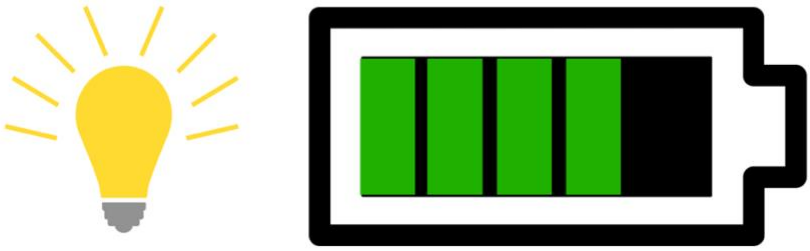
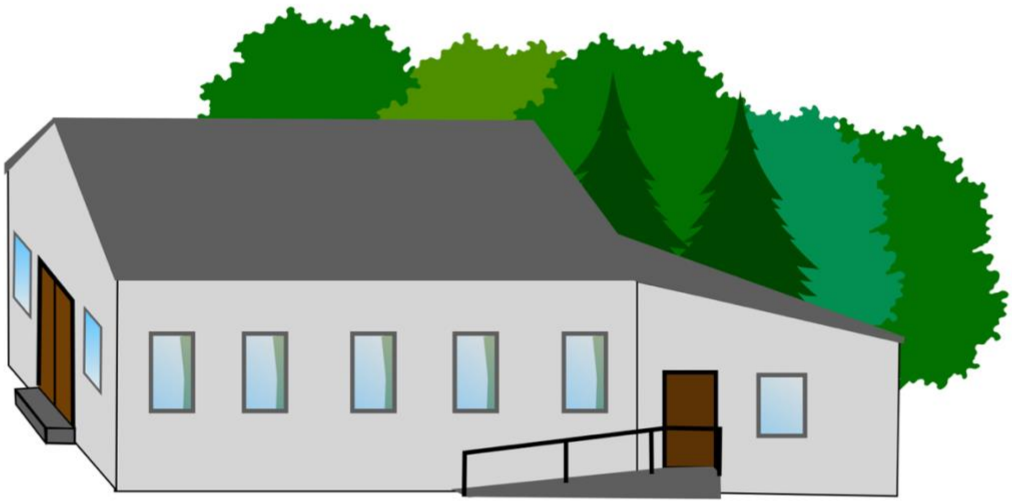
An introductory guide to battery storage for Village Halls





This guidance has been produced by Dr Freya Wise, Centre for Advanced Built Environment Research (CABER), University of the West of England, *in collaboration with* Action with Communities in Cumbria (ACT), January 2026.

Thank you to the several experts who have reviewed this guide.

This guide was produced as part of a fellowship funded by the Economic and Social Research Council, Grant reference: ES/Z504099/1

How to cite: Wise, F. (2026) 'An introductory guide to battery storage for village halls' available at: https://www.cumbriaaction.org.uk/what-we-do/community-buildings

Foreword by Lorrainne Smyth, CEO, Action with Communities in Cumbria

Welcome. You asked us for guidance on batteries and Village Halls, and we were lucky to have an academic offer their expertise to produce this guide. It's a detailed read, with lots of relevant information and a great resource to have alongside you when considering batteries for your hall.

Village Halls and other community buildings are such an important part of a sustainable community that helping them to be sustainable spaces and helping you, the members of the community, to run that space effectively, is a core part of ACT's work.

This guide will help you to think through whether a battery is right for your hall, the implications for your hall's energy use and costs, and design and management strategies to make a battery most effective and efficient for you and your carbon footprint. There are lots of links to more information and you can also contact us for support and access other resources on our website: https://www.cumbriaaction.org.uk

This guide has been written focussing on Cumbria, but has relevance to community buildings across England and links to ACRE – Action with Communities in Rural England, so readers can follow up their local rural support organisation.

I would like to thank Dr Wise for the time and effort that went into creating this guide. Thank you to all of you, who read and use it, for your commitment and energy in making your community buildings and Village Halls more sustainable and therefore of more value for your communities. If you find this guide useful please fill out the accompanying evaluation survey: https://forms.gle/eCAsfg1Y7AJnVHtdA

Happy reading.

Lorrainne

Executive summary

We think that you will definitely get the most out of this guide by reading the whole thing to develop your knowledge and understand some of the details and nuance related to this topic.

However, the ten key points are provided in this summary for your convenience and three checklists on what to think about before you get a battery and what your battery professional should do are provided at the end of the guide. A roadmap of the process is also provided at the end of the guide.

1. Batteries store electricity for later use which can have benefits for energy costs and climate change by shifting demand from peak times. Batteries can also have benefits for resilience to power cuts in certain scenarios but require extra systems for this to work.

2. LiFePO4 lithium-ion batteries and Sodium-ion batteries are probably the most suitable for village halls. Sodium-ion batteries have less environmental and ethical challenges; only limited sizes are currently available, but more are in development and costs are comparable.

3. Batteries have their own terminology which is important to understand when considering a battery system. All batteries require inverters and the most suitable will depend on your hall's circumstances and type of electricity connection.

4. Smart electricity meters are beneficial and allow you to take full advantage of your battery system, it is possible to use a battery without a smart meter, but its functionality will be limited.

5. Certain types of batteries can provide emergency electricity during power cuts, but this must be specifically set up and requires additional cost and complexity. The amount of back-up electricity a battery will give you depends on its size and how you use it.

6. Getting a battery which is the correct size for your hall is very important and to do this you need to think about how and when electricity is used in your hall currently and any planned future changes such as heat pumps or solar panels.

7. The upfront cost of a battery varies but for a village hall is likely to cost between £5-20k. Exact operational energy savings will depend on circumstances, but a battery could realistically save your hall several hundred pounds a year.

8. Batteries should be installed outside in a well-ventilated but secure enclosure. You will need to notify your insurance company and the local fire service and update your risk assessments when you install a battery.

9. Batteries come with energy management platforms and can be managed with an app on your phone. While you *can* just fit and forget your battery, you will benefit from tailoring its settings to how your hall is used.

10. Battery professionals should be qualified electricians who are MCS certified and have received training for the specific make of battery. The MCS and many battery manufacturers provide options to find installers.

Please read on for more details, explanation and rationale about all of the above!

1 Introduction

Welcome! There is lots of -often contradictory- information available online about battery storage, but nearly all of it is designed for homes and there is very little specifically available for village halls. This guide aims to provide an introduction to:

1. What battery storage is
2. Its advantages and disadvantages for village halls
3. The meaning of some key terms relating to battery storage
4. What those who manage halls should be aware of when considering whether battery storage is suitable for their hall.

Each village hall is, of course, different, and the exact system and whether it is suitable will depend on individual contexts and require professional advice and design. However, this guidance should help you to understand more about the subject so that you are aware of the pros and cons and can be better equipped to deal with any professionals that you subsequently work with. This guide is designed primarily with village halls in mind but may also have relevance for other community buildings.

The guide is arranged into several sections and more technical information is provided in boxes. There is a list of further resources at the end of the guide for those who wish to explore in more depth.

2 Table of contents

Table of Contents

3 What is battery storage and how can it help your hall?

Battery storage, also often known as **battery energy storage systems** (BESS) or solar batteries (if paired with solar panels) provides a way of storing electricity for a building so that it can be used later. As such, it doesn't reduce your energy demand but rather helps to *shift* it, which can have several benefits. We're all familiar with the concept of batteries from torches, mobile phones, and numerous other devices; battery storage for buildings is basically the same, just on a larger scale! If you'd like to understand the basic science, please see Appendix 1: How do batteries work?

The use of battery storage has been growing substantially both in the UK and around the world in recent years. Battery storage is useful for three main reasons, climate change, energy costs and resilience, these are introduced in the subsections below.

3.1 Climate change

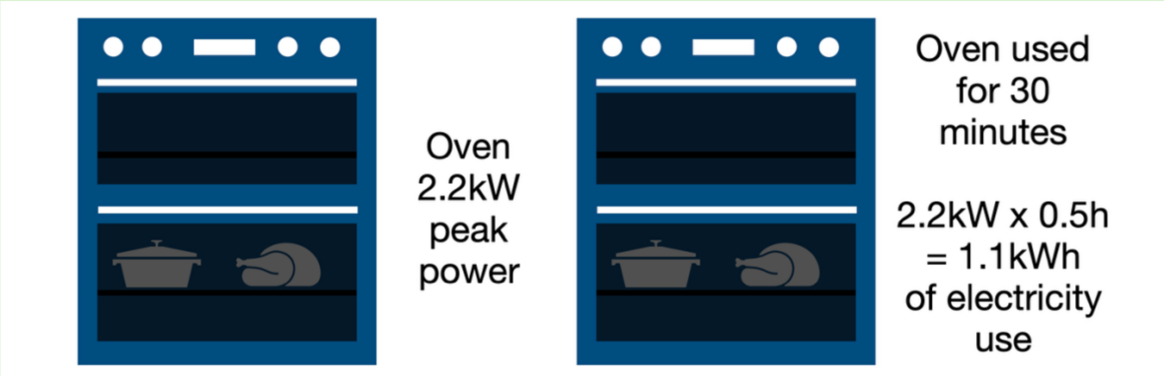
Electricity in the UK is generated from multiple different sources, including fossil fuels such as natural gas and low carbon renewable energy such as solar and wind power, as well as nuclear power and imports from other countries. Depending on how much demand there is on the grid, how sunny or windy it is, and how much energy is being imported at any one time, the carbon emissions associated with a unit of electricity will vary. Batteries can help to store energy when it is at its greenest and then release it for use when grid electricity is least green, thus reducing overall emissions.

For example, in 2024 the **carbon intensity** of electricity varied from 230 grammes of CO_2 per 1 kilowatt hour of electricity to 59 g of CO_2 per kilowatt hour, with an average across the year of 124g of CO_2 per kilowatt hour.[1,2]

Box 1: Key units

A **kilowatt** (**kW**) measures the maximum amount of *power* that an electrical device requires at any one moment, the higher the kW, the more power is needed. One kW equals 1,000 watts. An electric over for example might have a peak power of 2.2kW[3]. Peak power will be important later in the guide.

Energy demand for buildings is commonly measured in **Kilowatt Hours** (**kWh**). A kilowatt hour measures how much energy is used per hour. The *power* of a device (in kW) multiplied by its *time of use* (hours) gives the amount of electricity used in kWh. So, if the example oven was used for 30 minutes it would use 1.1kWh of electricity:



And if it was used for 4 and a half hours (to cook a Christmas cake for example!) it would use:

2.2kW x 4.5 hours = 9.9kWh

If you look at an electricity bill, it should tell you how many kWh have been used in that period as well as how much it costs, both overall and per kWh. Gas bills normally also show the value in kWh -although gas meters actually measure in cubic meters of gas and this is then converted to kWh- while other fuels such as oil are likely to be in litres which can be translated into kWh using conversion factors.

The amount of electricity that can be stored in a battery is measured in kWh.

The third important key term relates to carbon emissions. Carbon emissions from a building are commonly measured in **kilograms (kg) of carbon dioxide (CO_2) emissions**, shortened to **kg/CO_2**.

This is sometimes described simply as carbon emissions. 1 kg of CO_2 is the same as 1,000g of CO_2.

You may also sometimes see CO_2 equivalent or CO_2e emissions. The 'e' for equivalent is because different greenhouse gas emissions have different levels of potency in causing climate change and last for different lengths of time in the atmosphere. Methane for example is much more potent than carbon dioxide but lasts only around 12 years rather than centuries for carbon dioxide.

For simplicity, these time and potency factors are all combined into a **Global Warming Potential** (GWP) which uses kg/CO_2e as its unit of measurement. Using this system, 1kg of methane is equivalent to approximately 32kg of CO_2 for example[4].

Various organisations provide live details and forecasts of the carbon intensity of electricity on an hourly basis, and you can find links to some in the further resources. Batteries can be particularly beneficial in this respect if your hall has solar panels so that you can consume more of the green electricity that your panels generate yourself.

Batteries and other low carbon measures in village halls can potentially also act as flagships to encourage wider action in their local communities. This is because people can see and experience systems in use, ask questions and become more aware of the different options and their benefits. If you do get a battery, it is worth providing some information about the system on your hall notice board or in a local newsletter if applicable.

3.2 Energy Costs

Batteries can also help you to reduce your village hall's energy costs in two ways. Firstly, if you have solar panels, then you are paid less for *exporting* electricity to the grid than you pay to use electricity *imported* from the grid. This means that the more energy from your solar panels that you can use on site, the greater cost savings you will make.

However, your village hall will not necessarily need to use electricity at the times that your solar panels are generating. Often, for instance, more electricity will be used in the evenings, for lighting etc, when the solar panels are not generating because the sun has set. Batteries can store electricity during daylight hours when the hall may not be using very much and then release it later when electricity is needed, for example to charge storage heaters.

In recent years, there has also been an increase in 'time-of-use tariffs', this means that when demand for electricity is high, such as in the mornings and evenings when many people are using it, it is more expensive. While conversely, in the middle of the day and during the night, electricity is cheaper (and also greener as described in the last section). Once again batteries can be helpful with a time-of-use tariff by allowing you to purchase electricity when it is cheaper and then use it at peak times in place of the expensive grid electricity. This concept may be familiar to you if your hall has or has had storage heaters and an Economy 7 tariff.

Figure 1: Time of use tariff example

So, with this example, if you could shift just one kWh of electricity from peak time to overnight each day by using battery storage, you could save 25p a day which would be £91.25 a year.

A more ‘dynamic’ time-of-use tariff, which changes every half hour, could vary from around -5p per kWh (where you are actually paid for using electricity!) to 61p per kWh, with an export rate from 7p per kWh to 15p per kWh at peak times.

These figures are from Octopus business for Cumbria, July 2025. Doesn’t include VAT or standing charge[3]*.*

You can also combine a time-of-use *export* tariff with solar panels so that you can get the best rates for exporting the electricity that your panels generate. But make sure you read Section 6 about batteries and smart meters below to understand the requirements.

In some circumstances and perhaps increasingly in the future there may also be opportunities for halls with batteries to take part in ‘grid balancing schemes’ where, by using a little bit of capacity from multiple batteries across the country, the electricity grid can become more flexible, thus reducing the need for costly and carbon intense gas power top-ups at peak times. This is still a developing area but, in the future, might provide an additional source of income for some halls if they engage in these schemes[4].

3.3 Resilience to power cuts

Batteries can, with a number of caveats, be helpful in power cut situations by continuing to provide a certain level of electricity to your village hall. This could for example, mean that your hall could act as an emergency hub and provide facilities for local people to charge their phones or access a comfortable space with lighting. This can be very useful for halls in rural areas or where power cuts are a common occurrence.

However, ensuring that batteries can function during power cuts requires additional complexity and cost in the installation process. Depending on the size of the battery, there are also limitations on how much power can be provided and over what time scale. *In theory* batteries can be recharged during a longer power cut by an electric vehicle or a diesel generator but, as trials in Cumbria have found, this depends on both the vehicle, charger and the battery having specific functionalities and the system must be designed carefully.

Key considerations for batteries and power cuts are discussed in more detail in section 7.

3.4 Summary

Batteries can store electricity and then release it when needed later; this function means they can:

- Help reduce carbon emissions by allowing electricity to be stored when the grid has low carbon intensity (or when solar panels are generating) and then released for use when carbon intensities are higher.
- Help reduce energy bills by allowing increased use of self-generated solar energy (if your hall has solar panels) and by allowing you to take advantage of time of use tariffs.
- Help to increase resilience to power cuts in some circumstances and if properly designed

The next section will introduce you to different types of battery.

4 Different types of battery

There are five main types of battery chemistries, as well as some variations within the types.

4.1 Lithium-ion Batteries

4.1.1 Lithium Iron Phosphate Battery

At present these are probably the best type of batteries for village halls -and indeed homes- and are known by the snappy name of ‘LiFePO4 batteries’, although Sodium-ion batteries (discussed in section 4.5.2) are becoming a viable and more environmentally friendly alternative.

LiFePO4 batteries use iron phosphate (FePO4) as the cathode material (see Appendix 1) and the lithium ion moves between the positive and negative electrodes to charge and discharge the battery. They are more expensive than some of the other battery types below but have:

- high energy density- meaning that they can store more power in a smaller space
- longer lifespan than other battery types
- fairly rapid charging
- low maintenance requirements

You may have heard of batteries in cars, laptops and electric bicycles or scooters occasionally setting on fire or even exploding if they get overheated or receive sudden impacts, but these applications use other types of lithium-ion batteries. There is a much-reduced risk of this with LiFePO4 batteries because they are more chemically stable and are much less susceptible to overheating and to 'thermal runaway,' which is where overheating can create a feedback loop leading to more overheating and eventual spontaneous combustion. There are also now British Standards to ensure safety in battery storage, which is discussed in section 10.

LiFePO4 batteries also have slightly lower environmental impact and lower ethical concerns than other lithium batteries such as Lithium Manganese Cobalt Oxide batteries (NMC) batteries. Cobalt is a problematic material whose mining leads to toxic waste and often exploitative practices such as child labour. LiFePO4 batteries do not contain cobalt or other toxic materials, and this makes them safer and somewhat easier to recycle at the end of their lives. There are however still ethical and environmental concerns surrounding lithium itself and the development of sodium-ion batteries is starting to be a good alternative.

4.1.2 Lithium Manganese Cobalt Oxide (NMC) batteries

NMC batteries have been used in some electric cars and smaller electric devices such as laptops and phones as they have a higher energy density than LiFePO4 batteries. However as mentioned above, they contain toxic materials and are less thermally stable; meaning that they work less well in hot or cold temperatures and are more susceptible to thermal runaway. They also tend to have a shorter lifespan than LiFePO4 batteries.

4.2 Lead acid batteries

Lead acid batteries have previously been very common for battery storage, using readily available materials and technology that's been around for over 100 years. They are substantially cheaper to buy than LiFePO4 batteries. However, they last only around half the time and require regular maintenance, so LiFePO4 batteries are a better deal over time.

Lead acid batteries are easily recyclable but do contain toxic materials such as lead and sulphuric acid (the clue is in the name!). They also have lower energy density, so they are heavier and bulkier for the same amount of energy storage. They are not well suited to rapid and frequent charging and discharging, so are typically used as long-term storage for emergency use.

4.3 Nickel-Cadmium (NiCd) batteries

These batteries use nickel oxide and metallic cadmium as electrolytes. They are worth mentioning as you may have come across them in the past because they used to be used for rechargeable AA batteries. However, they are now illegal for most applications in the UK except for some industrial activities and certain medical equipment. This is because cadmium is highly harmful to both people and the environment.

4.4 Zinc-Bromide (ZnBr) Flow Batteries

Flow batteries store energy in two electrolyte liquids stored in separate tanks which circulate through a central stack to produce electricity. They require a large space and are very complex, so they are generally used in industrial applications or large-scale storage for solar farms. Their benefits are that they last a very long time and are very safe, but they are also extremely expensive and require a high level of maintenance.

4.5 Up and coming: Sodium-ion batteries and solid-state batteries

Both of these battery types are still in development. Solid state batteries are still very expensive and not readily available, but some sodium-ion batteries are now commercially available in the UK and may be a good alternative to LiFePo4 batteries.

4.5.1 Solid state batteries

Solid state batteries, as the name implies use solid materials rather than liquids or gels for the electrolyte substance in the battery. They have a higher energy density and faster charging times than lithium-ion batteries and can operate at a broader range of temperatures. They are currently still at the demonstration stage or for specialist applications only where they are very expensive, but they definitely show promise for the future.

4.5.2 Sodium-ion batteries

Sodium-ion batteries replace lithium with sodium; a much more readily available material which is substantially more environmentally friendly than lithium. Sodium-ion batteries also maintain their performance in a wider range of temperatures (the performance of LiFePO4 batteries reduces somewhat in temperatures below 0ºC whereas sodium-ion batteries remain stable down to -20ºC). Limited options and sizes are currently available, but more products are in development, and the costs are comparable to, if not slightly cheaper than, LiFePO4 batteries and should come down in the future. Sodium-ion batteries are therefore definitely worth considering at present and are likely to become an even better option in the future.

4.6 Second life batteries

These are not a good choice for village halls and should only be used in situations where continuous monitoring and professional and expert staff are available.

Increasingly there are batteries available on the market that are recycled from electric cars. These are known as second life batteries and will be important in the future to help reduce the environmental impacts of materials for new batteries and increase recycling rates. However, they have a higher risk of thermal runaway and are less reliable. Their performance and safety may improve in the future but currently they are not suitable for village halls.

4.7 Summary

- At present, Lithium-ion and lead acid batteries are the most common for small scale storage applications such as for village halls.
- LiFePO4 batteries are probably the best option for village halls, providing a good balance of safety, efficiency, low maintenance and reasonable lifespans even though they are somewhat more expensive to buy in the first place.
- Sodium-ion batteries are a promising alternative to LiFePO4 batteries and are certainly worth considering because of their lower environmental impact and better performance at a range of temperatures. There are currently limited choices available, but more products are under development

The next section explains some of the key terminology around batteries and discusses some of the key considerations. The rest of this guide uses examples of LiFePO4 and Sodium-ion batteries because these are considered the most suitable types for halls at present.

5 Key considerations and terminology

Some of the factors that you'll want to consider are fairly obvious such as how much a battery will cost, how long it will last and so on. But many aspects have their own 'battery specific' terms that you need be aware of, as well as how the battery will work with your other building systems. We'll start with some key terms; these are all also included in the Glossary at the end of the document so you can find them all in one place and easily remind yourself of any at a later stage.

5.1 Key terms

5.1.1 Storage capacity (or 'size') of battery

The capacity or size tells you how much energy a battery can store at any one time and is measured in kWh (see box 2 if you need a reminder of units). So, a small 5kWh battery can be charged with up to 5kWh of electricity from the grid or from solar panels for later release.

Non-commercial battery storage can range in size from around 2.6kWh to 35kWh and some can be 'stacked' where multiple units are connected to achieve larger sizes. Considerations for determining the size of battery that your hall might require are covered in section 8.

5.1.2 Depth of discharge (DoD)

However, just because a battery can store 5kWh of energy doesn't mean you can *use* all this energy. This is because completely draining a battery can damage it, so batteries have a '**depth of discharge'** -similar to the warning some mobile phones give you if their battery gets below 20%. The depth of discharge is the percentage that batteries can be safely drained to, after which they will automatically stop providing energy until they are recharged, to protect them from damage.

Most modern batteries have a DoD of at least 80% which would mean that our 5kWh battery could only provide 4kWh of power before it would have to be recharged. You need to be aware of different discharge rates when you've worked out the size of battery that your hall might require. Some LiFePO4 and sodium-ion batteries now have discharge rates of 90%, 95% or even 100% so checking the DoDs for different models of a similar size is important!

Typically, LiFePO4 battery manufacturers recommend that their batteries are managed to maintain an average state of charge over their daily cycle of around 40% (e.g. so they that don't sit either fully charged or empty for multiple days). Your battery professional should be able to advise on this after a discussion about how the battery will be used at your hall (there are more details on usage in section 8).

The variation of usable electricity with some different DoDs and battery sizes is shown in the table below and you can see the difference that it makes. For example, a 15kWh battery with a DoD of 90% would provide the same storage as a 13.5kWh battery with a 100% DoD.

Table 1: Useable space of different batteries sizes with different DODs

Depth of Discharge	*5kWh battery*	*8kWh battery*	*10kWh battery*	*13.5kWh battery*	*15kWh battery*	*20kWh battery*
80%	4.0	6.4	8.0	10.8	12	16
85%	4.25	6.8	8.5	11.48	12.75	17
90%	4.5	7.2	9.0	12.15	13.5	18
95%	4.75	7.6	9.5	12.83	14.25	19
100%	5.0	8.0	10.0	13.5	15	20

You can work out the 'usable space' in a battery for other sizes if you know the DoD, by multiplying the size of the battery by the DoD: e.g. a 7.5kWh battery with an 90% depth of discharge would be 7.5 x 0.9 = 6.75 kWh of useable space.

NB: All batteries use a little bit of electricity to keep them running but this isn't included in the size or depth of discharge value which is why they can get up to 100% DoD.

5.1.3 Charging and discharging rates, or capacity

The maximum amount of electricity a battery can store or discharge at any point in time is measured in kW. The cells which make up the battery have a certain rate at which they can be charged or discharged. This effects how quickly a battery can be fully charged or discharged and is affected by both the battery and the 'inverter' (discussed below in section 5.2).

So, let's take an example of a 15kWh battery which might be a reasonable size for a small village hall with medium use. If the battery has a charge and discharge rate of 3kW (they don't have to be the same but, for simplicity, we'll assume they are) then it would mean that:

1. You could only use a maximum of 3kW from your battery at any time (this becomes important in a power cut and is revisited in section 7).
2. You could only charge or discharge your battery at a rate of 3kWh each hour, so with a 15kWh battery it would take 5 hours to fully charge.
3. If you had solar panels covering the roof of your hall with the ability to generate a maximum of 10kW (10kWh) an hour on a sunny day, only 3kWh of this could charge your battery each hour and the rest would either have to be used immediately or exported to the grid.

It could also limit your savings from time of use tariffs as shown in the box below.

Box 2: time of use tariffs and charge/discharge rate example

Thinking about our example time of use tariff in section 3.2, you would pay 18p per kWh from midnight to 7:00 AM at the cheapest point and 43p per kWh from 4pm to 7pm at the most expensive point. So, over the seven hours of the night tariff, you could fully charge your 15kWh battery with grid electricity for £2.70.

Then let's imagine that the hall is booked between 4pm and 7pm for a party, who will be using the all the lights, a plug in sound system, the electric oven and hob in the kitchen and a bit of electric heating, totalling (coincidentally!) 15kWh of electricity over the three-hour peak period.

Because the discharge rate is only 3kW, a maximum of 3kW per hour or 9kWh in total could come from the battery while the remaining 6kWh would have to come from the grid. So, you would have saved £3.87 which, minus the £2.70 you spent to charge the battery in the first place equals a saving of £1.17 from using your battery. However, there would still be a bill of £2.58 for the remaining 6kWh used by the party which had to be met by the grid at peak prices.

But if the battery had a discharge rate of 5kW then the whole electricity demand of the party could be met by the battery (assuming a 100% depth of discharge!). This would save a princely £6.45 with a profit of £3.75 or even more if your battery was charged by ‘free’ solar power during the day rather than grid electricity.

If we, somewhat improbably, assume that there is someone in the hall using 15kWh of electricity between 4pm-7pm every night of the year and this was covered by the battery with the same cost assumptions it would equate to savings of between £1,369- and £2,354 a year (the upper end assumes all energy was supplied by solar). Realistically this is unlikely, and the figures would never be this tidy but savings in the several £100s would certainly be possible.

Understanding and getting a battery with a suitable charge and discharge rate is therefore very important to make sure that it can do all the things that you want it to do and is definitely something to check that your battery professional has calculated properly for your hall and battery size and included the number of daily cycles.

5.1.4 Round-trip efficiency

Every time we do something with electricity, such as running it through power lines, storing it, or changing its form, a small amount is lost. For a battery the ‘**round-trip efficiency’** refers to how much power is kept during a full charge and discharge cycle or ‘round-trip’.

Good quality LiFePO4 and sodium-ion batteries should have a round-trip efficiency between 90-97%. This means that if you fully charged and then discharged our example 15kWh battery you would get between 13.5kWh and 14.55kWh back. Obviously the higher the round-trip efficiency, the better!

The round-trip efficiency can also be affected by the type of inverter which is explained and discussed in section 5.2.

5.1.5 Lifespan and warranty

The lifespan of a battery is usually between 8 and 12 years although this can also be affected by the number of **cycles** of charging and discharging that it goes through (this includes partial cycles so for example discharging from 80% to 30% and then charging back to 50% would count as one cycle).

LiFePO4 and Sodium-ion batteries can generally manage between 6,000-8,000 cycles depending on the model. So, if we assumed that a battery would perform an average of 2 cycles a day it would last between 8 and 11 years. Lead acid batteries have much shorter lifespans with maximum cycles of around 3,000. Some manufacturers provide warranties based on cycles e.g. for 15 years or 6,000 cycles whichever comes soonest, while others simply provide a time warranty without a cycle limit e.g. 10 or 12 years.

As with the other details above it's important to check the warranty before you purchase a battery and understand the implications if it's limited by a number of cycles. For some halls, if they are used less regularly, it may be beneficial to have a model with a longer warranty even if it has a lower number of cycles, while other halls with higher usage may benefit from a simple time warranty and unlimited cycles.

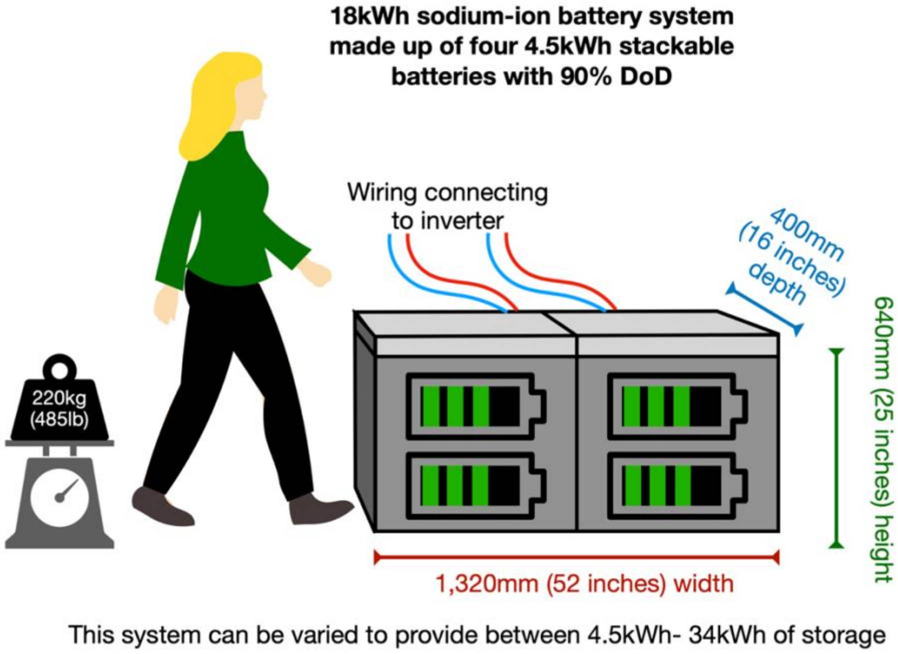
5.1.6 Weight and physical size

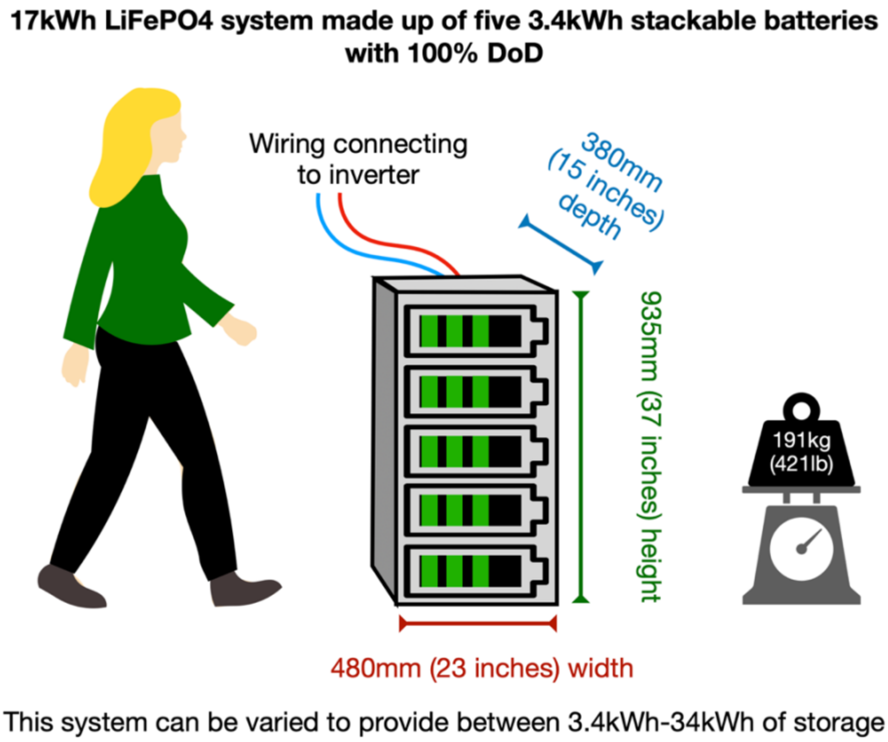
A LiFePO4 or Sodium-ion battery of around 5kWh -a common size as they are designed for homes- is generally around 338-525mm high by 480-550mm wide and 155-242mm deep (or about 13-21 inches high by 19-22 inches wide and 6-10 inches deep). They will take up a bit more space than this as they need to have ventilation room all around them and the system will also involve a separate inverter box (section 10 discusses the best location for your battery).

Batteries are quite heavy, and a battery this size will weigh between 48-55kg (about 106-121lb). They can be positioned on the ground or attached to a wall. The best place will depend on the available space and the size, and therefore weight, of the system.

Two examples of stackable systems are shown in the figures below, with a person for scale.

Figure 2: Weight and physical battery size: example A and B



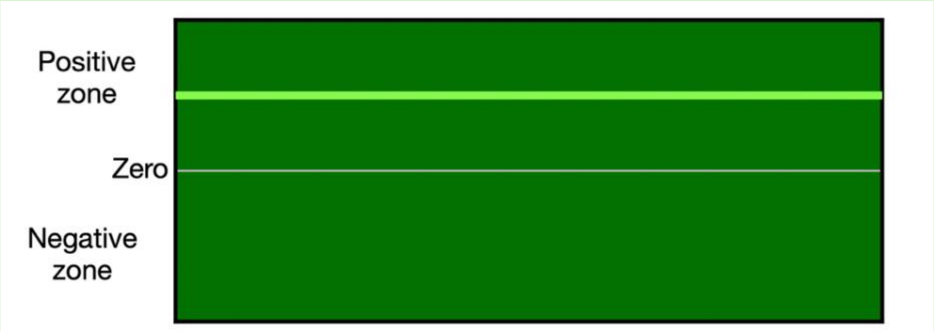


5.2 Inverters and AC/DC (no, not the band)

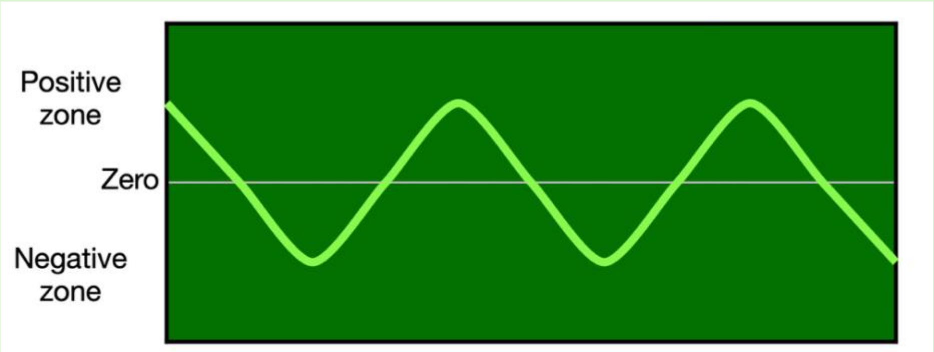
Inverters are a vital part of a solar panel or battery system and can be described as the ‘brains’ of the system. They also enable the electricity stored in a battery to be converted for use in your hall or exported to the grid. This is because batteries store DC or Direct Current electricity while the electricity used in buildings and transported by the grid is AC or Alternating Current. See box 3 for a brief explanation of AC/DC.

Box 3: Direct current and Alternating current

With **Direct current** (**DC**) the flow of electric charge (electrons) travels in one direction at a constant voltage and does not switch polarity. Batteries and devices with batteries in them all store DC electricity and this is also what is produced by solar panels.



With **Alternating current** (**AC**), the flow or current changes direction regularly and switches its polarity.



In the UK AC switches at a frequency of 50Hz (50 times a second). AC is used for distributing electricity because it is easier to change its voltage. Voltage is the 'push' that makes an electric charge move for example down an electricity wire. When electricity is generated, it is transformed to a very high voltage of about 400,000 volts for transmission. This reduces the current and thus the energy lost from heating the wires, increasing the efficiency of the transmission. This high voltage power is then transformed back down to around 230 volts for use in buildings.

NB: To ensure that the electricity system keeps working, the frequency of the grid must stay within 0.5Hz either side of 50Hz. Keeping the system balanced is the role of the National Grid Operator.

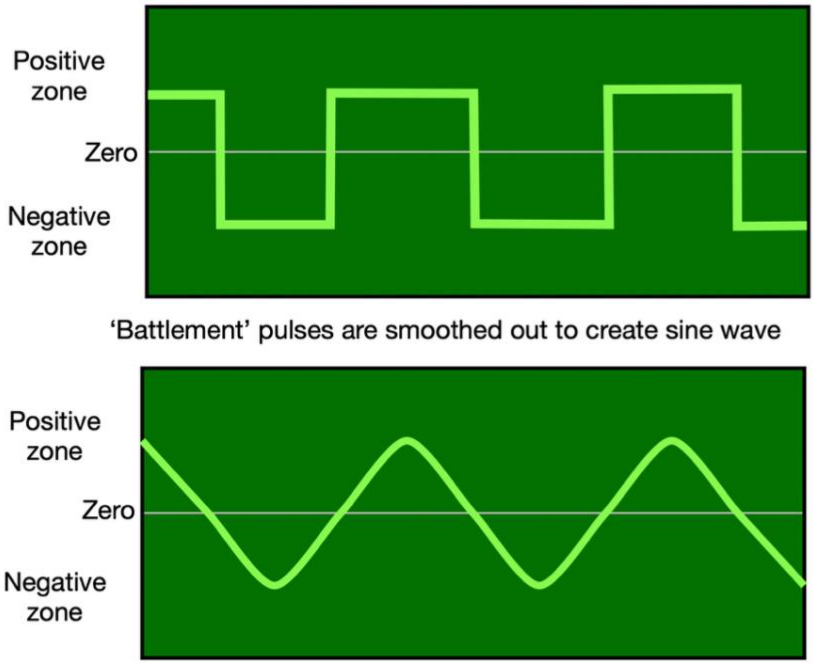
- If there is more electricity being supplied than is needed, for example on a sunny, windy day, the frequency will fall and either more energy will need to be stored, or some power generation will need to be turned off.

- If there is more demand than can be met by the supply, for example if lots of people across the country suddenly start using electricity in their homes, the frequency will rise and more energy will need to be taken from storage, imported, or power generation turned on.

Many devices such as laptops have a built-in battery and work on Direct Current, when you plug your laptop in, the charger has a converter in it to change the power from AC to DC.

Inverters convert DC to AC by taking the DC electricity and rapidly switching its polarity, to create pulses that are then smoothed out to create a 'sine wave' (the shape of alternating current) with the correct voltage for the application, i.e. 230V.

Figure 3: Converting DC to AC power



There is a link in the further resources where you can read more about the technical aspects of how inverters work if you are interested.

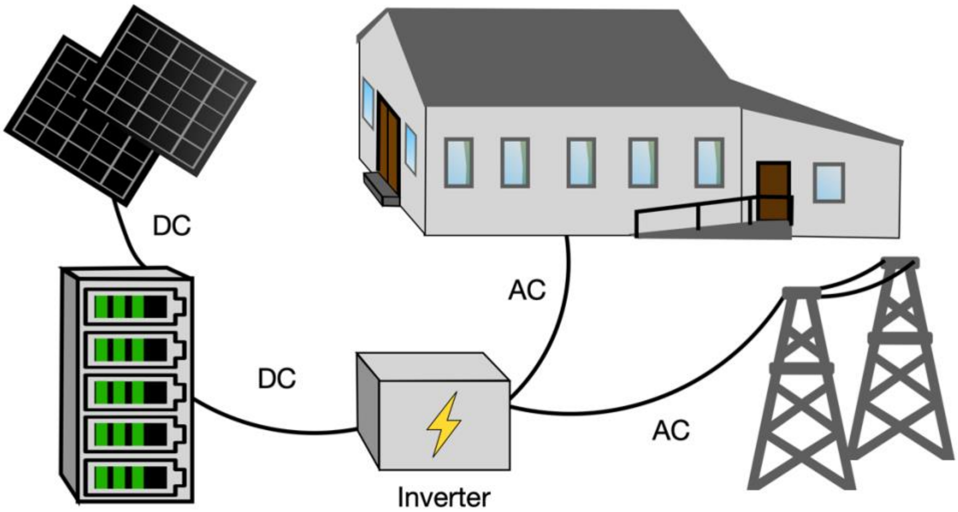
*NB: converting power from AC to DC is simpler and uses a **rectifier** which is generally built in, not a separate piece of equipment.*

Inverters are therefore very useful and important parts of your battery system and there are a few different types. The most appropriate will depend on the exact scenario in your hall and whether you have solar panels or not.

5.2.1 DC coupled

A battery that is DC coupled works with a solar PV system. DC electricity is generated by the panels and stored directly in the battery, there is then a single hybrid inverter beyond the battery that transforms the electricity from panels and battery to AC for use in your hall and export to the grid. DC coupled systems are generally cheaper and more efficient (around 98%) than AC coupled systems (around 90-94%) as they involve less equipment and fewer conversions so less power is lost.

Figure 4: DC coupled/hybrid system



DC electricity from solar PV is stored directly in the battery. DC electricity from the solar PV and battery is then converted to AC electricity for use in the hall or export to the grid

However, they are less flexible in terms of installation as the inverter needs to be positioned next to the battery. The fact that there is only one inverter also means that if it breaks, both batteries and panels won't work.

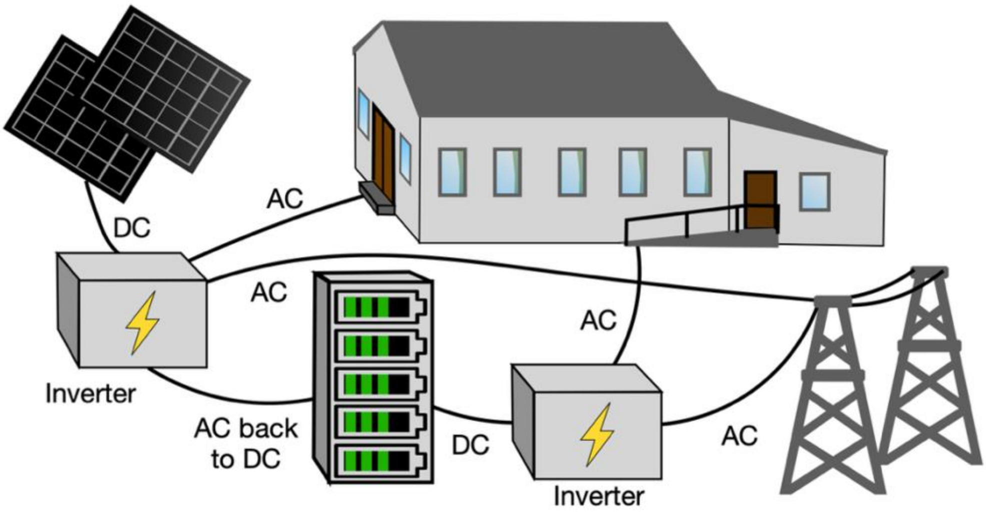
DC coupled systems (sometimes called hybrid systems) may offer advantages for halls where solar panels and a battery system are installed at the same time.

5.2.2 AC coupled

An AC coupled system will work with or without solar panels. In a system with solar PV the panels have their own inverter, as does the battery. The downside of this is that to store power from the solar panels in the battery, electricity is converted three times with three associated conversion losses:

- DC solar electricity is converted to AC
- The AC electricity is converted back to DC for storage in the battery
- When it is needed it is converted back to AC

Figure 5: AC coupled system



DC electricity from solar PV is converted to AC, then back to DC for storage in the battery. DC from the battery is then converted back to AC for use in the hall or export to the grid

They are also more expensive than a DC coupled system because of the extra inverter. However, an advantage is that they may be easier to retrofit with existing solar panel systems as in some cases existing inverter won't have to be replaced and they are simpler to set up to charge from the grid as well as from the solar panels.

AC coupled systems may have advantages for.

- Adding batteries to halls with existing solar panels
- A hall with only a battery system and no solar panels

A battery professional will be able to advise on which inverter is best for your own hall but it's worth understanding a bit about them.

5.2.3 Inverter sizing

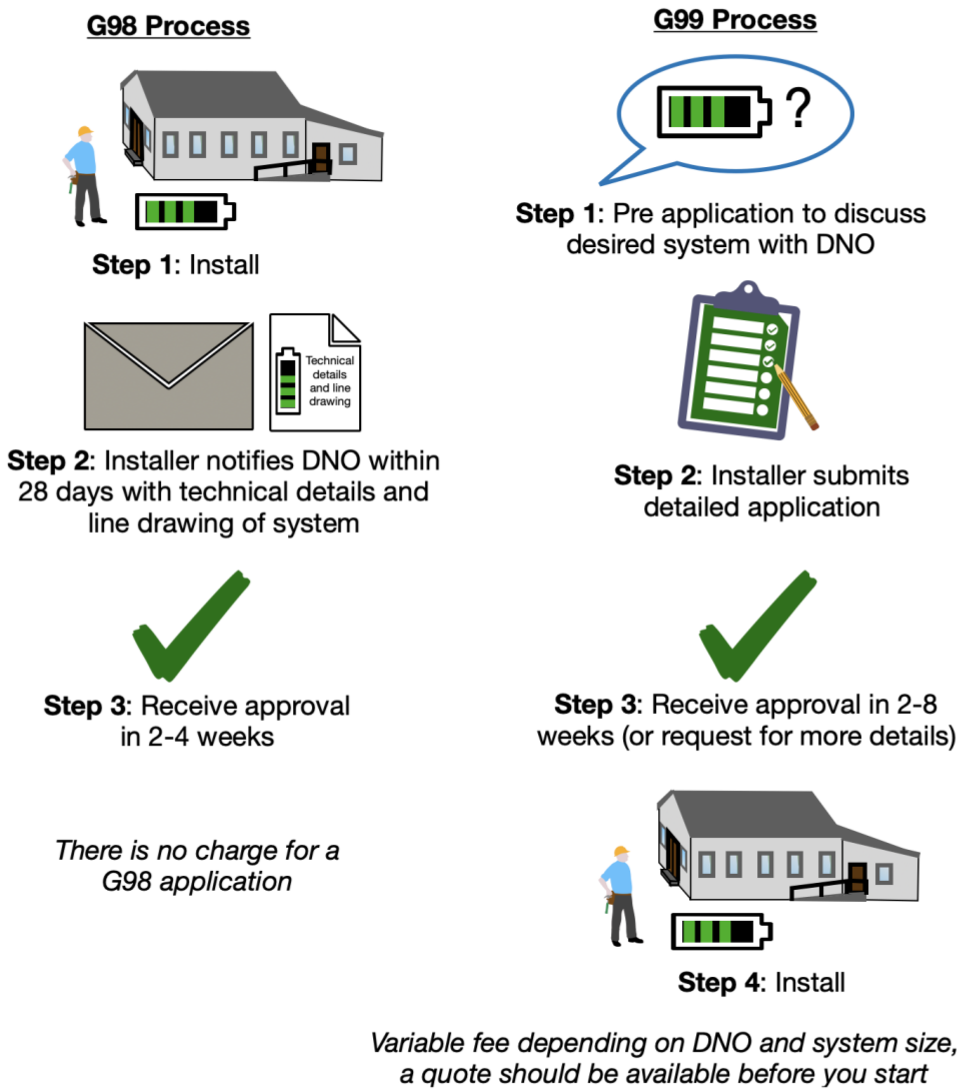
Getting an inverter of the correct size is important as it determines how much energy can flow through the system at any one time (similar to the charge and discharge rates in section 5.1.3). The inverter needs to be matched to the battery system rating and (if applicable) to the peak solar panel generation.

If the inverter is too small, it won't be able to convert all the electricity, which will result in losses over time and may reduce the life of the inverter. But inverters work most efficiently when they are working near their maximum capacity, so they don't want to be oversized either! It's important to talk to your professional about how your battery will be used so that they can size the inverter appropriately.

An application to the **Distribution Network Operator** (**DNO**) –who manages the power grid in a region, looking after the overhead wires, underground cables and electricity substations. In Cumbria the DNO is Electricity Northwest, and a link to a map of all the DNOs in the UK can be found in the further resources- is required to enable your battery and inverter system to be connected to the grid.

The process varies depending on the discharge capacity of the inverter. For homes, there is sometimes an attempt to keep the discharge capacity of the inverter no larger than 3.86kW as this needs a simpler approval process for connecting to the grid and can be done after the battery is installed (known as a G98 application). However, a village hall is likely to need an inverter larger than 3.86kW which requires a slightly longer approval process, and which needs to be completed before the battery is installed (G99 application). This approval process is required to make sure that the national electricity grid remains balanced as discussed in box 3, and to ensure that the local grid can manage the extra loads. The approval process will be completed by your installer, but it is worth double checking that it does actually happen, being aware that it will probably need to be completed before your battery is installed and factoring in time for approval.

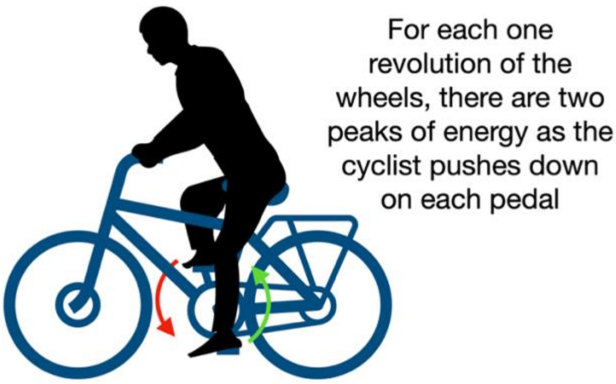
Figure 6: G98 and G99 approval process



5.3 Single or three phase?

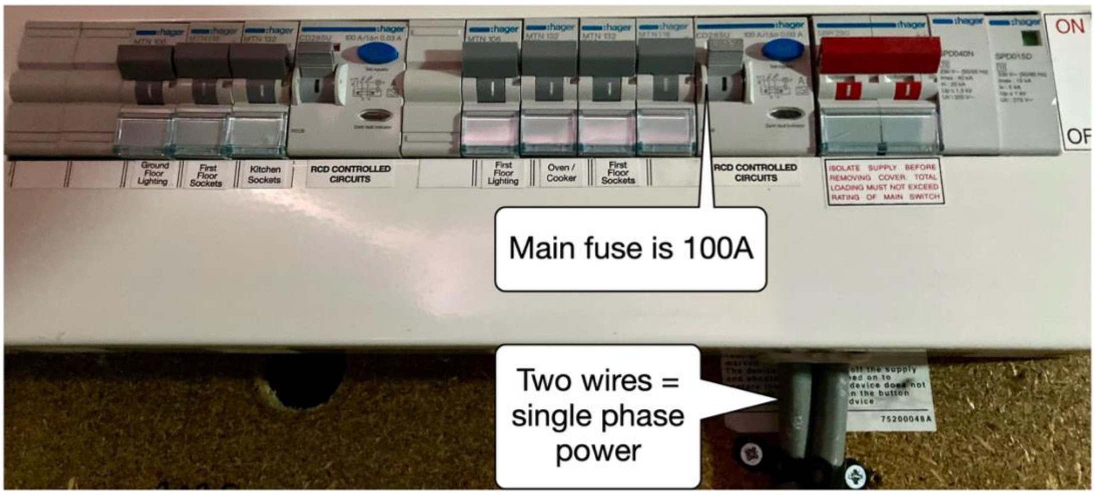
Your hall will be connected to the electricity grid and electricity will be supplied to it as either '**single'** or '**three-phase'** power.

With single-phase, the power supplied will ebb and flow because of the nature of AC electricity (see box 3). The best way to imagine this is to think of a cyclist pedalling; as they push down on each pedal the force increases and then decreases as the pedal comes up again[5]. This gives two peaks and points where there is no power output at all during each full spin of the wheels.

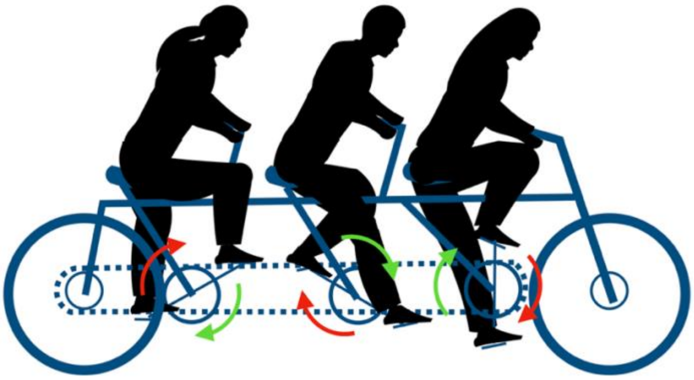


In Cumbria slightly more than half of halls have single-phase electricity. You can get an idea of this for your hall by seeing if you have two wires coming into your power board and one 60A or 100A fuse (likely to be single phase) or three wires and three - normally 100A- fuses (three phase).

Figure 7: Single phase fuse box with 100A fuses



Three-phase electricity has… yes, three wires! These are phased to provide the power peaks at slightly different times which smooths out the supply. You can imagine this as a three-person tandem bicycle where each cyclist is pushing down at a different time so that there is always force going into the wheels throughout each revolution.

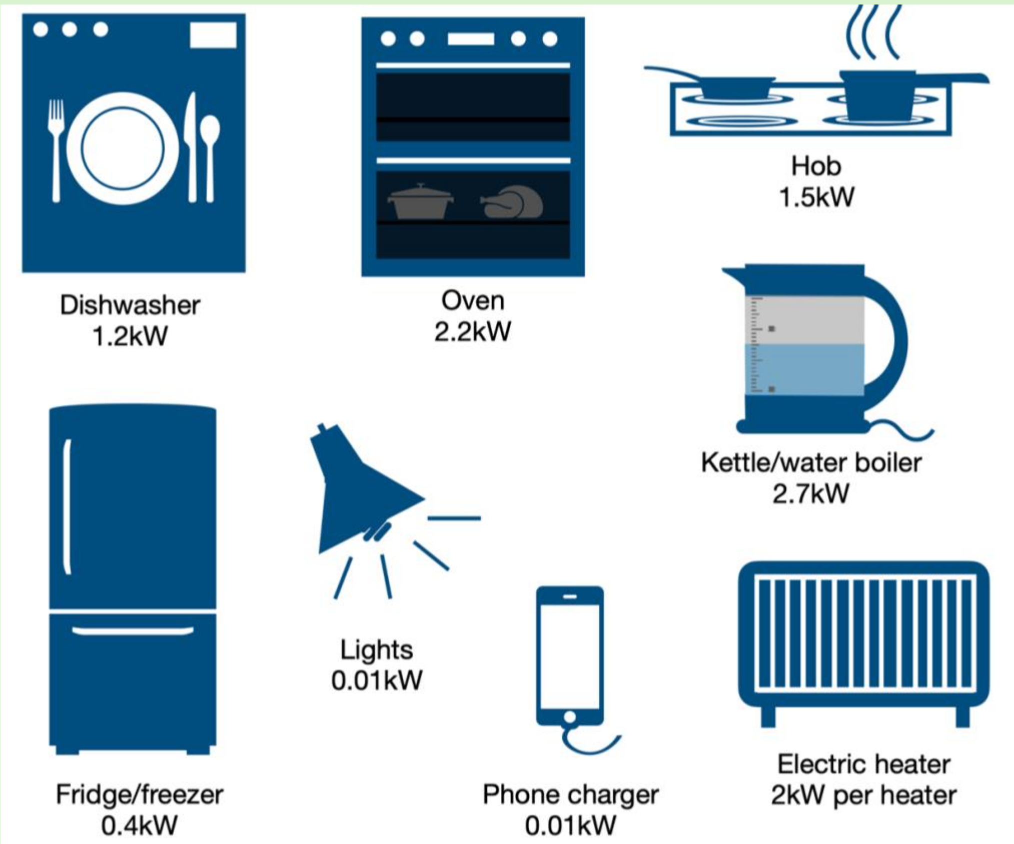


The type of power supply to your hall limits the **peak power demand** (measured in kW), which determines the number of electrical devices that can be used at any one time.

Box 5: Peak power

The figure below shows some approximate peak power values for a range of different appliances that you might find in a hall. These are domestic values and will be higher if your hall has larger commercial kitchen equipment. Modern LED lights have very low peak power, although if your hall has theatrical spotlights or similar they might use a bit more.

Figure 8: Peak power of different common devices

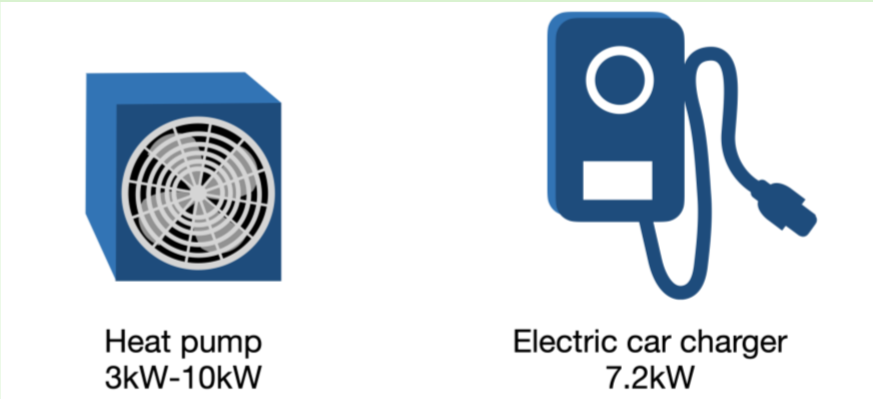


Peak power values from[3]

If all these things were being used to together (assuming 10 lights and 4 heaters) the peak power would be 16.11kW! In most cases all these systems won't be used at once, but you can see how the use of different equipment adds up, especially if your hall has electric heating.

If you look at other changes to your building (discussed further in section 8.3) such as a heat pump or electric car charging this can substantially increase the peak power demand for electricity.

Figure 9: Peak electricity demand of heat pumps and electric car chargers



Understanding your hall's peak energy demand as well as your daily and yearly demand is important for sizing your battery (section 8) and batteries and power cuts (section 7), as well as understanding if single or three phase power is most appropriate.

Single-phase with a 60A fuse will limit the peak power to around 10kW and with a 100A fuse to around 16kW. If you have peak electricity demands of more than this, such as if you are planning to install a large heat pump, you will need a three-phase power supply.

A three-phase power supply can usually be installed in a building by the **Distribution Network Operator** (**DNO**), Switching from a single to a three-phase power supply will cost a certain amount, exactly how much depends on where your hall is, the capacity of the local grid and other factors. Electricity Northwest state that the *average* price for a three-phase connection or upgrade is around £3,000-£5,000 but stress that this is only for guidance and encourage interested persons to get a detailed quote[6].

A rough rule of thumb as to whether there is three-phase power anywhere near your village hall is to look at the local power lines, if there are only two cables it's likely that there is only single-phase, if there are three cables it's likely that three-phase is available in the vicinity.

Figure 10: Left: a single-phase power line. Right: a three-phase power line

As well as higher peak power, the other benefit of three-phase electricity is that you can have an inverter of up to about 11.04kW in discharge capacity before you require the longer G99 pre-installation approval process.

Knowing whether your hall has single or three-phase power matters for batteries because a different inverter is needed and not all battery suppliers provide both types. For instance, it is currently challenging to get a three-phase inverter for a sodium-ion battery, although products are likely to be available in mid-2026.

5.4 Summary

- Batteries have their own terminology to describe their performance and it's useful to understand these terms if you're considering a battery for your hall, all the terms introduced in this section can also be found in the glossary.
- Inverters are vital parts of a battery system which affect charging and discharging rates and can be DC or AC coupled, the best type for your hall will depend on the specific circumstances and whether you have solar panels.
- The electricity supply to your hall can be single or three-phase and this effects the amount of electricity that you can use at any one time in your hall and the type of inverter that a battery needs.
- Whether your power is single or three-phase and the size of your inverter also effects the permission process required to connect your battery to the grid.

The next section discusses how battery systems and smart meters work together.

6 Batteries and smart meters

6.1 What do smart meters do?

You are probably familiar with smart meters as over 60% of UK households now have one. These use radio or mobile networks to transfer data about energy usage to energy companies, normally on fifteen- or thirty- minute intervals. They are also generally accompanied by in building displays which provide live data on how much energy is being used at any one time, as well as how much has been used thus far in the day. The displays can also tell you how much electricity costs at a particular point, and how much energy you are exporting to the grid if you have solar panels or batteries.

Figure 11: In building display showing current peak demand and current cost per hour

Smart meters are important for batteries as they are needed to take advantage of modern time of use tariffs and to enable you to be paid for exporting electricity to the grid as discussed in section 3.2.

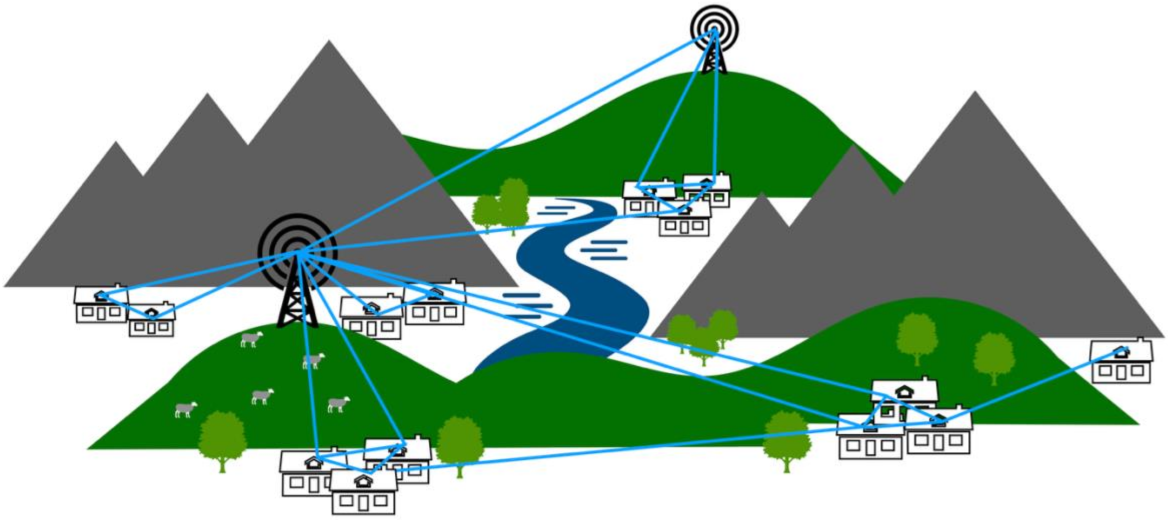
Previous generations of smart meters (SMETS1s) relied on Wi-Fi to operate which meant that they were problematic in areas with poor internet coverage. However, the more modern smart meters (SMETS2) use different secure networks and no longer need an internet connection. SMETS1 should no longer be installed but it's worth double checking with your energy supplier that any meter they install is a SMETS2.

In the north of the UK, smart meter data is transmitted using long range radio, with a low frequency of 420MHz which can penetrate buildings to a certain extent. In the south of the UK, mobile networks rather than radio are used to transfer data[7].

6.2 Where can smart meters be used?

In theory more than 96.5% of buildings can use smart meters but there are still some spots, often particularly in rural areas, where coverage is more limited. Radio network coverage in the north can also sometimes be impacted by local military installations.

In the south of England, the electricity company can install repeater aerials on your hall to try and increase mobile coverage. Meanwhile in the north, most buildings have smart meters that transfer data using a single frequency of radio, but dual frequency smart meters can be installed which can increase the connection potential. In addition, as more smart meters are installed, the radio network spreads further because they can act as repeaters, so even if a smart meter hasn't worked in the past, it may be an option in the future.



Each smart meter install extends the radio network into new spaces

Your energy company is responsible for installing smart meters and these are being rolled out across the UK, if you haven't already been offered a smart meter you can contact your energy supplier and request one which should be installed free of charge.

6.3 What if a hall can't have a smart meter?

The vast majority of halls should be able to use a smart meter but if for some reason a smart meter can't work in your hall then you will be limited in how you can use your battery. However, there are still a couple of options:

Option one: if your hall has an Economy 7 tariff, with an appropriately sized battery you can charge it on the cheaper night rate and then use it to meet the daytime electricity demand of the hall. This may still save money and reduce carbon emissions but is less flexible and the savings will be lower than if you can use full time of use tariffs. You will also not be able to export any electricity to the grid.

Option two: in some instances, it may be possible to get a separate ‘export meter’ which sits alongside your main meter, and which will monitor how much electricity is exported to the grid on half hourly intervals. You will need to check that this meter is acceptable to your energy supplier (many of them insist on smart meters). There is also a cost to install an export meter. If a smart meter won’t work in your hall, it is worth talking to a professional about the possibility of having an export meter and what this would allow you to do.

6.4 Summary

- Smart meters allow your hall to take advantage of time of use tariffs and be paid for exporting any unneeded electricity to the grid.
- Smart meters should work in the majority of buildings and are installed for free by your energy supplier. There are areas where coverage is limited, although this should hopefully expand in the future.
- If you can’t have a smart meter, you can still make savings with a battery using an Economy 7 tariff and may be able to export power to the grid with an export meter, but these options are more limited and less flexible.

The next section examines how batteries can work in power cuts and what is required to enable this.

7 Batteries and power cuts

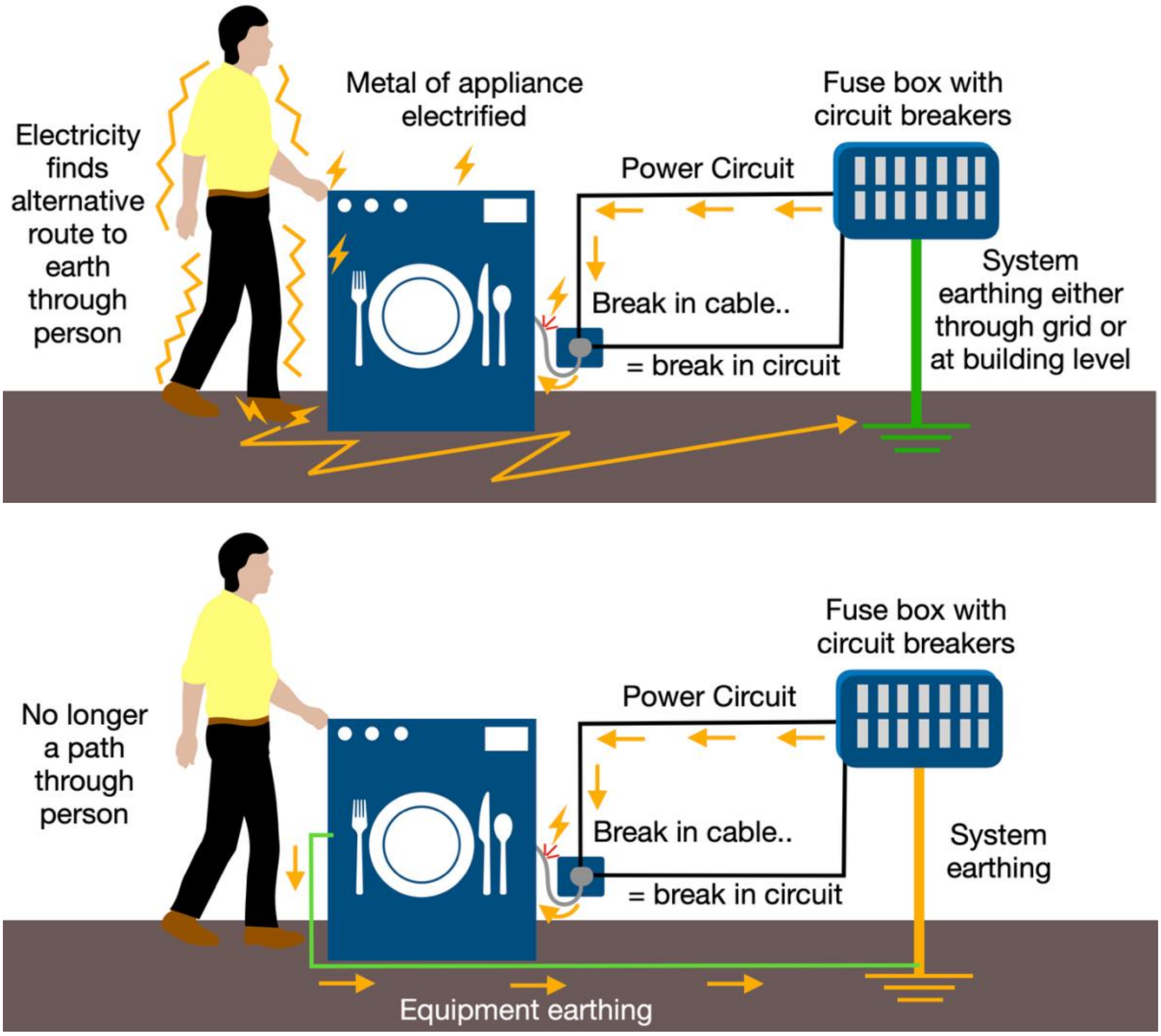
7.1 What is needed for batteries to work in power cuts

Many village halls may be interested in batteries to provide electricity in the event of a power cut so that the hall can act as a hub for the community. This is one of the key benefits of having a battery (section 3.3) however it comes with additional requirements and financial costs to set up. For batteries, this function is known as **emergency power supply** or **EPS,** and it is important to check that any battery and inverter that you select provides the option to have EPS as not all of them do.

If EPS is not set up for your battery, then during a power cut the battery and any solar panel systems will automatically disconnect from the grid and not work until the power cut is over. This ensures that no power is sent into power lines which engineers may be working on. With EPS, the battery system still automatically disconnects from the grid but then operates in what is known as ‘**island mode**’ to continue to provide power to your hall.

There are different levels of EPS from fairly simple to more complex and these are discussed below. For all levels however your hall will require an additional fuse box (known as a ‘consumer unit’). Your hall will also require its own ‘**system earthing’** if it doesn’t already have it. Earthing of your whole electric system stabilises the voltages provided by the different circuits in your hall and provides a level of surge protection. '**Equipment earthing'** provides protection from electric shocks from faulty devices or appliances by providing the electric current a path to the ground so that it doesn't seek a path through a person who touches the faulty device[8]. It automatically switches off the power to the faulty equipment by triggering a fuse or a circuit breaker so that it is safe.

Figure 12: (A) faulty equipment with no earthing, (B) Faulty equipment with earthing



In the UK all electrical systems must have some form of system earthing as a safety feature. Sometimes your hall will have its own earthing device (a TT system), sometimes however this earthing is provided through the grid (a TN system). The earthing arrangements should be checked by your electrician and/or battery professional when designing an EPS system and on-site earthing provided if necessary.

7.2 Levels of emergency power supply (EPS)

There are four levels of EPS functionality, and they vary in what they can do and whether the transition is automatic or manual:

Level 1 – automatic socket: one plug socket is simply wired to the EPS outlet of the inverter. When a power cut happens, this socket will become live after a few seconds and can power a couple of things via an extension cable e.g. a plug-in lamp, a phone charger or two and potentially a fridge.

Level 2 – automatic circuits: in this case the EPS output is connected to either a single electrical circuit or a group of circuits. Again, this is automatic so the power will begin to flow into these circuits a few seconds after a power cut happens. This could be used for important circuits such as lights, a fridge, potentially a kettle or water boiler and maybe plugs for charging mobile devices. This will require additional wiring to connect the circuits appropriately and alterations to your hall's fuse box.

Level 3 - whole building, manual: For this level the EPS outlet is routed into your main fuse box, and everything electrical in your hall will be powered by your battery in the event of a power cut. Level 3 requires the installation of a changeover switch, and this must be manually pulled after the power fails to switch the hall into island mode and turn on the EPS.

Level 4 – whole building, automatic: This is basically the same as level three but has an automatic changeover switch that senses voltage from the grid and switches automatically to the EPS if power fails. The power is likely to cut out for a few moments and then resume as the EPS comes 'online'.

Which level is most appropriate for your hall will depend on a range of factors. Level 1 is obviously the simplest system and may potentially be suitable if all that is required is somewhere for a few local people to charge their mobile phones. Level 2 is a step up from level 1 and is in some ways more complex and potentially more expensive than level 3 because it requires changes to the wiring of various circuits while level 3 theoretically only requires the addition of a changeover switch to the system. It may also be that all the systems that you want to use/not use aren't neatly divided into different circuits and further rewiring might be required to get the full benefits of level 2.

Lever 3 provides more flexibility than level 2 because any electrical systems in the hall can be used. However, this does require careful management to avoid quickly draining the battery on non-essential items. One option is to trip the fuses for circuits that you don't want to use before you switch the system into EPS mode, and this is a benefit of the manual rather than automatic switch-over, although again relies on the circuits being set up correctly. This could also be done simply by having clear protocols about what should and shouldn't be turned on during a power cut and making sure that anything unnecessary that is running is turned off before you switch the EPS on. If your hall has an electric car charging point for example this would definitely be a system to switch off, as would things like built-in sound systems, non-essential lights, extraction fans in toilets, etc.

For this reason, having the manual switch off for level three probably gives you more control than the automatic level 4 and will probably cost slightly less as well.

7.3 Other EPS considerations for your hall

7.3.1 Is EPS worthwhile?

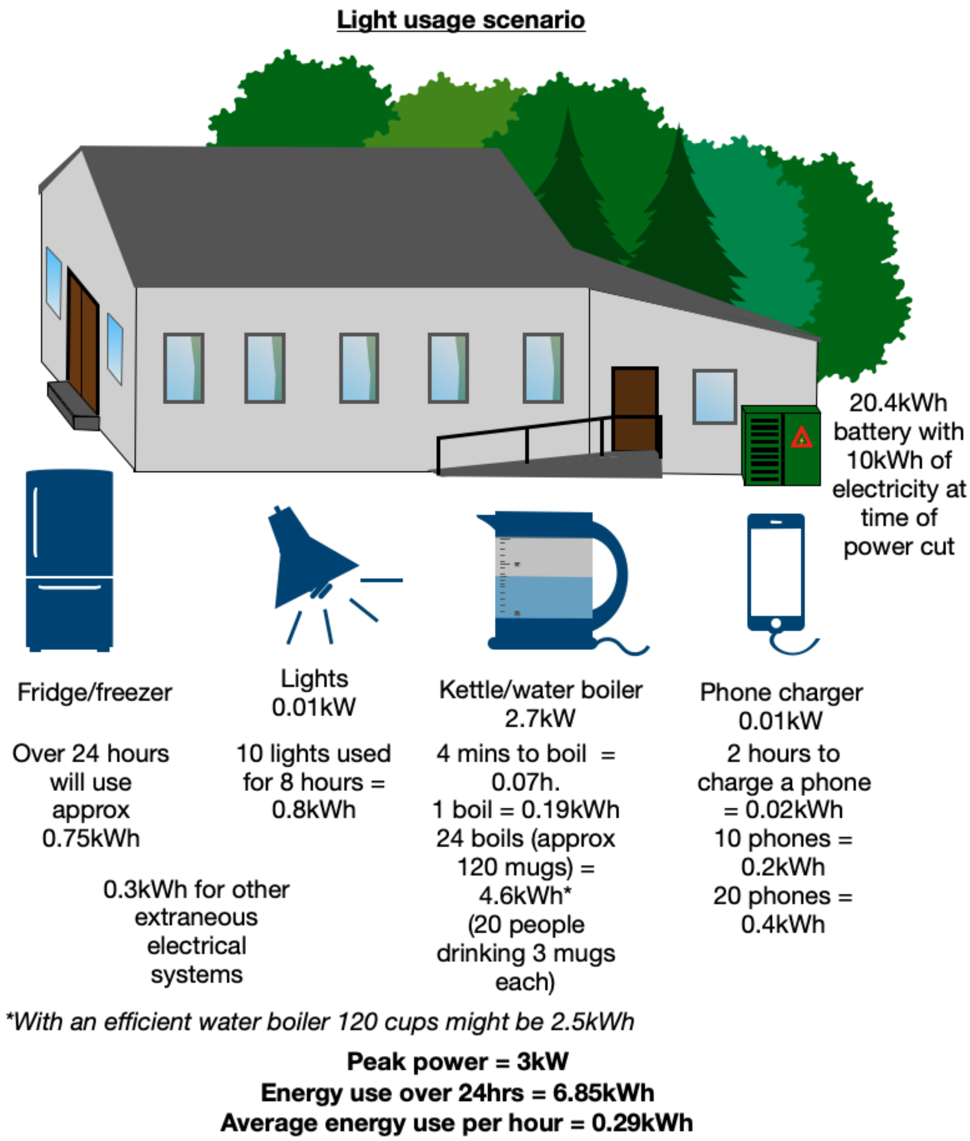
There are other aspects that you should consider as well when deciding whether to invest in EPS, what level to select and what size your battery should be:

1. How many of your hall's systems use electricity and how long is the power cut likely to last? This will affect the devices that you can run and the size of battery that you need. If for example you have electric heating and an electric oven and hob and you want to provide a warm space and hot food, then these electricity greedy systems will rapidly use up the electricity stored in your battery. If you are just wanting to provide lighting and phone charging, or if you have non-electric heating and cooking facilities then it is likely to last much longer. You can see two illustrative examples in the figures below.

2. How many power cuts does your area experience in a year and what other local spaces are available to act as emergency hubs? If there are very few power cuts and other suitable spaces locally, then maybe the additional cost and complexity of an EPS enabled battery is not necessary.

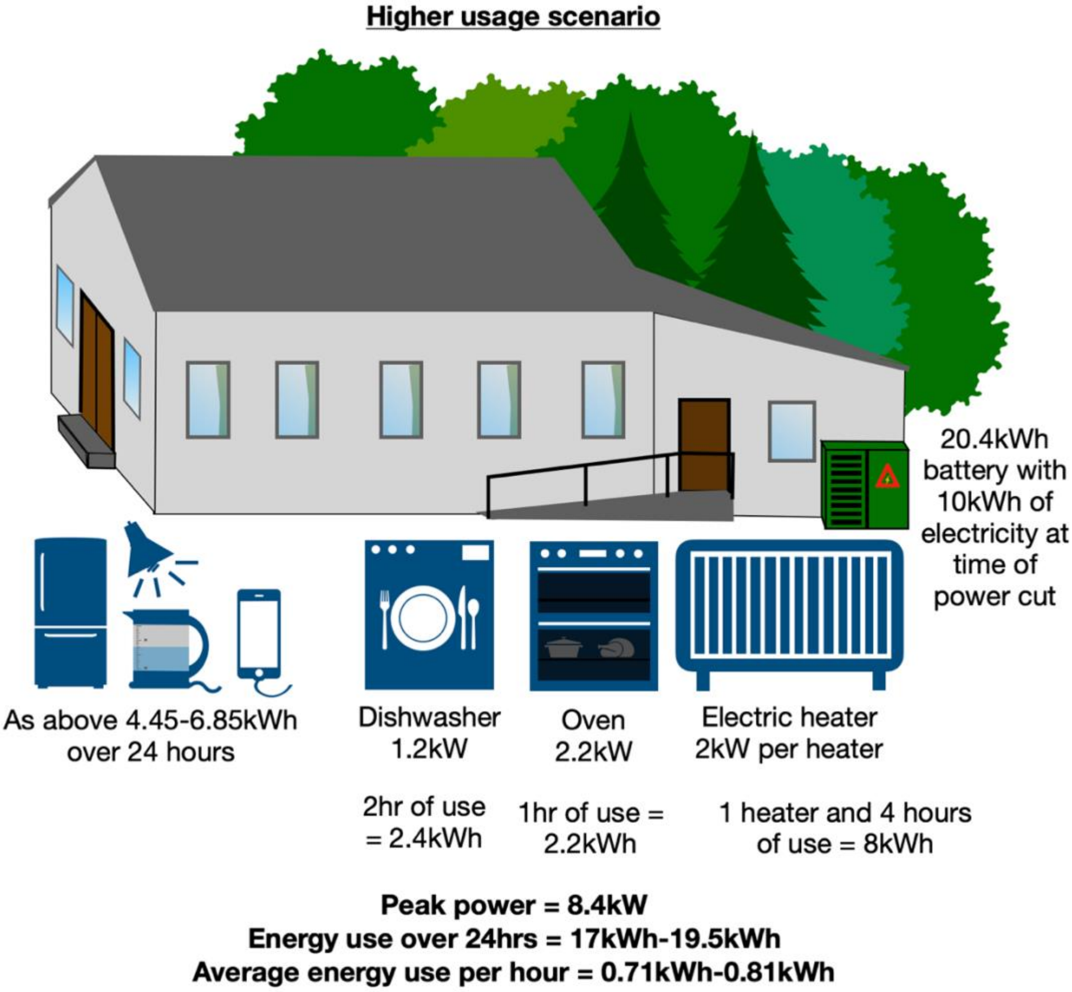
3. If you decide EPS is required, what will the hall be used for during a power cut and therefore what systems will need to keep working? Common examples include a space with lights where multiple mobile phones can be charged and hot drinks made. It may also be useful to provide a working fridge for people with medication that needs to be kept at a certain temperature.

Figure 13: Example of light usage during a power cut



With this example the 20.4 kWh battery could provide 34.5 hours (a day and half) of emergency power or potentially two days if an efficient water boiler was used instead of a kettle.

Figure 14: Example of high usage during a power cut



In this scenario, with cooking, some hot food, one dishwasher load and 4 hours of one heater in addition to the other items, the 10kWh of power in the battery will only last around half a day. Heating in particular uses a lot of electricity. You can therefore see that emergency power supply can be useful but does have limitations and that the more electricity you use, the less time the stored power will last. It is important to consider both overall electricity demands and peak power needs during power cuts.

7.3.2 Using your battery with power cuts in mind

As well as the electricity use over time, when using EPS the peak power and discharge rates of your battery and inverter also need considering, as does the overall efficiency of the system (section 5). This is because in island mode, if too many systems are demanding electricity at once, more power cannot be drawn from the grid so the inverter will overload and shut down. The system will then require resetting before it provides power again. This isn't a massive task but will be disruptive which is another reason why careful management of what systems are used and when during a power cut is needed.

If you have an EPS enabled battery you will also need to decide on how much battery charge to keep 'in reserve' in case of a power cut. For example, if your battery has been used all evening in anticipation of recharging it overnight and then there is a power cut the battery will be nearly empty and will not last very long.

You can set a minimum charge level (**state of charge** or SoC) when the battery is on the grid to a certain percentage, so that the charge never drops below this. If you had a 15kWh battery for example and you set the SoC on the grid to 50% then the battery would always keep 7.5kWh of electricity in reserve in case of a power cut. The SoC in island mode would then be the same as the overall Depth of Discharge of 80%-100% depending on your battery model.

The problem with this is that if you do limit the grid SoC to something like 50% it effectively halves the size of your battery for day-to-day use. You suddenly only have 7.5kWh of storage to play with rather than 15kWh which is a waste of the expensive battery that you've purchased. A range of figures for different battery sizes, SoCs and DoDs are shown in the table below to illustrate this point.

Table 2: Illustrative battery sizes, on grid SoC and island DoDs showing how much capacity might be available in each scenario

Battery size (kWh)	10kWh	15kWh	17kWh	20kWh	24kWh	30kWh	34kWh
Grid SoC (%)	75%	50%	75%	80%	50%	75%	80%
Storage for normal usage (kWh)	7.5	7.5	12.7	16	12	22.5	27.2
Island DoD (%)	100%	100%	100%	100%	100%	100%	100%
Storage for power cut (kWh)	2.5	7.5	4.3	4	12	7.5	6.8
Grid SoC (%)	50%	75%	80%	50%	75%	80%	50%
Storage for normal usage (kWh)	10	11.3	13.6	10	18	24	17
Island DoD (%)	80%	90%	80%	90%	80%	90%	80%
Storage for power cut (kWh)	4	3.4	10.9	9	4.8	5.4	13.6

The other issue to bear in mind is that it isn't good for batteries to sit at over 80% or under 20% charged for long periods of time as this effects their performance. It is good for them to be cycled (charged and discharged regularly) so for example it wouldn't be a good idea to purchase a vastly oversized battery and keep it charged to 80% all the time just to make sure that your hall had enough electricity for a power cut (and it would also make no financial sense, it's much better to use your battery!).

One approach would be to vary the grid SoC to mostly have it on 10% for example and then raise it during the winter when there are most likely to be power cuts. Alternatively, you could be more responsive and only raise the grid SoC when the weather forecast suggests that there is a risk of storms or high winds. The exact strategy will depend on how you want to balance preparedness for power cuts with general battery usage and will be affected by the specific circumstances of your hall.

7.3.3 Battery charging options during power cuts

If you have solar panels and an EPS enabled battery, the system can be set up so that solar energy can charge the battery during a power cut. This isn't standard however and it will:

- Only work with certain battery configurations
- Require the system to be designed so that the battery provides power to the solar inverter so it will continue to work during a power cut
- And cost more to set up

This can enable the battery to last for a longer period but does of course depend on when the power cut happens. If it's on a dark and stormy winter day your solar panels won't be generating much electricity anyway so there will be only limited benefit.

In theory, a battery at your hall operating in Island mode can be charged from an electric car, diesel generator (although not very sustainable!) or potentially a DNO supplied battery bank. Electric cars generally have much larger batteries than those used for energy storage in buildings, ranging from around 25kWh to 120kWh with an average around 70kWh[9] so they can offer several recharges to a building battery and can be very helpful. This happens in other countries but is new to the UK and is still at the trial stage.

Importantly it requires both the car and charger to be bi-directional -allowing both charging and discharging- and to have what is known as vehicle to grid (V2G) capacity. A number of car makers do have V2G capable cars, although not all by any means and V2G enabled chargers are currently very rare and more expensive. In addition, the V2G chargers currently available require a three-phase electricity connection (section 5.3). Vehicle to building (V2B) charging, when the building is in island mode also has additional requirements.

This isn't mainstream in the UK yet, but pilot projects are ongoing and solutions are starting to be available commercially so it may be worth considering and is a promising future technology. A national pilot is currently happening at Skelton Toppin Memorial Hall in Cumbria and is now up and running after a number of teething challenges.

Figure 15: Skelton Toppin Memorial Hall

7.4 Summary

- Battery installations can be designed to provide Emergency Power Supply (EPS) during power cuts but this requires additional costs and complexity in the set-up of battery systems and only works with certain batteries
- There are four levels of EPS, level 3 where the whole building can be switched to work off the battery, is likely to be the most appropriate for village halls but requires careful management of which electrical equipment is used to avoid overloading or quickly draining the system
- It is important to consider the frequency and length of power cuts as well as how much energy your hall will need during a power cut to get the right system and operate the battery so that it works for both everyday usage and emergencies
- Solar panels can be set up to charge batteries during power cuts and in certain instances electric vehicles may be able to be used to recharge building batteries although this technology is still developing.

The next section will discuss the factors that you need to consider when sizing a battery for your hall.

8 Sizing your battery system for your hall

8.1 Thinking about your current electricity demand

Getting a battery of the optimal size for your hall is obviously very important if it's going to do all the things that you want it to do (remember that when we talk about 'size' we're meaning how much the battery can store in kWh, see section 5.1). Your battery professional should do detailed calculations to size your hall's battery based on discussions about how you want to use it and the current and planned electricity demand in your hall. However, it's worth thinking about this a bit yourself so that you understand the basics and have an idea of what you're looking for before seeking professional advice so that you can engage in informed discussion.

The first step is to understand your hall's current electricity use; you should be able to get at least annual and potentially monthly figures from the hall's energy bills (note that you want figures based on actual meter readings not predicted or estimated ones). The average electricity use in Cumbrian Village Halls is around 2,000-5,000kWh per year, although for large halls with very regular use or halls with electric heating this figure can be much higher, in the 10,000-40,000kWh range.

Once you have an annual figure you can divide it by 365 to get a daily *average*, see the table below for some examples:

Table 3: Examples of Cumbrian village halls' electricity usage

Hall	Annual electricity demand of hall (kWh)	Daily electricity demand (kWh)	Floor area (size) of hall (m^2)	Hall heating type	Hall usage
A	925	2.5	135	Gas heating, with electric hot water	Hardly used
B	3,200	8.8	67	Some electric and some LPG heating	Very intermittent
C	4,576	12.5	300	Gas heating and electric hot water	Daily usage
D	7,969	21.8	360	Electric heating	Several times a week
E	13,500	37	520	Gas heating with electric hot water	Weekly usage
F	14,400	39.5	100	Electric storage heaters	Daily usage
G	18,775	51.4	374	Electric heating	Several times a week
H	37,550	103	840	Some electric convection heating, some oil heating	Daily usage

While just dividing your demand into a daily average is very straightforward it might conceal a lot of variation. The next step is therefore to think about *when* your hall uses electricity and *what* this electricity is being used on. Is the demand spread fairly evenly throughout the day and the week or is only on certain days and or at certain times? This will depend on the use that your hall gets and what electricity is used for, if it's mainly for lighting this is likely to be used more in the evenings (although this depends on how good the natural light is in your hall), if it's used for heating then the demand will obviously be much higher in the winter than the summer. If we take Hall D for instance which has electric heating, then just dividing the yearly demand by 365 won't help size the battery as the daily demand is likely to be much lower in the summer and much higher in the winter than this average.

If your hall already has a smart meter, you should be able to see a lot more detail about daily and seasonal energy use. If not, then you could experiment with some more regular manual meter readings for a couple of weeks to understand how your electricity demand varies.

Understanding your hall's current daily demand and how this is likely to fluctuate across both the day, week and the year will give you a rough idea of the size of battery that you might want. For many halls it may be possible to have a battery that covers a large proportion or even all your current electricity demand, while for some halls it will be only practical to have a battery that covers a percentage.

8.2 Sizing for current usage and power cuts

As discussed in section 3.2, to get the most benefits of batteries from a carbon and cost perspective you want to thinking about how much your battery could be charged overnight on cheaper, greener electricity. So, Hall C with an average daily use of 12.5kWh could cover the majority of its daily electricity demand with a 13.5kWh battery and a 5kW inverter - or potentially a larger inverter if the electricity demand was concentrated in only a few hours a day. This hall doesn't use electricity for heating, so the electricity is likely to be fairly consistent in different seasons although it may still vary across the week depending on how the hall is used.

If hall D -average daily use of 21.8kWh- is considered, 20.4kWh battery with a 11kW inverter would be able to cover the majority of the *average* daily energy use, by charging up at night on the cheaper tariff and then covering most of the hall's electricity demand during the day. As noted above a lot of this hall's electricity demand is for heating, meaning daily demand is likely to be much higher in winter and lower in summer. A larger battery might therefore be beneficial to cover more of the winter load and unneeded electricity could be exported to the grid at peak times in the summer, creating profit for the hall. This does however depend on what type of electricity tariff your hall has or is planning to have. If you can't sell energy back to the grid because you don't have a smart or export meter, then you will want to reduce times when your battery is oversized for your energy demand as otherwise this storage will be going to waste.

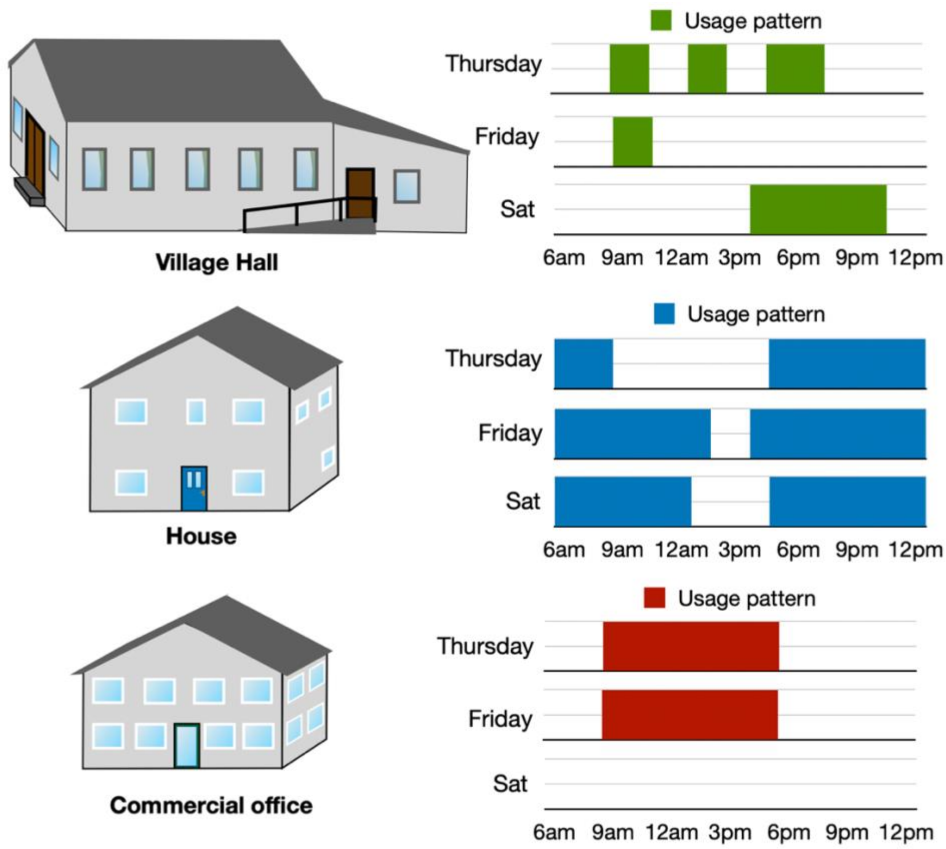
The advice generally is to err on the larger rather than smaller side when sizing batteries (within reason!). Some companies also provide 'stackable' or 'rack-able' battery options where you can add additional batteries to the system fairly easily if demands increase. If you want to use your battery for resilience during power cuts it is also important to think about the size requirements for this usage, and this can be something of a balancing act.

If you have a battery that is sized to meet one day of normal daily load and you use your hall in the same way during a power cut the battery (assuming it was fully charged when the power cut happened, see section 7.3.2) will only give you one day of power. However, your hall is unlikely to be used in the same way during a power cut. For households, demand during power cuts is likely to be much less as non-essential systems should be turned off and this is ideal for a village hall as well. But if your hall normally only gets light usage and is then being used as a community hub during a power cut, with more heating, lighting and use of electricity to charge devices then it may actually have *higher* demand.

As discussed in section 7 it is worth thinking about what you need your hall's battery to do during a power cut, how long you are likely to need it to last for and how important this functionality is compared with normal day-to-day operation. You could think about some different use scenarios and do some back of the envelope calculations to give you an idea about what size of storage you might need in different circumstances so that you can talk to your battery professional in an informed way. You could also consider the examples in section 7.3 and think about whether they have any relevance for your hall.

Bear in mind that most battery professionals will be used to sizing batteries for either residential or commercial projects and village halls often don't really fit either bracket in terms of how they are used.

Figure 16: Example usage patterns for halls, houses and commercial offices



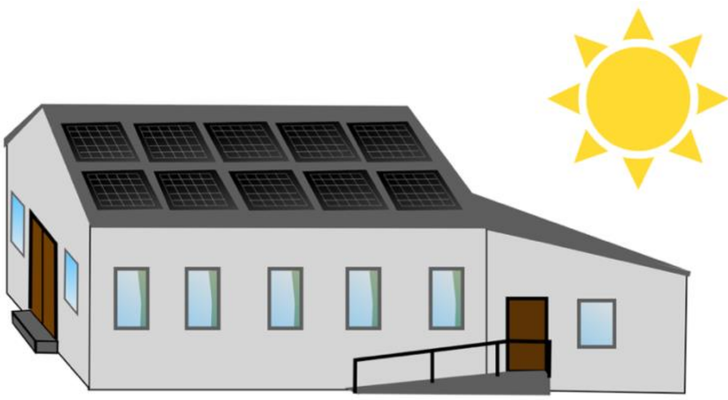
You will therefore have to be very clear with your battery professional on how your hall is used and what you need your battery to do so that they can design the right system for you. Thinking about your hall's needs in advance will help you do this and can also help with then being able to put a compelling case forward if you are seeking funding for your battery.

8.3 Planning for future changes

The final thing to consider when sizing a battery is whether you are planning any other changes to your hall at the same time or in the near future. For example, getting solar panels installed, insulating your hall or upgrading your heating system. All these changes are likely to affect the electricity use in the hall and therefore the size of battery that you will need. It is likely that many halls will be looking at a battery as part of larger alterations so thinking about how these changes will work together is a good idea. Some considerations for common changes and how they might affect your hall's electricity demand are listed below.

8.3.1 Solar Photovoltaic (PV) panels

Solar PV panels generate electricity from the sun's energy. Panels can be placed on a south, west or east facing roof or sometimes on the ground if there is sufficient space although this is rarer. They will generate the most energy on sunny summer days but can still generate some energy even when it is cloudy or in the winter. To be most effective they need a clear view of the sky so don't want to be overshadowed by trees or other buildings. Solar PV works very well with a battery, as the panels can charge the battery with 'free' electricity which can be stored until needed. Without a battery the electricity generated must be used at once or is exported to the grid and export payments are a lot less than you pay to import electricity.



If you have or are getting solar PV, then you should again think about when your hall is used and how this matches when the panels will be generating (i.e. during daylight!). For example, if your panels generate 15kWh of electricity between 11am-2pm but the hall is only used in the evenings then you will want a battery big enough to store this electricity until it is needed. As noted in section 7.3.3 you can also have your system set up so your solar panels can charge your battery during a power cut.

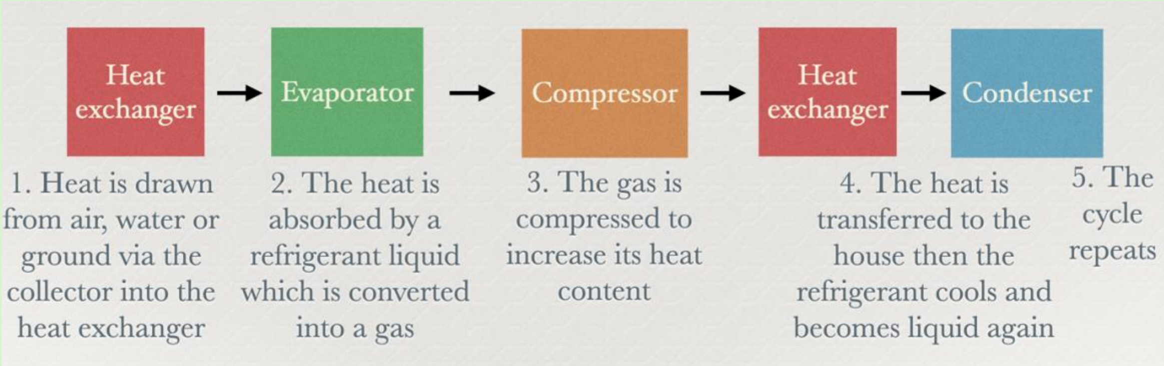
8.3.2 Air (ASHP) ground (GSHP) or water (WSHP) source heat pumps

Heat pumps work by taking naturally existing heat from the air, ground or water and using a heat exchanger to 'boost' it up to a useful temperature using electricity. Remember there is some warmth in the air at any temperature above absolute zero e.g. -273ºC. The heat pump process is very similar to how your fridge works except it raises rather than lowers temperatures. For more technical details on how heat pumps work see the box below.

Box 5: How heat pumps work

The main processes and components of a heat pump are explained in the diagram below.

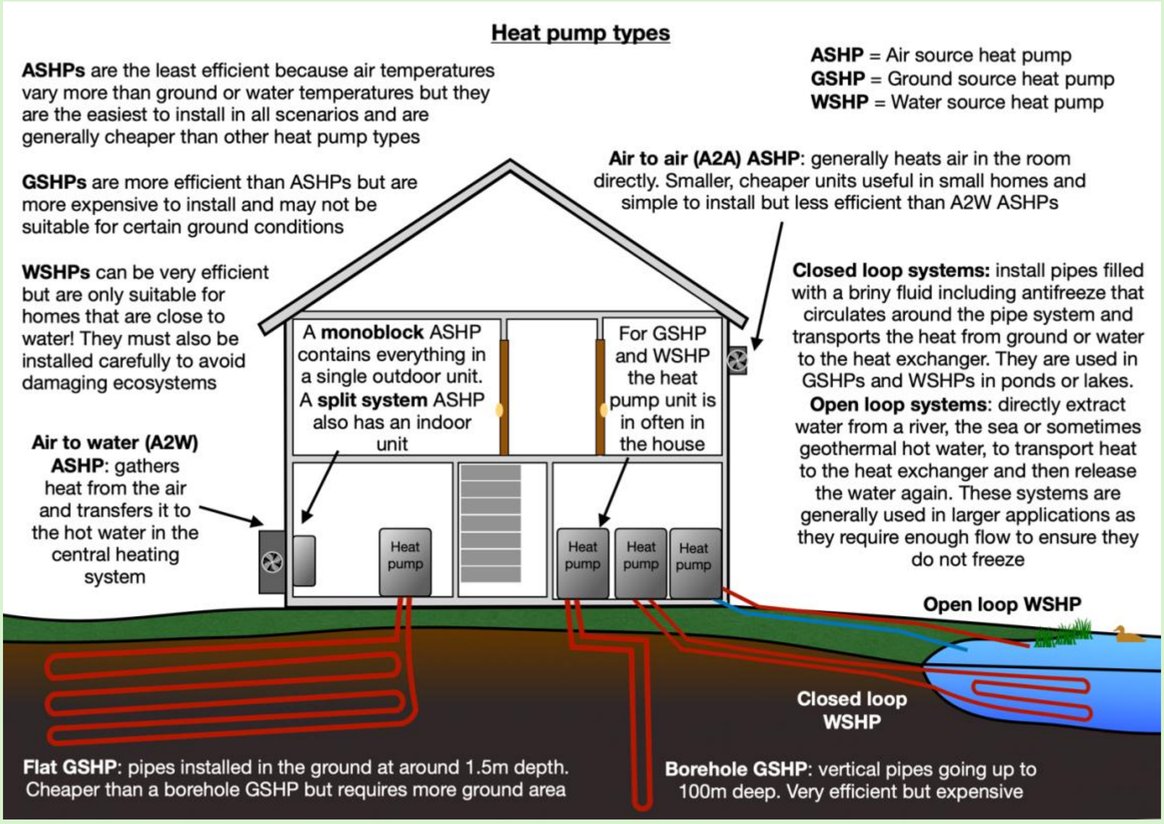
Figure 17: How heat pumps work



The evaporator drops the pressure so that the refrigerant begins to 'boil' at a much lower temperature than outside conditions. This is how it can extract heat from even very cold air, ground or water. The term 'refrigerant' is used, even though this relates to heating, because the technology was originally developed for refrigerators.

Figure 18 below shows the main different types of heat pumps and some of their variations.

Figure 18: Different types of heat pumps



Air source heat pumps and in particular air to water heat pumps are the most common in the UK as they can be used nearly anywhere and are cheaper than other heat pump types.

The main benefit of heat pumps is that they are very efficient. Modern gas and oil powered heating in practice is generally between 70-90% efficient, so if you put one 1kWh of gas or oil in you will get 0.7-0.9kWh of heat out. Electric heating is 100% efficient so 1kWh of electricity equals 1kWh of heat. Because heat pumps take existing heat and boost it, they are between 250-450% efficient, so for every 1kWh of electricity they provide 2.5-4.5kWh of heat. This means that they use less energy and create less carbon emissions for the same amount of heat and are a key tool to help us decarbonise buildings in the UK.

Installing a heat pump is therefore going to significantly affect your hall's electricity demand and therefore the size of battery that you might need, as you can see in these two examples.

Example 1: Hall G from the example above currently uses 18,775kWh of electricity a year and has electric heating. If we assume that 15,000kWh of this is used for heating and a 300% efficient heat pump is installed, the new heating demand would be only 5,000kWh. Plus the 3,775kWh for other electricity, gives a new total of 8,775kWh which is 47% less energy and would reduce the average daily electricity demand from 51.4kWh to 24kWh.

Example 2: Hall C currently uses 10,367kWh of mains gas for heating and 4,576kWh of electricity for other energy demands. If we assume that the current heating system is 85% efficient and that a 300% heat pump was installed the heating demand would drop to 2,937kWh. Added to the existing electricity demand this would give 7,513kWh of electricity per year, which reduces total energy by 50% but is a 64% increase in electricity and would increase the average daily electricity demand from 12.5kWh to 20.6kWh. NB: some of the initial electricity is used for water heating and if this was taken over by the heat pump it would reduce a little but for simplicity's sake this has not be factored in.

As you can see both cases have implications for the most appropriate battery size. So, if you are planning to install a heat pump at your hall in the five years after you have installed a battery it is worth considering what affect this will have and planning for it. As mentioned in section 5.3, a heat pump will also increase the peak electricity demands on your system so charging and discharging rates and inverter sizes must also be considered.

Batteries can work very well with heat pumps by charging up with cheaper and greener electricity and then powering the heat pump when it needs to run at more expensive times. Remember that each 1kWh of electricity from the battery can provide 2.5-4.5kWh of heat with a heat pump so it's a very efficient process. If the electricity initially comes from solar panels, all the better!

Other heating upgrades may include improving or replacing radiators or storage heaters with more modern heating emitters such as 'far' infra-red panel heating or high efficiency modern storage heaters. The best solution will of course depend on your individual hall.

8.3.3 Insulation, windows, doors and lighting

In some cases, it may be appropriate to add insulation to the roof, floors or walls of your village hall to reduce heat loss and therefore the amount of energy required to heat your hall. Particularly for wall insulation this needs to be done carefully with expert advice to avoid negative side effects such as causing or exacerbating damp challenges and is beyond the scope of this guide. Insulation could reduce heating demand by a certain percentage, potentially between 10-40%.

Replacing existing single- or double-glazed windows with triple-glazing and replacing existing doors may also be options that could reduce heat loss by a certain amount. Finally upgrading the efficiency of existing lighting systems so that they use less electricity can also be an option.

If you are undertaking or planning any or all of these other improvements alongside or soon after installing a battery in your hall this should be accounted for in sizing your battery system so that everything works together in the most efficient way.

8.4 Summary

- Getting a battery that is the right size for your hall's needs is important and it is beneficial to spend some time exploring how electricity is currently used in your hall on an annual, seasonal and daily basis.
- You also need to think about any changes you are likely to make to your hall, either at the same time or in the near future, as these may well affect your electricity demand and therefore require adjustments in battery size.
- Remember that your battery professional may not be familiar with the specific needs of village halls so you will have to clear about what you want and spending some time thinking about it beforehand will definitely help.

The next section considers the capital costs of battery installation and the potential energy bill savings that batteries can provide in different circumstances.

9 Costs

9.1 Capital costs

The cost of a battery will depend on the make, the size and the amount and complexity of any work that needs to be done to install it. As a rough guide, the average cost, including installation, per kWh of battery storage is between £265-450 in the UK (2025 figures). A table with indicative costs for some different sizes of LiFePO4 and sodium-ion batteries is provided below. Plus, of course optional 'extras' which you may need to take into account:

- Enabling emergency power supply (EPS) which could be between £1,000-£4,000
- Switching to three-phase power, suggested average for the northwest £3,000-£5,000

Batteries should be installed outside with good ventilation as will be discussed in section 10, but they do require a canopy over the top to shelter them from bright sun and heavy rain, and these can cost anywhere between £50-£200. If a full enclosure is required (for security reasons for instance) these can cost around a £1,000.

Table 4: Indicative cost for LiFePO4 and Sodium-Ion batteries

Battery type	Size (kWh)	System cost	Potential installation cost	System and installation total cost
LiFePO4 stackable battery system with 10kW single phase inverter and energy management system. 100% DoD, 96% efficiency. 12-year unlimited cycle warranty. Suitable for EPS.	10.2 (3 batteries)	£5,690	£1,400	£7,090
	13.6 (4)	£6,846	£1,600	£8,446
	17 (5)	£7,994	£1,750	£9,744
	20.4 (6)	£9,142	£1,750	£10,892
	27.2 (8)	£12,173	£1,750	£13,923
	30.6 (9)	£14,056	£2,000	£16,056
	34 (10)	£14,469	£2,000	£16,469
Sodium Ion battery with 6kW inverter* with energy management system. 92% DoD, 95% efficiency. 10-year unlimited cycle warranty. Suitable for EPS.	9 (2)	£3,016	£1,400	£4,416
	13.5 (3)	£4,422	£1,600	£6,022
	18 (4)	£5,302	£1,750	£7,052
	22.5 (5)	£6,708	£1,750	£8,458
	27 (6)	£7,588	£1,750	£9,338
	31.5 (7)	£8,994	£2,000	£10,994
	34 (8)	£9,874	£2,000	£11,874

**This is currently the largest commercially available inverter for sodium-ion systems. Larger systems are going to be released by June 2026, as are stackable batteries, currently they are wired in pairs which is fine but takes up a bit more space.*

At present:

> *'Buildings used solely for relevant charitable purposes, such as village halls or similar recreational facilities for a local community'*[10]

benefit from zero VAT on energy saving materials including batteries, and the costs in the table are shown without VAT on the battery systems. This VAT relief is currently predicted to last until the 31st of March 2027 although it may be extended in the future. A guidance sheet on VAT for Village Halls is available on request from ACT.

As a rough guide you can therefore see that a battery system for a village hall is likely to cost between £5k-20k, depending on size, complexity and other specific aspects.

9.2 Running costs and savings

LiFePO4 and sodium-ion batteries don't require a lot of maintenance but do need a check each year, similar to a boiler check, to ensure that they are in good working order.

As you may remember from section 3.2, batteries can save money by using time of use electricity tariffs and shifting energy use from the grid from expensive to cheaper time periods.

An example using different tariffs is provided below to the show the potential cost savings over a day for a fictional hall with a 31.6kWh battery. This hall has convection heaters which are turned on when the hall is in use: they use 4kWh of electricity per hour. On this fictional day the hall is being used as follows:

- 10am-12pm for a parent and toddler group (10kWh of electricity for heating and hot drinks)
- 4pm-6pm for table tennis (12kWh for heating, hot drinks and lighting)
- 6pm-7.30pm for a committee meeting (8kWh for heating, hot drinks and lighting)

Equalling 30kWh of electricity over the day.

The cost options are:

1. Currently electricity is costing a fixed 34p per kWh
2. On an economy 7 tariff the off-peak price between midnight and 7am is 23p/kWh and the peak price the rest of the time is 31/kWh
3. On a smart time of use tariff the price is 20p/kWh between midnight and 7am, 22p/kWh 7am-4pm and 7pm-midnight and 47p/kWh between 4pm-7pm.

Tariffs are based on Octopus Energy for commercial properties in South Lakeland in October 2025[11] *Note that all of these figures are* ***just*** *the electricity use and do* ***not*** *include standing charges.*

Scenario 1: 31.5kWh battery with different tariffs

Tariff 1: Current electricity cost = £10.20

Tariff 2: On economy 7 the battery could be charged at night for £7.27 and then used during the day, saving £2.93 or 29%. If this was the same every day the battery would save £1,069 over a year.

Tariff 3: On the smart time of use tariff the battery could be charged at night for £6.32 and then used during the day, saving £3.88 or 38%. If this was the same every day the battery would save £1,416 over a year.

If the hall had a smaller battery, of say, 17kWh, it couldn't cover *all* the daily demand, but it could cover the peak demand between 4pm-7pm.

Scenario 2: 17kWh battery with various tariffs

Tariff 1: Current electricity cost = £10.20

Tariff 2: On Economy 7 the battery could be charged at night for £3.91 and this power could be used during the day saving £2.00 or 20% compared to the current cost. If this was the same every day the battery would save £730 over a year.

Tariff 3: On the smart time of use tariff the battery could be charged overnight for £3.40, discharged in the morning and then recharged for £3.74 so that it could cover the 4pm-7pm period. This would save £3.06 or 30% compared to the current cost. If this was the same every day the battery would save £1,117 over a year.

In this scenario, with a smaller battery, the more variable time of use tariff provides greater savings than the Economy 7 option. Obviously, the use of the hall is unlikely to be this regular throughout the year so the hypothetical savings might be quite different in reality.

If your hall has solar panels, then, even on days when the hall is empty, the battery could still be used to provide income by charging from the solar (or the grid at low cost) and then selling back to the grid at peak times. Two more brief examples are provided below to illustrate scenarios with solar PV and to give you an idea of the types of energy savings that *could* be possible with different configurations.

Scenario 3: 17kWh battery and solar panels that generates an average of 15kWh per day (higher in summer and lower in winter!).

On a day when the hall isn't used, we'll assume that 1kWh of electricity is needed to keep the systems like the fridge and the security light working and we'll assume that this costs £0.20

If all the solar energy goes into the battery that is 15kWh of free electricity. If 14.4kWh (round trip efficiency again) of electricity is sold to the grid at peak times the hall would make a profit of £2.49 per day and £894 per year.

Scenario 4: As scenario 3 but with the solar PV used in the hall.

If the battery enabled the solar power to be used in the hall and it replaced 14.4kWh of import electricity at 34p/kWh it would save £4.90 per day, £1,787 per year. Or £3.17 per day and £1,156 per year if the import tariff was 22p/kWh.

In reality it would probably be a mix of on-site use and export so somewhere between the two figures.

You can therefore see that

A) Solar panels work very well with a battery
B) Being able to use the electricity generated by your solar panels is better than exporting it to the grid.

NB: Currently, if you have a battery only system without any renewable energy, it is not technically allowable to import grid electricity at cheap times and then sell it back to the grid later. This is because it is not exporting 'renewable energy', although anecdotally some energy companies have been known to turn a blind eye. It is very likely to be possible in the future as there will be more focus on using storage to balance the grid, but it is not currently permissible.

There are a lot of numbers in this section and of course any savings will depend on the specific hall, usage pattern, battery, and tariffs. But you can see that installing a battery in your hall is likely to save several hundred and potentially up to a thousand pounds a year in good conditions.

9.3 Are batteries worth it?

So, the question is, are batteries worth it financially speaking? And of course, the answer is, it depends! It depends on how and when your hall is used, what other green technologies it has and the energy tariffs that are available in your area. All these things will affect the savings that you might see from a battery and thus how long it takes to recover the initial cost of installing it.

Thinking about the examples above, a 17kWh battery might cost between £8,000-£11,000 and could save between £700-£1,800 a year. If we assume it might realistically save between £500-1,000 a year it would take between 8 and 22 years for the savings to outweigh the capital costs. As the battery is likely to last between 12-15 years you can see that it is unlikely to be a substantial money maker on its own.

However, most halls are unlikely to be able to purchase a battery without some form of funding support and if you can get some or even *all* the upfront costs covered by a grant or similar then a battery should be able to provide significant savings on your electricity bills during its lifetime. Batteries can often be included in larger funding bids to make halls greener and more resilience and, as discussed in section 8.3, batteries can work very well with solar panels and heat pumps. ACT can help support halls in Cumbria to find funding and a link to ACT's funding guide is provided in the Further resources section. A link to Action with Communities in Rural England (ACRE)'s map of similar organisations in other counties is also provided.

There are also other, non-financial benefits such as reduced carbon emissions by shifting demand to when more green electricity is being generated or improving resilience to power cuts with an EPS enabled battery. In addition, batteries can help to reduce the pressure on the national grid and while this isn't a direct benefit to your hall it has a wider societal benefit. In the future there may also be opportunities for halls with batteries to be paid if they allow their battery to be actively used for grid balancing (this just means that some of its capacity would be used to help smooth out peaks and troughs in demand, alongside lots of other batteries).

Whether batteries are worth it will depend on the individual circumstances of your hall but if you can find funding to help with the capital costs, they can definitely provide a number of benefits.

9.4 Summary

- The upfront cost of batteries and their installation varies but a battery for a village hall is likely to cost somewhere between £5,000 and £20,000 to buy and install, village halls benefit from a VAT exemption for batteries.
- The operational savings that batteries provide will depend on how and when the hall is used, the type of electricity tariff and whether you have other green technology, but a battery could realistically save at least several hundred pounds a year.
- If funding can be found to cover some or all of the upfront costs of a battery then they can lead to significant operational savings on your hall's energy bills as well as reducing carbon, balancing the grid and improving resilience in some circumstances.

The next section discusses considerations around where your battery should be installed and important safety requirements.

10 Location, safety and installation

10.1 Location

Battery storage systems have very low fire risks if installed correctly. LiFePO4 batteries are lower risk than other types of lithium batteries and sodium-ion batteries have even lower risks as they are more chemically and thermally stable (section 4). However, in the very rare event of a fire, batteries can cause severe consequences, including releasing hazardous gasses, burning for a long time and, in very rare circumstances, potentially even exploding. If you have done any risk assessments, you may recognise this as a very low probability but high impact risk.

Batteries should be installed outdoors with good ventilation to prevent overheating. While it is *possible* to install batteries indoors it increases the risks, often isn't practical and is strongly not recommended.

If batteries *are* installed indoors, **they must**:

- Be in a separate space away from any used areas of the hall
- Not be near any emergency exists from the building
- Have their own ventilation system
- Be well away from any fluctuating heat sources such as boilers or cookers
- Not have anything else stored around them (particularly nothing flammable!)
- Be fire compartmentalised away from used areas of the hall.

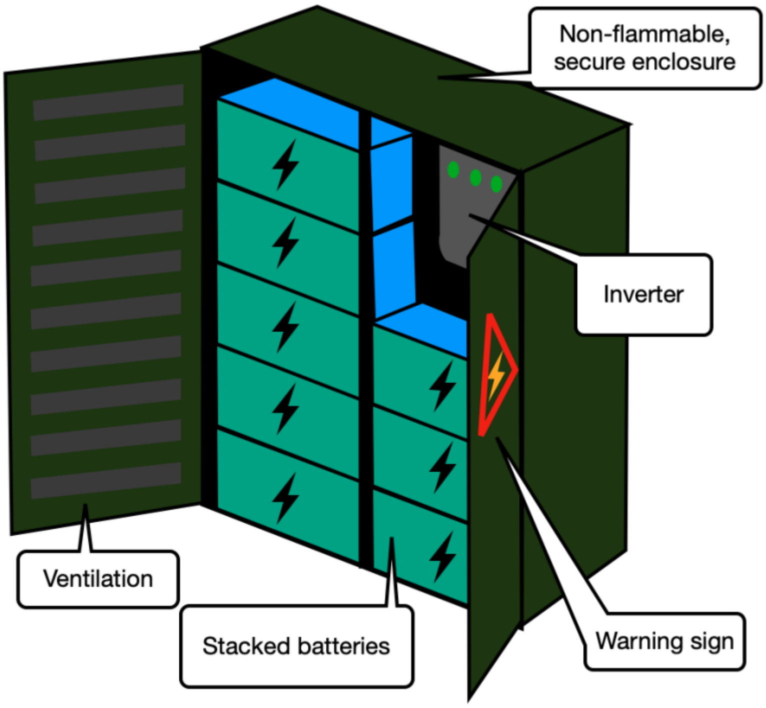
In homes, garages are sometimes suitable indoor locations but since village halls don't normally have garages(!), an appropriate indoor location is not generally possible, so outdoor installation is needed and recommended.

Figure 19: Real examples of domestic (left) and commercial (right) battery locations

For outdoor installation batteries need to be well ventilated but protected from direct sun and rain with a small canopy. Some batteries such as the sodium-ion batteries come with their own waterproof enclosures. You should check that any battery you get can be placed outdoors (and see section 11.3 on operating in cold weather).

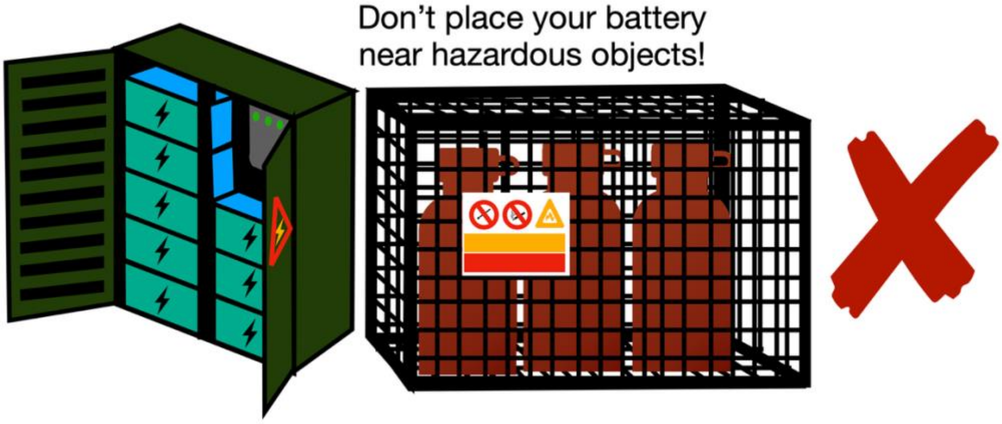
A more substantial enclosure for batteries is likely to be needed in village hall scenarios for security and to prevent tampering, theft, or damage. You could think of this as similar to a gas bottle cage for instance but with a roof and solid sides. You can get specific battery storage cabinets which include ventilation systems and fire resistance which is probably worth the extra cost.

Figure 20: Battery storage cabinet



This enclosure should:

- NOT be placed next to any fire exits from your hall, within 10 feet of combustible materials, or within 20 feet of public spaces unless made of certified fire-resistant materials.
- NOT be made of easily flammable materials such as wood
- NOT be placed next to anything hazardous (for instance, if you have gas tanks or cylinders *don't* install the battery next to them!)
- HAVE some form of fire monitoring in place to give early warning if there are issues, especially if they are out of the way or your hall is not used regularly.
- HAVE warning signage to indicate that a battery is stored there so that any emergency services will be aware.



The inverter for your battery can generally go in the enclosure as well. The enclosure will need a connection to your hall's electricity system, and the location may be informed by the location of your current fuse box.

Your battery professional should be able to advise on the best location for your battery, and you may also wish to seek advice from your local fire service.

10.2 Other safety considerations

Currently there is limited regulation around the safe storage of batteries although a public standard PAS63100 is now available for domestic installations and many of the same considerations will be relevant to village halls (a link is provided in the Further resources section). You should check that your installer is both aware of and following the best practice laid out in this standard.

You will need to notify your insurer if you get a battery system and they may have specific requirements for its location (such as being outside), they are also likely to require you to update your risk assessments and fire plans which is good practice anyway. It is worth approaching your insurance provider to understand their requirements early in the process so that you can make sure that your installer fulfils any requirements. There is a link to guidance created in association with insurance companies in the further resources list. You should also inform your local fire service, in writing, that you are getting a battery and provide them with details of the system and its location which they can file so that they have the information in case of an emergency.

A battery should have a maintenance check by a qualified person (such as the installer) every year. Some battery manufacturers also require additional checks every few years to maintain their warranty. Once you have decided on a make of battery it is worth checking the warranty requirements to ensure your battery professional is complying with them.

A helpful risk management flowchart for battery storage in village halls, created by the National Innovation Centre for Rural Enterprise, in association with Community Action Northumbria (CAN) is provided in the further resources list.

10.3 Installation

Your battery professional will be able install your battery and it is unlikely to take more than a day to actually install. The only exception is if you want a complex emergency power supply installation that needs lots of rewiring of circuits in your hall. Batteries may require a small plinth below them and if your hall is at risk of flooding this needs to be considered when siting the battery.

Most *domestic* battery installations fall under permitted development rights and don't require planning permission. However non-domestic battery installations *may* require planning permission, so it is worth querying this with your local authority planning department in advance. Some local authorities run drop-in sessions where you can go and ask questions. Batteries may fall under permitted development, but this does vary so it's important to check. If your hall is a Listed Building or in the curtilage of one, or in a conservation area it is much more likely that planning permission will be needed. Your battery professional may be able to advise if they have done other installations in the local area but make sure that they are not just assuming it will be the same as a domestic property.

This section may have left you feeling intimidated by the requirements to ensure battery safety. But good outdoor installation is actually fairly simple and will mitigate most of the risks as long as it is accompanied by appropriate management systems.

10.4 Summary

- Batteries for village halls should be installed outside in well-ventilated but secure locations, special 'battery enclosures' can be used. The battery should have a yearly maintenance visit by a qualified person
- You should notify your insurance provider and local fire service when installing a battery and update your risk assessments and fire safety procedures
- You should check with your local authority planning department to see if your battery needs planning permission, it *may* fall under permitted development rights, but it may require planning permission.

The next section discusses the systems for managing your battery once it's installed.

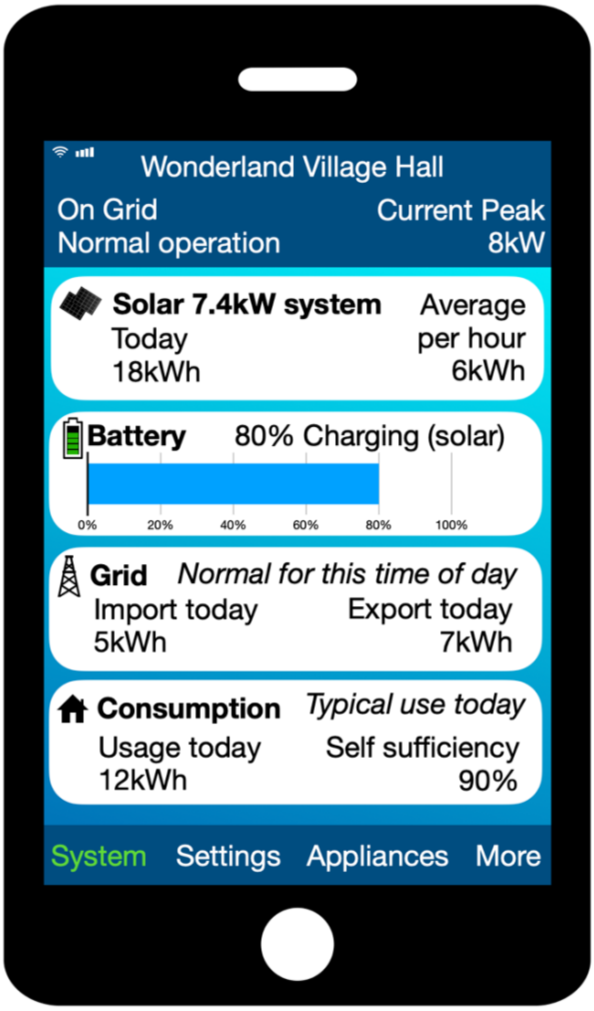
11 Operation

11.1 How is a battery controlled?

Batteries are controlled by an electronic 'energy management system' which can generally be used through an online platform or an app on a phone. This software comes with the battery and will typically show you:

- How much charge your battery has and whether it is currently charging or discharging
- The current cost of importing energy from the grid and the export price if applicable
- How much energy is currently being used in your hall and from what source (grid, battery, solar panels etc)
- Current solar power generation (and sometimes predicted for the next few hours) as well as totals for the day
- Other large electrical loads such as heat pumps, electric car chargers etc
- Current and historical data on energy production, consumption and storage
- The overall health of the battery system and inverter

Figure 21: Example of battery management app



Your battery professional should set up the system, connect the battery, inverter and any other systems such as solar panels to the management system and then invite you to join it, normally using your email address. They should then help you to organise the initial settings for how you want your battery to function and show you how to use and change them. It is probably worth having several people from the hall there when your installer is setting this up so that more than one person learns how to use the system.

You may also wish to consider having a display screen somewhere in your hall that shows live what your battery and any other systems are doing with some accompanying explanatory text. This is part of the education and awareness raising that your hall may wish to participate in to encourage others in your community to consider similar systems. It may also allow you to make a case for ‘added value’ in any funding bids.

11.2 How should you use your energy management systems?

These systems generally have algorithms and smart technology built in so that over time they will learn how your hall is used and adjust how they manage the battery accordingly to maximise savings. If you have a variable smart energy tariff (which varies depending on the predicted mix of national energy generation and demand), the system can download the next day’s price predictions from the energy supplier and automatically adjust charging and discharging to maximise savings.

You can normally override any automated settings. So for example, if your hall normally has a lower level of usage but one day of the week is always particularly busy, you can set up a schedule for this so that your battery knows it should keep more charge to cover this extra demand rather than exporting it to the grid (remember that using cheaper energy on site generally saves more than exporting it because you mostly get paid less for exporting energy than you are charged for importing it). You can also set up and vary things such as what percentage of the battery you always want to keep charged in case of a power cut if your battery has emergency power supply enabled.

This may sound onerous but, because of the automated settings, once you’ve initially set the system up and tailored it over the first few months to how your hall is used, it shouldn’t require much input. In fact, you can just leave it after the initial set up and it will manage the battery itself without you having to do anything. But *you* are likely to know more about how your hall is used that an automated system, so you’ll probably get more benefits if you engage with the system a little, tailor it over a few months and keep a general eye on it.

11.3 Operating in cold weather

Lithium-ion batteries have reduced operation in cold conditions. This is because the electrolyte in the battery becomes thicker in the cold which means the transfer of the lithium ions is slower (See Appendix 1 for information on how batteries work). What this means is that that charging and discharging the battery is slower in cold conditions.

Figure 22: Grid level battery storage in cold weather with conditioned enclosures

LiFePO4 batteries have better performance than other lithium-ion batteries in cold weather. They can perform normally down 0ºC and then from 0ºC to -10ºC they can be discharged although this will be up to 30% slower than normal. They cannot be charged if they are colder than 0ºC as this can cause long term damage to the battery. The battery management system should help to manage this and will prevent charging below 0ºC and turn the battery off below -10ºC to prevent damage to it. Some manufacturers recommend fully charging the battery from the grid during the night if it's going to be very cold to help prevent it dropping in temperature.

Sodium-ion batteries have better performance in cold temperatures because the sodium-ions can move more easily in colder weather. They can maintain their performance in temperatures down to -25ºC so may be a good choice for rural areas where the temperature may be lower on more regular occasions.

Specific battery enclosures can be helpful for managing low temperatures as they often have insulation (as well as maintaining good ventilation, which is important, see section 10.1). Some battery enclosures can even come with an integral heating unit to prevent temperatures dipping too much in the enclosure. It will depend on what you want the battery to do, how vital it is that it can perform in all conditions, and what type of battery you get as to whether it is worth the extra cost of a heated enclosure.

Your battery professional should be able to advise on looking after your battery in cold weather, how much the system will do be able to do automatically and any manual actions that you need to take in hot weather.

11.4 Summary

- Batteries come with energy management systems in an online platform and/or app which allows you to see details about your battery and real time

- You can also manage how it behaves, such as setting up schedules for when the battery should charge and discharge to match your hall's usage
- The energy management system can manage your battery automatically without regular input from you but it's a good idea to invest some time in setting it up and tailoring it to your hall
- You may also wish to add a display screen in your hall that shows live what the battery is doing as part of an education initiative
- LiFePO4 batteries will have reduced performance below 0ºC and won't work at all below -10ºC while Sodium-ion batteries can function down to -25ºC. An appropriate battery enclosure can help to keep the battery warmer, and the management system should prevent the battery operating if it is too cold.

The next, and penultimate section, provides considerations for how you should choose battery professionals and the qualifications they should have.

12 Choosing battery professionals

12.1 Qualifications and standards

As you'll have gathered through the course of this guide, you need to choose your battery professional carefully so that they can give you useful advice and correctly design and install your battery.

A battery professional should be a qualified and registered electrician so that they can carry out the set up and wiring of the battery safely. Alternatively, if they are part of a larger company with separate designers and installers, the battery should be installed by a qualified and registered electrician. They should also have at least completed training with the manufacturer of the battery that you wish to install. This is often a requirement of the battery warranty so is important to check. Some manufacturers have additional requirements such as being signed up to their installer scheme and this can be checked on the manufacturer's website.

It is important that any battery professional is a member of the Microgeneration Certification Scheme (MCS), which provides quality standards for renewable energy generation such as solar panels and for heat pump and battery installations. Batteries must be installed by a MCS approved professional to enable electricity to be exported to the grid. The further resources provide a link to the MCS website which has a function to allow you to check that your professional is MCS registered. It's also worth checking that they're registered specifically for batteries rather for only for solar panels for example. Being registered with the MCS provides a level of quality assurance that your battery will be designed and installed properly.

Your battery professional must also be a member of a 'competent persons scheme', which means that they must operate under quality standards and will provide you will a certificate that work complies with Building Regulations after the battery is installed. MCS approved installers must be members of a competent person scheme. The most common schemes for electrical work such as batteries are:

- NICEIC - National Inspection Council for Electrical Installation Contracting
- NAPIT - National Association of Professional Inspectors and Testers
- ELECSA – no acronym

As mentioned in section 10, your battery professional should also follow the PAS63100 on safe battery installation in domestic properties. Village halls are of course not domestic properties, but a lot of the standard will be relevant, and the rest can be adapted as required. Your battery professional being aware of and following this standard is an indication that they take safety and quality seriously.

Three other standards that they are likely to be aware of are:

- '**British Standard 7671: requirements for electrical installations. IET wiring regulations.**'[12] This standard is about to be revised to state that batteries should not be installed *inside* in homes. It is worth asking to make sure that your battery professional is familiar with this Standard.
- '**The Institution of Engineering and Technology, Code of practice for electrical energy storage systems.**'[13] This guidance provides information about battery systems in both domestic and commercial buildings, again, your battery professional should be aware of it.
- '**NFPA 855, Standard for the Installation of Stationary Energy Storage Systems.**'[14] An international Standard which includes lots of information about safe locations for batteries at both building and grid levels. Although it's not UK specific your battery professional may mention this Standard as it's commonly referenced.

You can ask what standards your battery professional is working to and mention some of these to see if they have at least heard of them as an indication of their knowledge levels and commitment to safety and quality.

12.2 What they should do when designing and installing your battery

When designing your battery system your battery professional should be engaged with you and take the time to understand how you want to use your battery so that they can size it correctly for your needs (section 8). They should be able to clearly explain the pros and cons of how emergency power supply works and what the set-up requirements are if this is a consideration for your hall. In addition, they should:

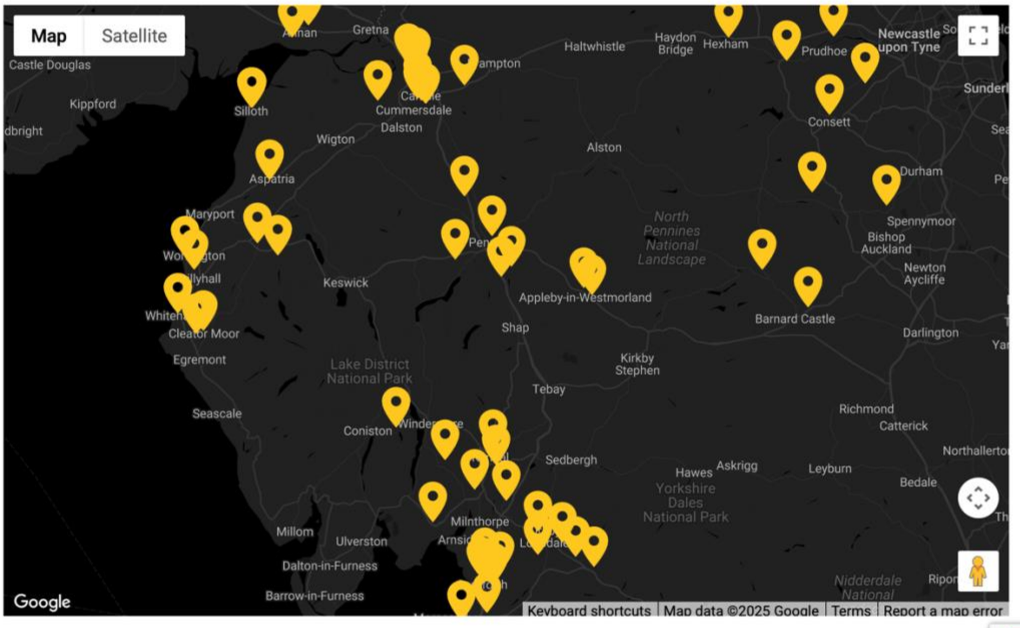
- Provide you with the appropriate paperwork such as a clear explanation of the design, chosen location and reasoning
- Provide you with a quote with itemised costings (Battery, inverter, battery enclosure, labour, EPS requirements etc).
- Let you know when your G98 certificate for grid connection approval will arrive after the installation or factor in time for the G99 certificate to be approved before installation if needed (see section 5.2.3 for a reminder of these).
- Provide full contact details so that you can follow up with any questions or get help with any problems after installation
- Provide written information on how the EPS system works, if applicable
- Provide you with your system's MCS certificate around a month after the installation
- Provide you with an electrical safety certification for the wiring after installation
- Provide you with information about any warranties and a warranty certificate after installation.

The installer should also explain to you how the system works once it is set up and help you to select the initial operating parameters in the energy management software. They should leave you with written details for your specific system and either provide or tell you where to access a manual and other support (e.g. a link to the manufacturer's website).

12.3 How to find a local battery professional

There are several different ways that you could go about finding a battery professional in your area. The MCS have a searchable database of approved installers which you can filter by technology type i.e. batteries, and then by location. Using this will ensure that any professionals you find are MCS approved.

Figure 23: MCS approved battery installer map



Screenshot of map for battery installers from the MCS website[15]

Another approach, if you know what make of battery you are interested in, is to look on the manufacturer's website. Most provide either a list or a search function to help you find a local installer who has completed the training to install that type of battery. This should provide you with a level of reassurance that the installer should fulfil the warranty requirements for the battery, although you should also check that they are MCS approved.

Finally, depending on your current electricity company, they may provide an option to have a battery installed as one of their additional offers. This may have some advantages because, *in theory*, if they already know you as a customer, some parts of the process may be slightly smoother. However, the disadvantage is that most energy companies only offer one or two makes of battery in limited sizes which may not be ideal for your hall. In addition, at the time of writing, no energy companies currently offer sodium-ion batteries as an option.

You will need to check that any battery professional has the appropriate qualifications as described in section 12.1, and that they are willing to understand how village halls work so that they can design the battery properly. A final option to find battery professionals is to use word of mouth recommendations for professionals who have worked with other local village halls or homes in your area. If you use this option, it is still important to make sure that the battery professional has all the suitable qualifications and training needed for *your* hall's project.

12.4 Summary

- Battery professionals should be qualified electricians approved by the MCS and members of a 'competent persons scheme', they should also have completed training for the relevant make of battery
- They should engage with you throughout the process and provide you with detailed paperwork and the appropriate certificates and warranties once the battery is installed
- Routes for finding battery professionals include through the MCS database, battery manufacturers websites, energy companies or word of mouth.
- You should check that any battery professionals you select have the appropriate qualifications

13 Conclusions

Well done for reaching the end of this guide! Hopefully you will have found it useful and now have a better idea of the things to consider when deciding if your hall would benefit from a battery and how to get the most out of your battery if you decide to go ahead. You may want to revisit different sections of the guide at different points in your battery planning journey.

In summary, batteries can provide a range of useful benefits for village halls, especially if integrated with other sustainable systems, and they provide a wider benefit to society as well. However, like many things, they are not silver bullets and require careful planning and a level of management to get the most benefit out of them.

Read on for the glossary, further resources, and two checklists.

Good luck in your battery journey!

***Disclaimer**: While every effort has been made to ensure the accuracy and relevance of the information in this guide neither the author, the University of the West of England or Action with Communities in Cumbria can accept any responsibility for the effects of any actions taken as a result of the information contained in this guide. Batteries are complex technical systems, and advice from suitably qualified professionals must always be sought for specific projects.*

Checklist 1: Before you decide to get a battery

There are a number of questions to answer and things that you need to think about to help you decide if a battery is worthwhile for your hall.

1. Do some investigation into how much electricity your hall currently uses, what it is used for and when it is used.

A. Are there regular daily, weekly or seasonal patterns? If your hall is only used once a month it's probably not worth it.
B. Are usage patterns and electricity use likely to change when you get a battery, for example if you are making other changes?

Take some meter readings or look at smart meter data, don't just rely on energy company estimates and look at your booking diary.

2. Understand what you want your battery to do and how you can use it

A. Do you have or could you get a smart meter? This will make your battery much more flexible
B. Are smart tariffs available in your area and/or from your current energy supplier?
C. Does your battery need to provide an emergency power supply (EPS)? Is it worth the extra expense and complexity to make this work?
D. If EPS *is* required, what will you need it to do and how long will it need to last?

This will help you to understand and be able to clearly communicate the requirements of a potential battery system

3. Think about how you are going to pay for a battery and how much it will cost and save

A. Will you be applying for funding to cover all or part of the cost?
B. Thinking about your usage, how much might a battery save over a year?
C. If you changed energy supplier would savings be higher?
D. Will you need other expensive changes such as three phase electricity?
E. Would it be feasible to get solar panels at the same time?

This will help give you a rough idea about potential costs and help you gather useful information for any funding bids.

4. Think about where your battery could be located

A. Do you have an outdoor location that would work for a battery?
B. What requirements do your insurers have for battery storage?
C. What is your current fire and risk assessment policy, and will you be able to update it appropriately if you get a battery?

5. Think about whether you have the capacity and enthusiasm to get a battery installed

A. Is there a person or persons on the committee or possibly someone else in the community who is interested and willing to lead on the process?
B. Who will be the contact point with your battery professional?
C. Who will manage the battery once it is installed?

These can be different people and roles can be shared, but at the end of the day someone has to take responsibility and have the time to make it work

Checklist 2: Your battery professional

Once you've decided that a battery is a good idea for your hall, you need to find a battery professional and work with them to get the battery designed and installed.

1. Make sure that they are appropriately qualified

A. The installer should be a qualified electrician and member of a competent persons' scheme
B. The company should be MCS approved
C. They should have experience with the make of battery you want

2. They should be willing to learn and listen

A. They are unlikely to be village hall experts, but they should be willing to listen to your experience and apply their knowledge to village hall specific circumstances
B. They may be used to residential settings and want to install a battery inside in lieu of a garage but should accept you telling them it must be outside.
C. They should be able to explain technical aspects clearly and justify their position and recommendations

3. They should be able to give you appropriate paperwork pre-installation

A. A fully costed, detailed and itemised quote, including any 'extras' such as secure enclosures, three phase connections, EPS set up, etc.
B. A clear timeline, including the need for any pre-approval processes such as planning permission, G99 grid connection approval etc
C. Proof that they are appropriately qualified (you can independently check this with the MCS and the battery manufacturer)
D. Contact details so that you can communicate easily with them

4. They should provide appropriate 'commissioning' and information post-installation

A. Electrical safety certificate after installation
B. Details and certification of any warranties for the system after installation

C. MCS certificate (up to a month after installation)
D. G98 certificate (if not G99) (up to a month after installation)
E. Written details of how any EPS system works
F. A handbook/instructions on how the battery works
G. Setting up the management app/platform for the battery and providing guidance on how to use it.
H. Provide information about how to contact them or the manufacturer if anything goes wrong or needs follow up.

You should also notify your insurance company and the local fire service once your battery is installed and update your policies and risk assessments.

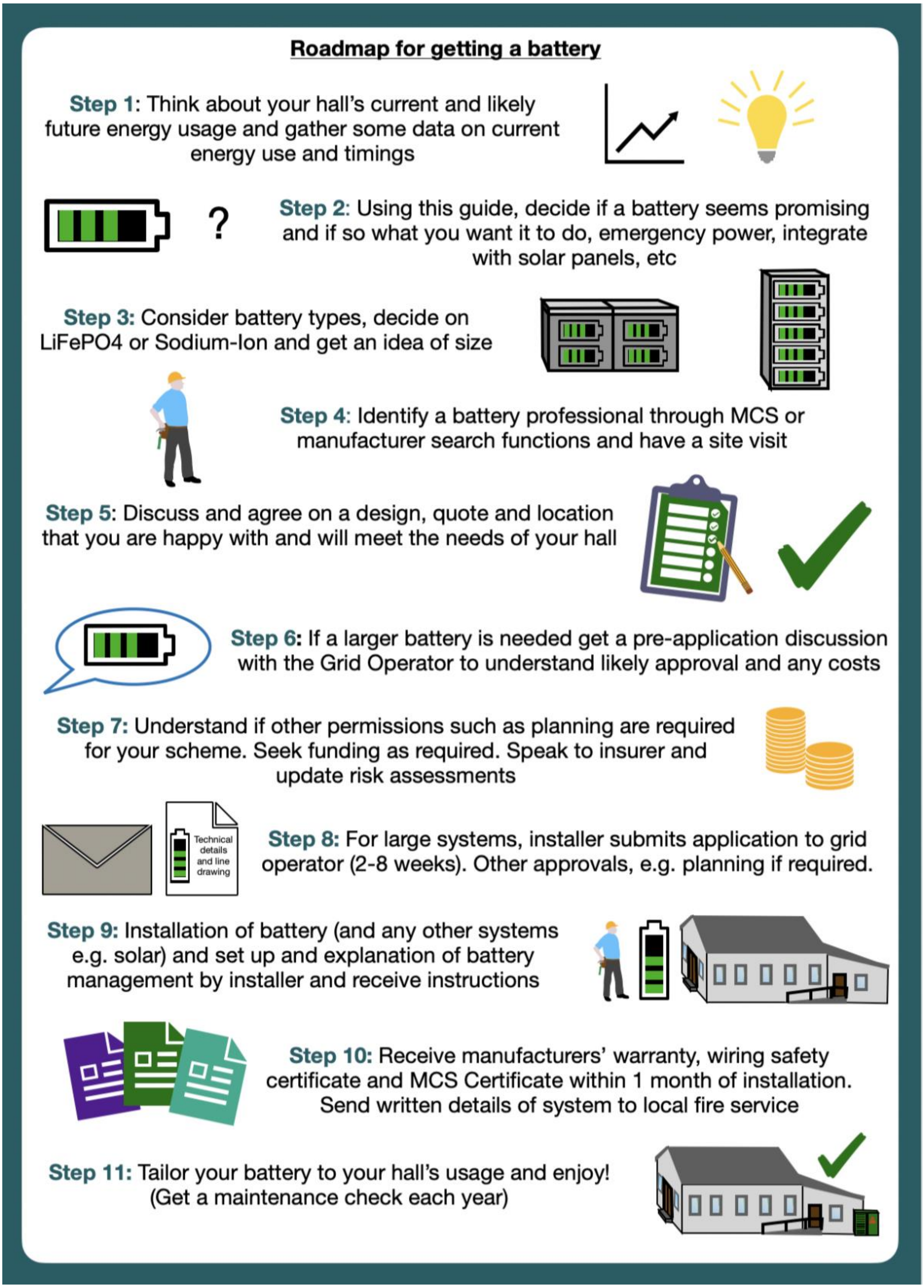
Checklist 3: What should your battery quote include?

It is worth checking that you fully understand any quotes that you receive for a battery and make sure that you ask questions and get clarifications in writing if needed. Here are a few of the key things that any quotes should include:

1. Itemised costings including the battery, inverter, wiring work, battery enclosure, installation costs (such as a plinth if required), EPS hardware if required, other systems such as solar panels if relevant.
2. Whether VAT is being applied or not (see section 9.1)
3. It should be clear what is included and what is not. For example, are extra costs relating to grid approvals, planning applications or additional fire safety equipment included or not?
4. Details of the size and functionality of the system, including both the battery and the inverter, links to the specific product datasheets for the type and size of battery should be provided on request.
5. Details of where the battery will be sited at your hall, such as a sketch map or at least a note that it will be placed as agreed on the site visit.
6. Confirmation that the battery system with be designed and installed in line with any requirements to ensure that the manufacturer’s warranty will be valid.
7. Confirmation that the battery will be installed in accordance with MCS requirements.
8. Clear contact details so that you can get in touch with the battery professional with any queries before, during, and after the installation.

While this might not be included in the quote itself you should also receive something in writing about expected timelines for the project, including estimates for any permissions, such as grid connection times.

Roadmap of the process

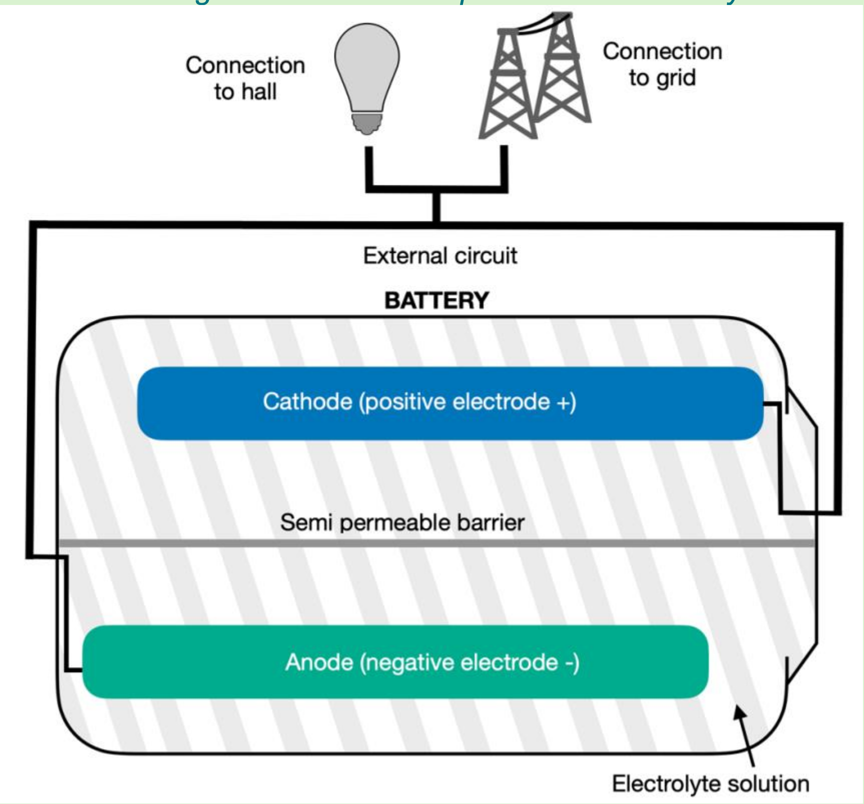


Appendix 1: How do batteries work?

Batteries were first invented in the 1780s by Italian Scientist Alessandro Volta. A battery stores chemical energy and converts it to electrical energy. Their main components are:

- Two electrodes, an anode (the negative electrode) and a cathode (the positive electrode), generally made of different types of metal
- An electrolyte solution which can be a liquid, a gel or a solid between the two electrodes
- An external circuit connecting to things are using or providing electricity

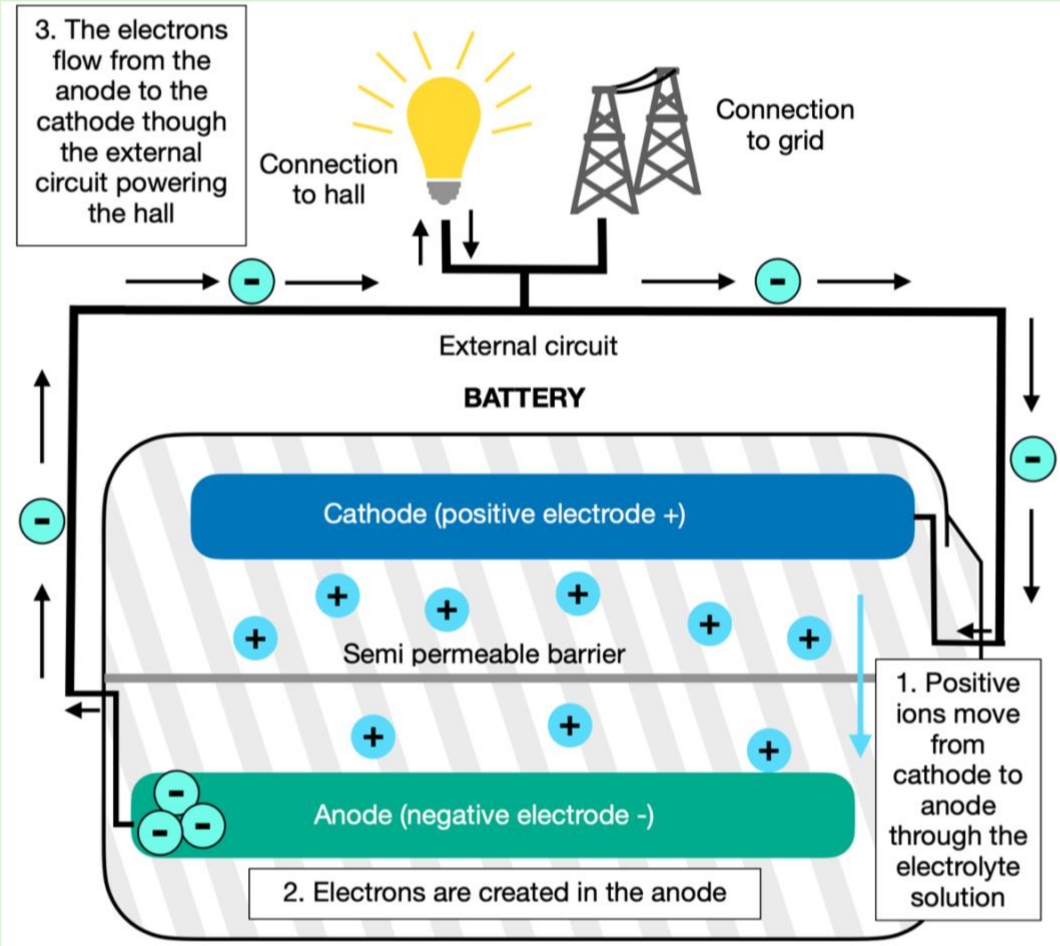
Figure 24: Main components of a battery



Electricity is made up of a flow of electrons. In a battery chemical reactions produce electrons in one of the electrodes.

When the battery is discharging a flow of positively charged 'ions' travel through the electrolyte from the cathode to the anode. This creates electrons in the anode which flow through the external circuit to the cathode, powering any attached electrical systems on the way. As the battery is used these reactions create additional chemical products which build up and create resistance. When this resistance gets too great the flow stops and the battery is fully discharged (i.e. flat).

Figure 25: Discharging a battery

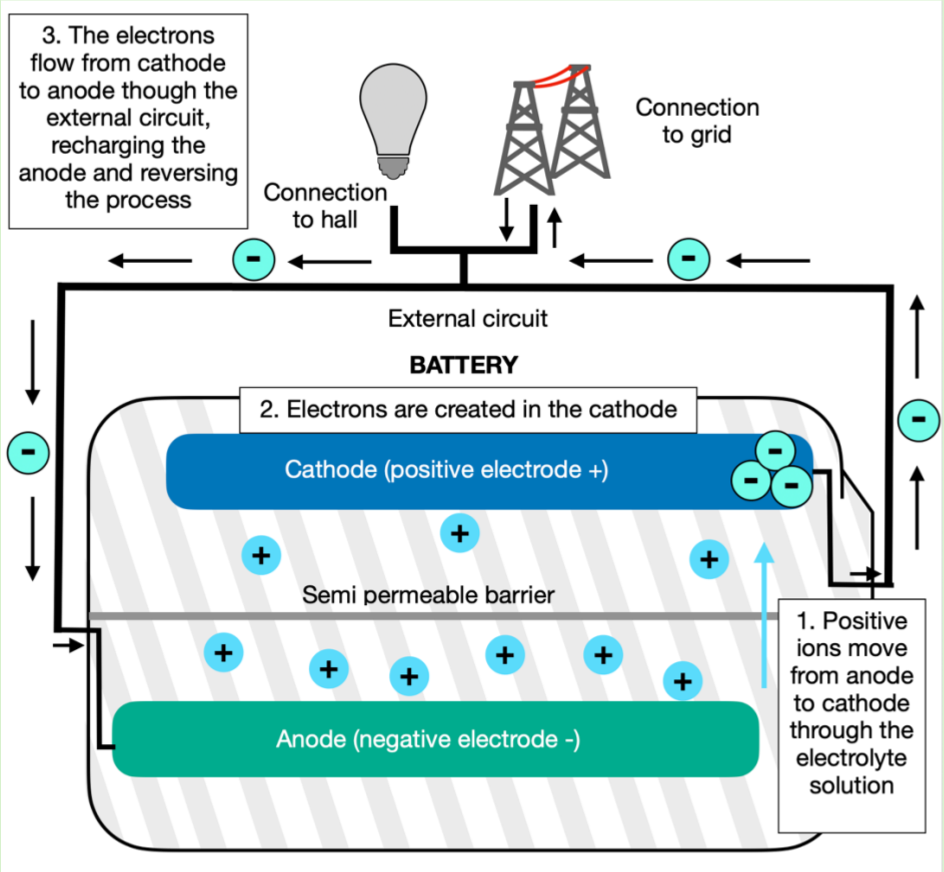


To charge the battery, an external source of power is connected to the external circuit, this could be electricity from the grid or from another source such as solar panels. Connecting this power reverses the chemical reactions and the flow of electrons and ions, recharging the battery.

However, this replacement isn't quite as 'tidy' as the initial reaction, meaning that each charging cycle degrades the electrodes by a tiny amount.

Over a long period of time the structure of the battery becomes messier, reducing its efficiency and eventually (after thousands of cycles) causing it to stop working entirely. Because the battery works on a chemical process it can be affected by external temperatures although how much so depends on the type of battery.

Figure 26: Charging a battery



A link to a more detailed description of battery function is provided in the further resources section.

Glossary

Anode – The negative electrode in a battery

Amps – A measure of electrical current

AC (alternating current) – The type of electricity supplied through the grid; with AC the flow of electrons regularly switches current and polarity

Air source heat pump (ASHP) – A heat pump which draws its heat from the outside air

BESS (battery energy storage systems) – Large scale battery storage for buildings

Bi-directional charging – A charger, such as for an electric car that is able to move electricity in both directions, e.g. from hall to electric car and from electric car to hall

Cathode – The positive electrode in a battery

Carbon intensity – The quantity of carbon emissions associated with producing a unit of electricity, measured in grammes or kilograms of CO_2e. This will vary depending on the source of electricity.

Charge/discharge rate – How much a battery can charge or discharge in an hour, it is measured in kW and is affected by both the battery and the inverter.

Changeover switch – A manual or automatic switch to transfer your hall's electricity system from being attached to the grid into island mode in a power cut scenario.

Capital costs – Any upfront financial costs associated with a setting up a battery system

Circuit – A complete and closed path around which an electric current can flow, powering any devices attached to it.

Consumer unit/fuse box – The box housing the fuses for the electrical circuits in your hall

Competent persons scheme – Government schemes for different types of tradespeople who must operate under quality standards and can thus self-certify that their work complies with Building Regulations

Cycles – Where the battery is charged and then discharged and a measure of battery life

DC (Direct current) – The type of electricity stored in a battery, with DC the flow of electrons goes in one direction at a fairly constant voltage and doesn't switch polarity

Depth of Discharge (DoD) – The percentage that batteries can be safely drained to, for modern batteries this is normally between 80%-100%.

Distribution network operator (DNO) – The organisation responsible for managing the grid in a region of the UK. In Cumbria this is Electricity Northwest.

Dynamic time of use tariffs – An electricity tariff where the cost per kWh varies on a 30-minute timescale based on how much energy is energy is being generated nationally

Earthing (equipment) – Provides protection from faulty electrical devices or appliances

Earthing (system) – Stabilises the voltage of the system and provides surge protection, can be either at building level or through the grid.

Economy 7 tariff – A energy tariff that has two rates a day rate and a lower night rate for the seven most ‘off peak’ hours.

Electrodes – A conductor through which electricity enters or leaves an object such as a battery

Electrons – A subatomic particle which makes up the flow of electricity

Electrolyte – A substance, often a liquid or gel through which ions can move

Emergency Power Supply (EPS) – A set up allowing your hall to be powered by the battery during a power cut.

Energy management system – A webpage and/or app to manage your battery system when it is operating.

Export meter – A specific meter that measures the electricity that is exported to the grid

Export tariff – An energy tariff for the electricity that your hall exports to the grid

Fuse – A safety device consisting of a strip of wire that melts and breaks an electric circuit if the electric current exceeds a safe level, also known as a circuit breaker

Grid balancing – actions taken to maintain the frequency of the grid with 0.5Hz either side of 50Hz. For example, switching additional power supply on or off or where a small amount of capacity from multiple batteries is used to help keep the grid balanced.

G98 process – An approval process for smaller battery systems which can be done *after* the battery has been installed

G99 process – An approval process for larger battery systems which must be done *before* the battery is installed

Ground source heat pump (GSHP) - A heat pump which draws its heat from the ground

Hertz – A unit of frequency used for electricity and radio systems

In-home display – Used to show the energy use of your building as measured by your smart meter

Inverter – Manages the battery system, converts electricity from DC to AC power and moves electricity from the battery or solar panels to the hall and/or the grid

Ions – an atom or molecule with a net electric charge due to the loss of gain of one or more electrons

Island mode – When the hall is operating disconnected from the grid during a power cut scenario

Kilowatt – Measures the amount of power that an electricity device requires at any one moment

Kilowatt hour (kWh) – Measures the energy used by an appliance, system or building or available to be used

LiFePO4 batteries – Uses iron phosphate as the cathode material and lithium ions move between the positive and negative electrodes to charge or discharge the battery

Listed Buildings – Official designation of heritage buildings that imposes additional planning requirements for most changes to buildings

Microgeneration Certification Scheme (MCS) – A quality assurance scheme for installation of renewable energy technologies and batteries

Operational costs/savings – The costs and/or energy savings related with running a battery once it is installed

PAS63100 – The publicly available standard on the safe installation of batteries in domestic settings

Peak power – The peak electricity demand requirements at a certain point in time

Rectifier – A simple electrical device to convert AC electricity to DC electricity

Round trip efficiency – Measures the efficiency of a battery charging and discharging cycle between 3-10% of the electricity will be lost in the process meaning that a battery is likely to be 90-97% efficient

Second life batteries – Batteries that are reused from other sources such as old electric car batteries currently not safe for use in village halls

Single phrase electricity – Electricity that is supplied through two wires and that ebbs and flows because of the nature of AC electricity

Smart meter – A meter that measures energy use and automatically provides this data to the energy supplier at half hourly intervals, can also be linked to an in-building display to show the use live energy use.

SMETS1 – A previous generation of smart meter that relied on Wi-Fi to transmit data and that often failed if you switched energy supplier

SMETS2 – The current version of smart meter that uses a different and more secure network to transmit data and that is supplier agnostic

Sodium-ion batteries – Sodium ions move between the positive and negative electrodes to charge or discharge the battery

Solar PV – Cells that generate electricity from solar energy

Solar Thermal – A system that uses solar energy to heat water

Stackable batteries (or rackable batteries) – batteries that can be combined with others to create a larger storage system.

State of Charge (SoC) – The amount of charge in a battery

Storage capacity – The amount of energy that a battery can store measured in kWh

Three phase electricity – Electricity that is supplied in three wire and which provides a smoother and less fluctuating supply because the phases balance.

Time of use tariffs – Electricity tariffs that charge different amounts for energy depending on the time it is used.

TN system (earthing) – An electrical system where earthing is provided through the electricity grid, the hall will require its own earthing if EPS is required

TT system (earthing) – An electrical system where the hall has its own earthing system

Vehicle to building (V2B) – An electric car and charger that is set up to enable discharging from the vehicle to the building when it is operating in island mode

Vehicle to grid (V2G) - An electric car and charger that is set up to enable discharging from the vehicle to the building when it is operating on the grid

Ventilation – Good ventilation is required for batteries and inverters to prevent dangerous overheating

Voltage – Is a measure of the force or push that makes an electric charge move, for example down an electricity wire

Warranties – A guarantee that your battery will work for a certain amount of time or use or will be replaced for free

Water source heat pump (WSHP) - A heat pump which draws its heat from a body of water such as a river or a lake

Further resources

Detailed information about how batteries work
https://www.science.org.au/curious/technology-future/batteries

Current and predicted carbon intensity of the UK electricity grid
https://carbonintensity.org.uk

Detailed information about how inverters work
https://theengineeringmindset.com/power-inverters-explained/

Map of all the Distribution Network Operators (DNOs) in the UK
https://www.energynetworks.org/customers/find-my-network-operator

Detailed article about smart meters in the UK
https://www.saga.co.uk/magazine/homes/smart-meters-everything-you-need-to-know?srsltid=AfmBOooiAzuq0Wwa7hbmZ7Nawhwn8LGzNuvXtqskBMx9SON8-5Xs9UDx

User resources showing Octopus Energy agile import and export tariffs vary across the year in the North West of England https://energy-stats.uk/octopus-agile-outgoing-export-north-western-england/ and https://energy-stats.uk/octopus-agile-north-western-england/

ACT's funding guide for village halls and community groups can be downloaded here: https://www.cumbriaaction.org.uk/resources/toolkits-workbooks

ACRE's map of rural development organisations for each county in England who offer support to village halls https://acre.org.uk/acre-network-directory-map/

British Standard PAS 63100 on safe battery installation in domestic settings, can be adapted for village halls https://knowledge.bsigroup.com/products/electrical-installations-protection-against-fire-of-battery-energy-storage-systems-for-use-in-dwellings-specification

Downloadable guidance on safe battery installation for commercial settings, can be adapted to village halls, created with insurance companies.
https://www.thefpa.co.uk/advice-and-guidance/free-documents?q=RE1

Manufacturer guidance for safe battery installation following PAS 63100 again focussing on homes https://www.elevenenergy.co.uk/post/best-locations-for-installing-your-sodium-battery-system-according-to-pas-63100

Useful flow chart and guidelines on safety and battery storage. Scroll down the page to the 'Resources' section and select 'risk management flowchart visual'.
https://nicre.co.uk/case-studies/safe-battery-installation

MCS find an installer tool https://mcscertified.com/find-an-installer/

References

1. National Grid Electricity Systems Operator. NESO's Carbon Intensity Dashboard. 2025. Accessed November 28, 2025. https://dashboard.neso.energy/

2. Carbon Brief. Analysis: UK's electricity was cleanest ever in 2024. Carbon Brief. January 2, 2025. Accessed November 28, 2025. https://www.carbonbrief.org/analysis-uks-electricity-was-cleanest-ever-in-2024/

3. Octopus Energy. All our tariffs. Octopus Energy. 2025. Accessed November 28, 2025. https://octopus.energy/

4. Potts T, Cowrie E. The role of batteries in the optimisation of energy systems in community buildings in North East Scotland. Published online 2022.

5. Crown Energy. Difference between single-phase and three-phase electricity explained. Crown Energy. June 29, 2023. Accessed November 28, 2025. https://www.crownenergy.co.uk/news/difference-between-single-phase-and-three-phase-electricity-explained/

6. Electricty Northwest. 3 phase electricity. 2025. Accessed November 28, 2025. https://www.enwl.co.uk/get-connected/connections-faqs/

7. Data Communications Company. Does a smart meter need Wi-Fi? Smart DCC. 2025. Accessed November 28, 2025. https://www.smartdcc.co.uk/our-smart-network/does-a-smart-meter-need-wi-fi/

8. Childress A. Ultimate Guide to Electrical Grounding and How It Works. Family Handyman. September 12, 2023. Accessed November 28, 2025. https://www.familyhandyman.com/article/electrical-grounding/

9. Fully Charged. EV Database. EV Database. Accessed November 28, 2025. https://ev-database.org/uk/cheatsheet/useable-battery-capacity-electric-car

10. HM Revenue and Customs. Extension of VAT energy-saving materials relief. GOV.UK. January 11, 2024. Accessed November 28, 2025. https://www.gov.uk/government/publications/vat-energy-saving-materials-relief/extension-of-vat-energy-saving-materials-relief

11. Octopus Energy. Octopus Shape Shifters | Dynamic Business Electricity Tariff. Octopus Energy. 2025. Accessed November 28, 2025. https://octopus.energy/[...path]

12. BSI. BS 7671:2018+A3:2024: Requirements for Electrical Installations. IET Wiring Regulations. BSI. 2025. Accessed January 13, 2026. https://knowledge.bsigroup.com/products/requirements-for-electrical-installations-iet-wiring-regulations-3

13. The Institution of Engineering and Technology. Code of Practice for Electrical Energy Storage Systems, 3rd Edition. The IET. 2024. Accessed January 13,

2026. https://shop.theiet.org/code-of-practice-for-electrical-energy-storage-systems-3rd-edition

14. The National Fire Protection Association. NFPA 855, Standard for the Installation of Stationary Energy Storage Systems (2026). 2026. Accessed January 13, 2026. https://www.nfpa.org/product/nfpa-855-standard/p0855code

15. MCS Foundation. Find An Installer. MCS. 2025. Accessed November 28, 2025. https://mcscertified.com/find-an-installer/