar immersion device could divert excess PV generation to power the immersion heater of a hot water tank. Note that PV generation is lower in winter, but there is likely to be some contribution towards water heating in the middle of the day.

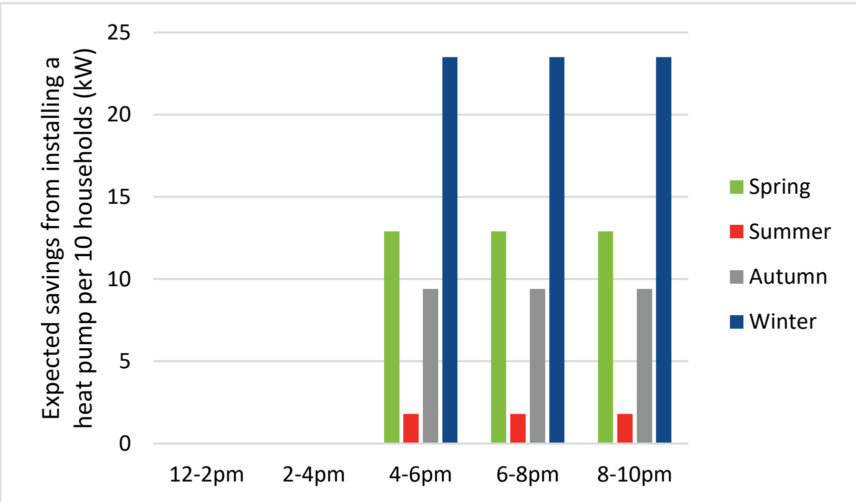
### Example payment

For the Coxmoor Wood constraint zone, the total payment over a 4-year contract for replacing 100 electric showers by mixer showers would be about £297. For the Drayton zone, it would be a total of about £119. Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Replacing peak rate electric heaters with a heat pump

| | |
|---|---|
| Type of measure: | Energy Saving |
| Attractiveness to network: | 👍👍👍 |
| Customer benefits: | 👍👍 |
| Type of contract: | Availability only or Traditional mix |

Peak-rate panel heaters or electric radiators are likely to have a high electricity consumption during the early evening in winter. In suitably insulated properties, electric heaters can be replaced with a wet central heating system supplied by an air or ground-source heat pump. The heat pump extracts heat from its surroundings and as a result, about 1kWh of electricity can produce 3kWh of heat.




### Savings potential

For a standard 3-bedroom semi-detached home in the south east, the heating demand is about 13,000kWh. A home heated by peak-rate electricity is likely to be under-heated, with rooms only heated when occupied. The electricity consumption of the heat pump is about one third of the heating demand. Taking these factors into account, it is estimated that after switching from electric radiators to a heat pump the savings are likely to be about 4,767kWh per year. The reduction in electricity consumption in kW was estimated using degree day data and assuming the standard periods for heating used when generating an Energy Performance Certificate (EPC), for 10 homes.

### Value stacking and funding

Funding is available for heat pumps from the Renewable Heat Incentive (RHI), which will be available until at least 31 March 2021. If a heat pump supplies more than one house – or a business – it could be eligible for the non-domestic RHI which pays a lower amount over 20 years instead of the domestic RHI, which makes payments over 7 years. While fitting a new wet central heating system, additional savings could be achieved by replacing an electric shower with a mixer shower supplied by the heat pump. A solar PV system can supply power for the heat pump, however there is limited generation in winter when the heat pump is used most. There is potential for heat pumps to offer grid services, with the output reducing during grid constraint events. The output could also be increased if the network is over-supplied.

### Example payment

It is estimated that for the Coxmoor Wood zone, the total payment for replacing peak-rate heaters with heat pumps in 10 homes would be £1,622 over the 4-year contract (see the Appendix). Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Large domestic battery on a time-of-use tariff


| | |
|---|---|
| Type of measure: | Indirect Demand Response |
| Attractiveness to network: | 👍👍👍 |
| Customer benefits: | 👍👍 |
| Type of contract: | Utilisation only |

Larger domestic battery systems can typically have a capacity of 5 to 13.5kWh. Some manufacturers have modular systems where the capacity can go up to about 20kWh. The battery can charge from a solar PV system for free, or from the electricity grid at a reduced rate during off-peak periods with a time-of-use (TOU) tariff. New tariffs are becoming available for electric vehicle charging which can supply power overnight for 4 hours at as low a cost as 5p/kWh. The charged battery can supply the home during peak-rate periods. or potentially offer grid services.

### Flexibility potential

Depending on the model of battery, it can output up to 3.68kW with a standard grid connection or 5kW with a full G99 grid connection. Under normal operation, while charged, the battery will supply power based on the household demand, up to the maximum power output. Where batteries offer grid services, there is potential for some systems to set the level of battery output and schedule when this occurs.

When offering grid services, the power output which could be provided depends on the battery capacity and the period the power is supplied over, as shown in the table below.

| | Battery Capacity (kWh) | | |
|---|---|---|---|
| Power output | 5kWh | 8kWh | 13.5kWh |
| 2kW | 2.5h | 4h | 6.75h |
| 3.6kW | 1.39h | 2.2h | 3.75h |
| 5kW | 1h | 1.6h | 2.7h |

It is normally possible to notify the battery manager a day or two in advance of an event. They can ensure the battery is charged - during an off-peak period - and schedule it to supply power during the event. This may be carried out by the battery supplier / manufacturer who manages the contract with the network operator, or by an energy manager.

### Value stacking

Combining a battery with a solar PV system allows excess solar generation to be stored and used for free in the evening, reducing household import at peak times. Households on a time-of-use tariff can charge the battery on off-peak and discharge during peak-rate periods, saving money. Additional revenue could be avalable from Community Flex from reducing household import during an electricity network constraint event. In addition, the battery could provide grid services for National Grid supporting Firm Frequency Response (FFR). Note that when one service is provided, it may not be possible to also provide another.

### Example payment

In Drayton zone, the estimated payment for 10 x 13.5kWh Tesla Powerwall 2 batteries with a 5kW grid connection for a 4-year utilisation-only contract would be £1,729 (£1,623 net if charged from the grid at 5p/kWh). In Coxmoor Wood, the equivalent would be £2,067 (£1,905 if charged at 5p/kWh) – note that it could only supply a household (and possibly also the grid) for 3.75hrs at maximum output. Payments will vary between constraint zones and exact values would be calculated by SSEN.

## Community Battery

| | |
|---|---|
| Type of measure: | Indirect or Direct Demand Response |
| Attractiveness to network: | 👍👍👍 |
| Customer benefits: | 👍👍 |
| Type of contract: | Utilisation only |

A community battery is large battery, typically 200 to 2000kWh, which is privately owned, located "before the meter" that serves more than user (so not just the owner) and can provide multiple services to the energy system. Residential or commercial end-users can use such a battery to store excess solar energy for later use or charge it at a reduced rate with a time-of-use (TOU) tariff. Network operators can leverage this form of energy through TOU tariffs or direct demand response events to shift load and reduce peak load on the network.

### Flexibility potential

Batteries are typically characterized by two ratings: the amount of energy they can store, in kWh, and the amount of power they can provide, in kW. The combination determines how much flexibility they can provide. As a rule of thumb, the average peak household consumption is approx. 1kW so a 200kWh community battery can supply 200 houses with power for about 1 hour. Since for peak shaving and congestion management only part of the power needs to be provided by the battery, such a system is well-suited to manage substantially longer periods of high demand.

### Value stacking

Community batteries provide value to many actors in the energy system. Local residents and business can more effectively use their own generated solar energy, or trade within the community. The battery owner / operator can participate in demand response schemes that help the network operator manage constraints. Beyond that, the battery can provide grid support services like Firm Frequency Response to National Grid. (FFR). Currently, revenues from this are likely to exceed those from constraint management at the distribution level. Note that depending on the battery's capacity, not all services may be provided concurrently.

### Example payment

Community batteries are a relatively new development. Their economic feasibility strongly depends on projected growth in demand and associated constraint events, existing feed-in-tariff and TOU schemes and the amount of locally produced excess energy from solar panels. A detailed business case should be developed for each potential deployment of a community battery to determine payment levels to end-users and payback times for the battery owner / operator.

The sensitivity to local circumstances is reflected in payment levels observed in case studies abroad. In favourable conditions, the value provided to the network operator can be almost £2500 per MW per month, yielding a payback time of approximately 5 years[4].

4 DNV GL, Feasibility and scalability of the community battery

## EV charging – delaying charge time

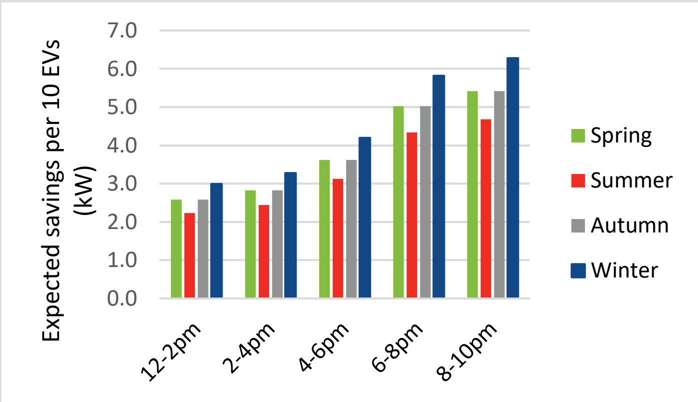
| | |
|---|---|
| Type of measure: | Indirect Demand Response |
| Attractiveness to network: | 👍👍👍 |
| Customer benefits: | 👍👍 |
| Type of contract: | Utilisation only |

There is a need to decarbonise transport as well as electricity generation. In 2018, the UK Government announced that all new cars and vans sold in the UK by 2040 should be zero emissions capable (electric, plug-in hybrid electric or hydrogen). There were 30.9m licensed petrol and diesel cars at the end of 2018 with 620k alternate fuel cars. The expected growth of electric vehicles will present challenges to the electricity network with vehicle charging. Customers can support network operators in managing the increased (peak) load by shifting the charging time to off-peak hours.

### Flexibility potential

A study by Element Energy showed the average annual charge for an EV was 1,760kWh/year, with 75% of charging taking place at home and households typically using 3.6 or 7kW chargers[5]. Charging demand is higher in winter when battery performance is lower, and heating is required in the vehicle. The My Electric Avenue project involved over 100 Nissan Leaf drivers in clusters of 10 or more households. There was an average peak in demand of about 1.2kW at about 8pm from EV charging when taking into account diversity from households charging at different times.[6]

Average power consumption for EVs was estimated from the My Electric Avenue demand profile, with compensation made for time of the year based on Element Energy report data. It assumes that 50% of households could be persuaded to delay charging to outside the peak period, perhaps by switching to an EV time of use tariff e.g. Octopus EV tariff at 5p/kWh for 4 hours overnight.




EVs represent a large amount of controllable load: an attractive option for peak reduction to network operators and customers alike, as delayed charging is normally possible while retaining convenience levels.

### Value stacking

The batteries in EVs can be used to provide electricity to homes during peak hours or when installed solar panels don't provide electricity, thereby taking on a role similar to that of a home battery. Additionally, EV batteries can provide monetizable congestion management and grid support services to network operators.

### Example payment

For 10 households engaged – owning one EV each – with 50% delaying charging to outside peak hours, total payment levels for a 4-year contract in Coxmoor Wood are estimated to be £345, and for Drayton £125. Payments will vary between constraint zones and exact values would be calculated by SSEN.

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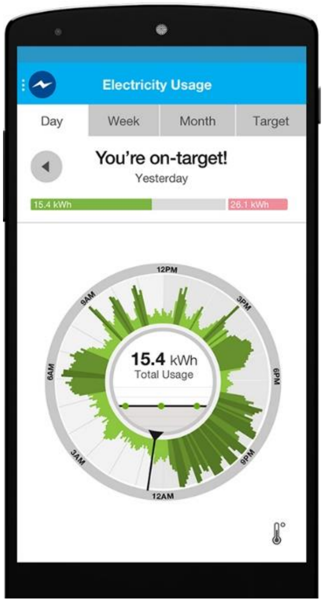
[5] Electric Vehicle Charging Behaviour Study, Element Energy (29 Mar 2019) www.element-energy.co.uk/wordpress/wp-content/uploads/2019/04/20190329-NG-EV-CHARGING-BEHAVIOUR-STUDY-FINAL-REPORT-V1-EXTERNAL.pdf [Accessed 11/9/19]
[6] My Electric Avenue, Project Close-down report (March 2016), myelectricavenue.info/project-documents, [Accessed 25/9/19]

## Smart Apps for behaviour change




| | |
|---|---|
| Type of measure: | Indirect Demand Response |
| Attractiveness to network: | 👍 |
| Customer benefits: | 👍👍 |
| Type of contract: | Availability only or Traditional mix |

Smart Apps for behaviour change provide customers with personalised insights in how they use energy and combine this with tips on how to lower their energy bill. Customers save money by reducing their energy consumption or by shifting it to off-peak times when lower tariffs apply, or other rewards are provided. The apps often contain a gaming element, challenging the user to improve on earlier savings, or save more than others in his community. Apps like this provide a fun and efficient way to engage customers in energy saving and load shifting, while simultaneously strengthening the relationship between the app provider, e.g. the energy supplier or network operator.

### Savings potential

The savings potential for these types of applications strongly depends on the apps ability to give relevant, targeted and actionable advice to its users. Achieved savings have shown to be 2% in terms of energy consumption and up to 30% of load reduction during peak events[7].

Network operators support energy awareness applications. For behaviour change to substantially and sustainably contribute to peak load reduction it is important that the app is used persistently across the customer base for customers to internalise the behaviour change. Additionally, successful apps should provide a communication channel for network operators to advertise e.g. peak event and associated perks.

Customers need to have a real ability to act on the provided advice, and the app should support a accessible and attractive feedback system with positive dialogs about energy management.

### Value stacking

Smart Apps for behaviour change can be expanded to include a localized component, where e.g loyalty points can be earned for energy saved, which can be spent at selected retailers or donated to a local charity, reducing app usage churn and benefit the customer and community. App providers can develop revenue sharing models with providers white goods and lightning soluitions to promote customer savings by switching to energy-efficient appliances.

### Example payment

The total payment level for the 4-year contract providing a Smart App for behaviour change to 1,000 households is estimated to be £518 for the Coxmoor Wood zone and £248 for the Drayton zone (see the Appendix). Payments will vary between constraint zones and exact values would be calculated by SSEN.

[7] https://www.engerati.com/article/addictive-energy-saving-apps-energy-management

## Energy Advice

| | |
|---|---|
| Type of measure: | Energy Saving and Indirect Demand Response |
| Attractiveness to network: | 👍 |
| Customer benefits: | 👍👍 |
| Type of contract: | Availability only or Traditional Mix |

Energy advice given to households is one way of encouraging reductions in, or time-shifting of, electricity use . Advice can be combined with providing technologies like those in this brochure. It may be delivered via generic leaflets, other communication means such as social media, or as more bespoke advice from independent energy practitioners, energy suppliers or network operators. Programs which do not deploy technology can appear relatively cheap in cost per kW but have high levels of uncertainty in savings, and longevity of electrical load impact, so have greater risks for DNOs.

### Savings and Flexibility potential

Load reduction from energy advice programs occurs when awareness raising is combined with the ability to act. Recent projects demonstrating this include:

- SAVE[8] (SSEN) in the Solent area had several strands. Engagement and nudge techniques (by post and online) with dynamic pricing were used to encourage reduced household consumption from 4 to 8pm. Reductions averaged 1.8% for behaviour change only – achieving up to 3.8% or 24Wh per household – and 2.6% with incentives (raffle for a shopping voucher). Community Energy Coaching achieved demand reduction of over 10% in some groups with active sign-up rather than just promotion, and over 50% participation when messages were from a community group.
- energywise[9] (UK Power Networks) was a project focussed on areas with high levels of fuel poverty in London. The project achieved overall energy savings of 3.3%, and 23W (or 5.2% ) peak energy demand per household through advice provision only.
- Power Saver Challenge[10] (Electricity North West Ltd) - energy advice & small interventions linked with an area-based peak-time energy saving competition, resulted in savings of 1.1kWh per household.

### Value stacking and sources of funding

Additional value from energy advice programs are largely soft, less monetizable benefits such as a better understanding of the role of the network operator and an increased sense of community. They are likely to allow referral of householders to energy efficiency, benefits maximisation and other support services that may be relevant to their situation, improving the local community's health, wellbeing and financial stability.

### Example payment

The total payment level over a 4-year contract for providing energy advice encouraging "shifting" energy use out of peak periods to 100 households is estimated to be £207 for the Coxmoor Wood zone and £99 for the Drayton zone (see the Appendix). Payments will vary between constraint zones and exact values would be calculated by SSEN.

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[8] SAVE – Solent Achieving Value from Efficiency https://save-project.co.uk/ (Accessed 15 Nov 2019)

[9] Vulnerable Customers and Energy Efficiency (energywise) Project Closedown Report, December 2018

[10] Power Saver Challenge Project Closedown Report, January 2017 www.enwl.co.uk/globalassets/innovation/power-saver-challenge/power-saver-challenge-closedown-report.pdf [Accessed 14/11/2019]

# Appendix – Methodologies for calculations

This Appendix provides details of the assumptions that were made when estimating the kW savings achieved for groups of properties after an intervention is deployed. It also shows simplified calculations which estimate the Community Flex payments based on the kW savings. These are for Social Constraint Managed Zones (SCMZ) in Drayton and in Coxmoor Wood. Note that the contract values for other SCMZs will be different and estimates for payments would need to be based on the contract for the zone considered.

## Domestic LED

If a 50W Halogen spotlight bulb is replaced by a 4W LED, the saving per bulb would be 46W.

- Maximum peak demand reduction possible through replacing 1000 halogen spotlight bulbs: 1000 x 46W = 46,000W saving

Not all will be operating at the same time – household activities in different rooms change during the evening – and date as sunset time changes (calculations use those for London). This will cause a variation in diversity factor. Those used are from a recent study of an LED trial in the Solent area [11].

- Applying a 15% diversity factor during peak hours (4-8pm): 0.15 x 46,000 = 6,900W (6.9kW)
- And a diversity factor of 10% during off-peak hours: 0.10 x 46,000 = 4,600W (4.6kW)

### Payment levels

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm

- It tends to be dark in November by 4.30pm and so it is suitable to use a value of 6.9kW for the savings from 1000 LED bulbs, taking diversity into account.
- The payment for an availability only contract for Drayton is £33/kW

Expected payment from 4-year contract = 6.9kW x £33/kW = **£228**

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in November, December and January from 3.50pm until 8.20pm

- It is possible to estimate the average saving from the LED bulbs from the graph of the Domestic LED page. Between 4pm and 6pm the saving is 6.5kW and between 6pm and 8pm it is 6.9kW, so the average saving is 6.7kW.
- The payment for an availability only contract for Coxmoor Wood is £69/kW

Expected payment from 4-year contract = 6.7kW x £69/kW = **£462**

## LED Street Lighting

Assume 20 lighting units in a residential street are replaced: 20 x 95W = 1,900W saving

- Maximum peak demand reduction possible through replacing 1000 SOX sodium streetlights: 1000 x 95W = 95,000W (95kW)

Whilst streetlamps are certain to be in use once turned on (i.e. 100% diversity factor), they will not always be operating at peak times throughout the year as sunset times change. The calculations for the variation in savings with time of year used the average sunset time in London for each month, with street-lighting light-up time assumed to occur 30 mins after this.

### Payment levels

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in November, December and January from 3.50pm until 8.20pm

- It is possible to estimate the average saving from the LED bulbs from the graph of the Domestic LED page. Between 4pm and 6pm the saving is 35kW and between 6pm and 8pm it is 95kW, so the average saving is 65kW.
- The payment for an availability only contract for Coxmoor Wood is £69/kW

Expected payment from 4-year contract = 65kW x £69/kW = **£4,485**

## Office/Commercial LED Lighting

The calculation for replacing office lighting assumed a relatively small office, occupied from 8 am until 6 pm. Old-style T8 fluorescent tube lighting was replaced with modern LED panels, with 36 T8 fluorescent tubes replaced by 12 LED panels which could produce the same level of lighting.

The old fluorescent tubes were assumed to be recessed in the ceiling, with 3 tubes fitted in each suspended ceiling tile space. There were 12 such light fittings across the office, making a total of 36 tubes. These were replaced by 45W LED panels, with 12 panels replacing 36 tubes for the same level of light output.

It was assumed that there was a diversity factor of 90% during working hours as some members of staff may have been out of the office. Between 5 and 6pm this reduced to 70% as staff left and 5% between 6pm and 7pm, with no consumption afterwards as the building was locked.

- Consumption for a T8 lighting unit: 3 x 25W = 75W
- Saving from replacing T8 lighting unit with LED panel: 75W – 45W = 30W
- Saving from replacing 1000 T8 lighting units: 1000 x 30W = 30,000W = 30kW
- Saving from replacing 1000 T8 tubes: 1000 x 10 = 10kW
- However not all will be operating during peak time:
- Applying a 90% diversity factor during office hours (9-4pm): 0.90 x 30,000 = 27,000W (27kW)
- 70% diversity factor in arriving/leaving periods (8-9am, 5-6pm): 0.70 x 30,000 = 21,000W (21kW)
- And 5% diversity during out of office peak hours (6-7pm): 0.05 x 30,000 = 1,500W (1.5kW)

### Payment levels

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm

- Taking the value from the graph for office lights for the 4pm – 6pm covers most of the window.
- kW reduction of 1000 office lights from 4pm – 6pm = 21kW
- The payment for an availability only contract for Drayton is £33/kW

Expected payment from 4-year contract = 21kW x £33/kW = **£693**

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in December, January and February from 3.50pm until 8.20pm

- It is possible to estimate the average saving from fitting LED office lights from the graph on the Office lighting page for the winter period. Between 4pm and 6pm the saving is 21kW and between 6pm and 8pm it is 0.75kW, so the average saving is 10.9kW.
- The payment for a 4-year availability only contract for Coxmoor Wood is £69/kW

| Expected payment from 4-year contract = 10.9kW x £69/kW = **£752** |
|---|

## Solar PV

The solar PV systems considered in this scenario was either a single 10kW or 10 x 1kW PV systems located in Reading and facing south at an angle of 35 degrees. The PV generation was estimated based on data from Renewables.ninja[12] which simulates the hourly average kW output throughout the year for PV systems of different sizes, locations, orientations and inclinations.

There is little or no PV generation in the late afternoon/early evening in winter. For many areas where the electricity network is constrained, maximum demand also occurs on winter evenings between about 4pm and 8pm. This means that solar PV on its own is likely to be of limited benefit on its own in such situations – and so no Community Flex payments would be received - but might be combined with a battery.

For example, the constraint period for the Coxmoor Wood zone is between 3.50pm and 8.20pm in December, January and February and so there is likely to be no direct benefit from solar PV systems during constraint events. However, if the PV system are used to charge a battery earlier in the day which could supply power to the household during the event, then the PV system can provide benefit.

## Insulation: Loft, cavity wall and solid wall

Assessments were made of the savings which would be achieved following insulation for homes using peak rate electric heaters as the primary heating source. Data from the National Energy Efficiency Data Framework (NEED)[13] showed the savings achieved after different types of insulation. This was for homes heated with a gas boiler, across all property types. Assuming that the gas boilers were about 90% efficient it was possible to estimate the savings which might be achieved in a home using peak rate electric heating as the primary form of heating.

- Average saving after loft insulation for a home heated by gas = 500kWh
- Saving after loft insulation when using peak rate electric heaters = 0.9 x 500kWh = 450kWh
- Average saving after cavity wall insulation for a home heated by gas = 1000kWh
- Saving after cavity wall insulation when using peak rate electric heaters = 0.9 x 1000kWh = 900kWh
- Average saving after solid wall insulation for a home heated by gas = 1600kWh
- Saving after solid wall insulation when using peak rate electric heaters = 0.9 x 1600kWh = 1440kWh

The savings per month were estimated using 20-year averages for degree days for the Thames Valley region[14]. It was assumed that the heaters ran for 9 hours per day during the week and 16 hours per day at the weekend. The evening heating period was from 4pm to 10pm and it was assumed that average consumption was the same across all heating hours in the month. This allowed an estimate of the kW reduction in electricity consumption to be made.

12 www.renewables.ninja (Accessed 19 Sept 2019)

13 National Energy Efficiency Data Framework (NEED) impact of measures data tables 2019 www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-impact-of-measures-data-tables-2019 (Accessed 13 Sept 2019)

14 20-year average values, Degree day data, http://vesma.com/ (Accessed 25 Sept 2019)

### Payment levels

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in December, January and February from 3.50pm until 8.20pm. The graphs on the insulation pages were used to estimate the kW savings for each technology for winter evenings.

Loft insulation:

The kW saving between 4pm and 8pm (as a nearest approximation) is 2.2kW for insulating 10 homes
The payment for an availability only contract for Coxmoor Wood is £69/kW

Total contract payment over 4 years for insulating 10 homes = 2.2kW x £69/kW = **£152**

Cavity wall insulation:

The kW saving between 4pm and 8pm is 4.4kW for insulating 10 homes
The payment for an availability only contract for Coxmoor Wood is £69/kW

Total contract payment over 4 years for insulating 10 homes = 4.4kW x £69/kW = **£304**

Solid wall insulation:

The kW saving between 4pm and 8pm is 7.1kW for insulating 10 homes
The payment for an availability only contract for Coxmoor Wood is £69/kW

Total contract payment over 4 years for insulating 10 homes = 7.1kW x £69/kW = **£490**

## New heating controls or peak rate heaters

Heating demand for a standard 3-bed semi-detached home is about 13,000kWh per year[15]

It is estimated that savings of about 5% can on average be achieved with improved heating controls. However, a diversity factor of 70% is added to take into account the fact that some households may heat their homes at different times to the assumed 4pm to 10pm evening heating period.

Overall the annual energy saving is estimated to be 455kWh. The monthly electricity savings were estimated using 20-year averages for degree days for the Thames Valley region. It was assumed that the savings were equally split across the heating hours during the month.

### Payment levels

Assuming an availability-only contract is used

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm
An estimate of the payment for Drayton can be obtained using the value of kW reduction between 4pm and 6pm during the Autumn. Note that this figure has been skewed by savings in September and October being lower. As a result, the payments in a more detailed assessment are likely to be higher.
kW reduction from new heating controls for 10 households between 4pm – 6pm = 0.9kW
The payment for an availability only contract for Drayton is £33/kW
Expected payment from 4-year contract = 0.9kW x £33/kW = **£30**

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in December, January and February from 3.50pm until 8.20pm

[15] Sutherland Tables, Comparative domestic heating costs, South East, July 2019, Space and Water Heating for Houses.

An estimate of the average savings from installing new heating controls in 10 electrically heated homes can be obtained from the graph on the page for the measure.
The kW saving between 4pm and 10pm is 2.25kW for fitting new heating controls in 10 homes
The payment for an availability only contract for Coxmoor Wood is £69/kW
Total contract payment over 4 years for new controls in 10 homes = 2.25kW x £69/kW = **£155**

## Replacing peak-rate electric heaters by modern storage heaters

For a semi-detached home in the South East, the annual heating demand is 13,000kWh. It was assumed there was some under-heating of homes using peak-rate heaters as well as heating outside the standard heating times. A diversity factor of 70% was used to account for this. The electricity consumption from the peak rate heaters was therefore about 9,100kWh. The consumption per month was estimated using 20-year average Degree Day data for the Thames Valley region. This was assumed to be spread equally across the standard heating hours of 9 hours on weekdays and 16 hours at the weekend.

### Payment levels

Assuming an availability-only contract is used

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm

- kW reduction for 10 households replacing peak rate heaters with storage heaters during the Autumn for the period from 4pm – 6pm = 18kW
- The payment for an availability only contract for Drayton is £33/kW

Expected payment from 4-year contract = 18kW x £33/kW = **£594**

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in winter from 3.50pm until 8.20pm.

- kW reduction for 10 households replacing peak rate heaters with storage heaters during winter for the period 4pm to 8pm = 45kW
- The payment for a 4-year availability only contract for Coxmoor Wood is £69/kW

Expected payment from 4-year contract = 45kW x £69/kW = **£3,105**

## Replacing electric showers

Calculations assessing the kW savings from replacing electric showers used data from a study by Unilever, which showed the average frequency of showers is 0.4 per person per day, and the average electric shower length is 7 minutes 24 seconds[16]. A total of c. 15% of showers take place during the peak in electricity consumption between 4pm and 8pm. According to the ONS 2018 Families and Households data release, the average UK household contains 2.38 people[17]. It was assumed that the shower replaced was rated at 9.5kW.

[16] Hendrickx et al, Objective measurement of showering behaviour in the UK and a behavioural intervention to reduce water use in the shower, www.watefnetwork.co.uk/files/default/resources/Conference_2015/Presentations/06-HendrickxFinal.pdf [Accessed 10/09/19]

[17] Office for National Statistics - Labour Force Survey (LFS), Families and households: 2018, Release date: 7 August 2019 www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/familiesandhouseholdsfamiliesandhouseholds {Accessed 26/9/2019]

### Payment levels

| Assuming an availability only contract is used |
|---|

*Drayton*:

The constraint window for Drayton is on weekdays in November (autumn) from 4.30pm until 6.10pm

- kW reduction for replacing 100 electric showers for the period from 4pm – 6pm = 3.6kW
- The payment for an availability only contract for Drayton is £33/kW

| Expected payment from 4-year contract = 3.6kW x £33/kW = **£119** |
|---|

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in winter from 3.50pm until 8.20pm.
An approximate value of the kW saving during an event can be obtained by averaging values of the kW savings for the periods of 4pm-6pm and 6pm-8pm.

- kW reduction for replacing 100 electric showers for the period from 4pm – 6pm = 3.6kW
- kW reduction for replacing 100 electric showers for the period from 6pm – 8pm = 5.0kW
- Average kW reduction from 4pm – 6pm = 0.5 x (3.6 + 5.0) = 4.3kW
- The payment for a 4-year availability only contract for Coxmoor Wood is £69/kW

| Expected payment from 4-year contract = 4.3kW x £69/kW = **£297** |
|---|

## Replacing peak rate electric heaters with a heat pump

For a standard 3 bed semi-detached home in the south east, the annual heating demand is about 13,000kWh[18]. However, a home heated by peak rate electricity is likely to be under heated, with rooms only heated when occupied. It was estimated that the consumption from the electric heaters was about 70% of the normal heating demand or 9,100kWh

After installing a wet central heating system supplied by the heat pump, it is assumed the lower costs and improved control allows the household to heat their home to the level of the standard heating demand. The electricity consumption of the heat pump is about one third of the heating demand or in this case 4,333kWh. Therefore, the estimated annual kWh saving after fitting the heat pump is 4,767kWh.

In order to estimate the savings in power, 20-year average degree day data for the Thames Valley region was used to determine the reduction in electricity consumption at different times of the year. It was assumed that homes were heated for 9 hours per day during the week and 16 hours per day at weekends as for the standard heating regime used when generating an Energy Performance Certificate. Savings during the heating hours for a month were assumed to be at the same level.

### Payment levels

| This assumes that an Availability only contract is used. |
|---|

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm

- Taking the value from the graph for the kW reduction for 4pm – 6pm in Autumn = 9.4kW
- Note that this underestimates the payment as heating is lower in September and October.
- The payment for an availability only contract for Drayton is £33/kW

| Estimated payment from 4-year contract = 9.4kW x £33/kW = **£310** |
|---|

[18] Sutherland Tables, Comparative domestic heating costs – South East – July 2019, Space & Water Heating for Houses.

*Coxmoor Wood:*
The constraint window for Coxmoor Wood is on weekdays in December, January and February from 3.50pm until 8.20pm

- The graph on the heat pump page indicates that the kW saving in winter between 4pm and 8pm from replacing peak electric heaters with heat pumps in 10 homes is 23.5kW.
- The payment for an availability only contract for Coxmoor Wood is £69/kW

Estimated payment from 4-year contract = 23.5kW x £69/kW = **£1,622**

## Large domestic battery on a time-of-use tariff

Large domestic batteries currently have a usable capacity which might range between 5kWh and 13.5kWh depending on the model selected. There is potential for this stored energy to be discharged over the period of a grid event. If the whole useable capacity of the battery is discharged, the power that can be output is the usable battery capacity divided by the time of the length of the grid event. The battery would provide indirect demand response with a Utilisation Only contract.

Using the Tesla Powerwall 2 which has a usable battery capacity of 13.5kWh, and assuming this is all discharged during the grid event, it is possible to estimate payments for the Utilisation Only contracts for example Community Flex zones.

### Payment levels

This assumes that a Utilisation only contract is used.

*Drayton:*
There are estimated to be 6 constraint events per year and so a total of 24 over the 4-year contract. Each event occurs between 4.30pm and 6.10pm and so is 1 hour 40 minutes long. If fully charged, the battery can discharge its maximum output of 5kW for the full duration of the event.

- Total kWh discharge per battery during 4-year contract = 5kW x 1.666h x 24 = 199kWh
- Total discharge for 10 Tesla Powerwall 2 batteries over contract = 1.99 MWh
- Utilisation only contract for Drayton zone = £868/MWh

Estimated payment for 10 Tesla Powerwall 2 batteries in the Drayton zone = 1.99 x £868 = **£1,729**

Note that some of the electricity discharged by the battery may have been imported from the grid. On an EV tariff charging 5p/kWh, the cost of the electricity at Drayton would be £50/MWh

If all the electricity came from grid charging, the net payment would be = 1.99 x (868 – 50) = £1,623

*Coxmoor Wood:*
There are again likely to be 6 constraint events per year and so a total of 24 over the 4-year contract. Each event occurs between 3.50pm and 8.20pm and so are 4 hour 30 minutes long. If the full capacity of the Tesla Powerwall 2 battery is discharged over the event period, the battery could output fully charged, the battery can discharge its maximum output of 5kW for the full duration of the event.

- Battery power output = Battery capacity ÷ Event duration = 13.5 ÷ 4.5 = 3kW
- Total kWh discharge per battery during 4-year contract = 3kW x 4.5h x 24 = 324kWh
- Total discharge for 10 Tesla Powerwall 2 batteries over contract = 3.24 MWh
- Utilisation only contract for Coxmoor Wood zone = £638/MWh

Estimated payment for 10 Tesla Powerwall 2 batteries in Coxmoor Wood = 3.24 x £638 = **£2,067**

Note that some of the electricity discharged by the battery may have been imported from the grid. On an EV tariff charging 5p/kWh, the cost of the electricity at Coxmoor Wood would be £50/MWh

If all the electricity came from grid charging, the net payment would be = 3.24 x (638 – 50) = £1,905

Note that there might be remuneration challenges if the battery is owned by the social landlord and receives Community Flex payments, while the household pays for electricity to charge the battery which is exported to the grid during a constraint event.

## EV Charging – delaying charge time

As the number of EVs increase on the network, their charging will add challenges in supplementary load, especially if this is at times when network constraints are likely to occur. If customers can be encouraged to charge an electric vehicle outside of peak-times, perhaps by encouragement to use an off-peak charging tariff specifically designed for EVs, this will mitigate such additional demands on the electricity network.

To provide an indicative payment level estimate, we used the following assumptions:

- 50% of households with an EV could be persuaded to delay charging to outside peak time
- Each household owned only one EV or would only charge one EV at a time.

**Payment levels**

Assuming a utilisation-only contract is used

*Coxmoor Wood:*

- Constraint window for Coxmoor Wood – weekdays in December, January and February (winter)
- Time of constraint: 3.50pm until 8.20pm = 4.5 hours
- For the calculation, the average saving from 4-6pm and 6-8pm is used.
- There are likely to be 6 constraint events per year or a total or 24 over the 4 –year contract
- The Utilisation only contract for Coxmoor Wood is £638/MWh
- Total kWh reduced by delayed charging of 10EVs = (4.2kW + 5.8kW)/2 x 4.5h x 24 = 540kWh

Total contract payment over 4 years for 10 EV-owners = 0.54MWh x £638/MWh = **£345**

*Drayton:*

- Constraint window for Drayton – weekdays in November (autumn)
- Time of constraint: 4.30pm until 6.10pm = 1.66 hours
- For the calculation, the saving from 4-6pm is used.
- There are likely to be 6 constraint events per year or a total or 24 over the 4 –year contract
- The Utilisation only contract for Coxmoor Wood is £868/MWh
- Total kWh reduced by delayed charging of 10EVs = 3.6kW x 1.666h x 24 = 144kWh

Total contract payment over 4 years for 10 EV-owners = 0.144MWh x £868/MWh = **£125**

## Smart Apps for behaviour change

Smart Apps for behaviour change provide customers with personalised insights in how they use energy and combine this with tips on how to lower their energy bill, often combined with gaming elements.

Apps can be distributed to a large group of customers with relative ease, but uptake, prolonged use and long-term behaviour change cannot be expected from all recipients.

For providing an indicative payment level estimate, we use the following assumptions:

- App distribution to 1,000 customers with a 5% uptake rate
- Average peak load reduction for active customers is 15%
- Average peak household consumption is approx. 1kW
- The kW saving for peak hours for a 1,000-home campaign = 1,000 x 0.05 x 1 X 0.15 = 7.5kW.

### Payment levels

| This assumes an availability-only contract is used |
|---|

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in December, January and February from 3.50pm until 8.20pm. The payment for an availability only contract for Coxmoor Wood is £69/kW

| Total contract payment over 4 years for a 1,000-home campaign = 7.5kW x £69/kW = **£518** |
|---|

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm. The payment for an availability only contract for Drayton is £33/kW.

| Total contract payment over 4 years for a 1,000-home campaign = 7.5kW x £33/kW = **£248** |
|---|

## Energy Advice

Energy advice provided to households is one possible way of encouraging reductions in electricity use, or time-shifting of electricity use. Advice can be aimed at both behaviour change and deploying technologies like those in this brochure and is often most effective when combined with, or in support of, technology-driven interventions.

Targeted energy advice is more labour-intensive than large-scale mobile app deployments but also enjoys a higher uptake rate (plus allows identification of potential for other technology interventions).

For providing an indicative payment level estimate, we use the following assumptions based on case studies quoted in the main brochure text:

- Energy advice is provided to 100 homes with a 20% uptake rate
- Average peak load reduction for active customers is 15%
- Average peak household consumption is approx. 1kW
- The kW saving for peak hours for a 100-home campaign = 100 x 0.2 x 1 X 0.15 = 3kW.
- No factor has been applied to account for drop off / fatigue of residents losing interest in the project, resulting in reduced savings over a long period – this aspect is not well defined so in reality a gradual reduction in savings is likely to be seen.

**Payment levels**

| Assuming an availability-only contract is used |
|---|

*Coxmoor Wood:*

The constraint window for Coxmoor Wood is on weekdays in December, January and February from 3.50pm until 8.20pm. The payment for an availability only contract for Coxmoor Wood is £69/kW

| Total contract payment over 4 years for a 100-home campaign = 3kW x £69/kW = **£207** |
|---|

*Drayton:*

The constraint window for Drayton is on weekdays in November from 4.30pm until 6.10pm. The payment for an availability only contract for Drayton is £33/kW.

| Total contract payment over 4 years for a 100-home campaign = 3kW x £33/kW = **£99** |
|---|

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Action for Warm Homes

Scottish & Southern Electricity Networks

NAVIGANT A Guidehouse Company