centre for sustainable energy

Battery storage

Store the excess electricity you generate at home

Domestic battery storage is a rapidly evolving technology which allows households to store electricity for later use.

Domestic batteries are typically used alongside solar photovoltaic (PV) panels. But it can also be used to store cheap, off-peak electricity from the grid, which can then be used during peak hours (16.00 to 20.00).

Solar PV and batteries

If you have solar PV you can generate plenty of electricity when the sun is shining. But on overcast days you'll make less, and you'll make none at all at night. This generally doesn't match up with when you want to use electricity; it's at night when you want the lights on and to use appliances like a dishwasher or TV.

The electricity you generate but don't use is typically exported into the national grid and used elsewhere – it's not wasted. You can get paid for this (see SEG below), but the payment is much lower than the price you pay for electricity, so it's better financially to use as much as possible in the home.

This is where battery storage comes in. If you can store the electricity generated during the day, you can use it later in the evening and the following day, reducing the amount of electricity you purchase from the grid. There are other ways to use more of your solar generation, without the need to buy a domestic battery. See Getting the best from your solar PV panels for more information.

Most domestic storage batteries won't be situated in the living room, but we've included this picture of a Sonnen battery to give some idea of size. This is a 5kw model and it measures 88 cm x 67 cm x 23 cm.

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Batteries, time-of-use tariffs and heat pumps

Some batteries can now import and export electricity directly from the grid and you could install a domestic battery without having any renewable generation. With a time-of-use tariff your battery can store cheaper electricity during off-peak hours (typically at night) to be used when electricity is more expensive.

Some batteries can track the price and only charge when electricity is at its cheapest. Storing energy in this way could enable you to pay lower prices for a large quantity of your electricity consumption. This could work particularly well if you have a heat pump or other electric heating as some of your heating costs could be met with cheap rate electricity.

On a national scale, as more renewable generation is installed it will eventually exceed demand during off-peak periods and will need to be stored for use when demand is high. Domestic battery storage can play its part in this.

Smart Export Guarantee (SEG) payments

The Smart Export Guarantee (SEG) is a government policy that was introduced in 2020 to replace the feed-in tariff and ensure that households can be paid for renewable electricity they export to the grid.

This is most commonly associated with solar PV, however more recently households can be paid for energy that is exported from certain domestic batteries, though not all have this capability and the installation must be Microgeneration Certification Scheme (MCS) certified.

Energy suppliers set their own SEG rates with the average around 4p/kWh, but it can be as high as 15p/kWh.

Financial savings

While a battery may save on imported electricity costs, their capital cost remains high. Payback periods are 8-12 years, which is similar to their reported lifespan, and will depend on a number of factors:

- The size of your PV array.
- The size and cost of the battery system.
- How much electricity you use in the mornings and evenings which could be supplied by the battery.
- The cost of electricity supplied via the grid and whether you use a ToU tariff.
- Whether you have a heat pump or other electric heating.
- How much you would be paid for exporting the electricity to the grid instead of charging a battery.

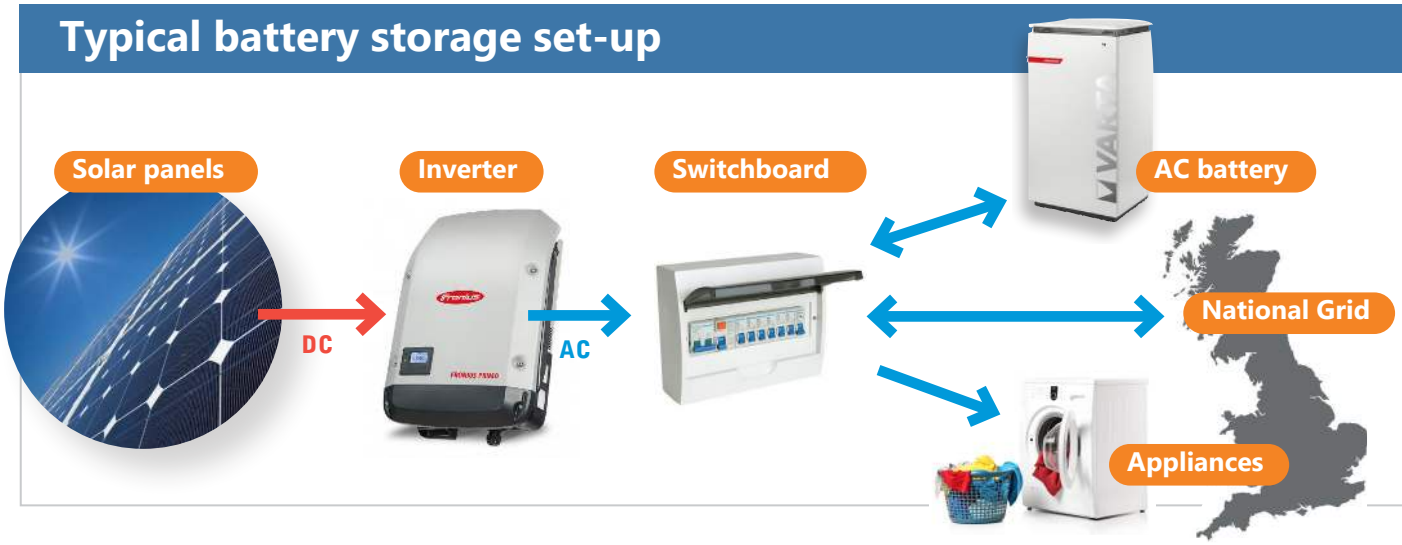
Calculating simple payback period

A typical household may consume 3,500kWh of electricity per year and a typical solar array may generate 2,800kWh in that time. Of this, the household may use 30% with the rest being exported to the grid. With a 6kWh battery the household may now be able to use 70% of the solar generated energy – more than twice as much.

The table below shows how the numbers might stack up. Here, the key variables are the capital cost of the battery, the unit cost of grid electricity and the SEG payment. With a SEG payment of 4p/kWh, the payback period is 12 years. If the SEG payment increases to 15p/kWh, the payback period would increase to 19 years – arguably longer than the battery's lifespan – as the relative benefit of not having a battery has increased.

On the other hand, capital costs are likely to keep falling which will decrease the payback period. An increase in grid electricity costs will also reduce the payback period.

Typical battery storage set-up



This demonstrates the complexities and dynamic nature of calculating whether a battery is a good investment.

	3.5kW Solar PV	3.5kW Solar PV + 6kWh battery
Solar generation used	30%	70%
Solar generation used	840kWh	1,960kWh
Grid electricity saving (34p/kWh)	£286	£666
Solar generation exported	1,960kWh	840kWh
SEG payment (4p/kWh)	£78	£34
Total saving/ income	£364	£700
Capital cost of battery	–	£4,000
Additional saving from battery	–	£336 (£700 minus £364)
Simple payback	–	12 years

It gets more complicated if we consider time-of-use tariffs.

If we take the typical 3,500kWh annual household electricity usage and divide equally across the year, it uses 9.6kWh per day. Assuming a battery has enough capacity to supply this and is 'charged' at a cheaper rate of 12p/kWh, the annual cost of electricity would be £420 (assuming there is no solar PV installed).

A standard tariff of 34p/kWh would cost £1,190 per year, giving an annual saving of £770. If the battery costs £6,000 then the payback period is eight years. Installing solar PV in this scenario would further reduce the payback period.

Electric vehicles

An electric vehicle (EV) is essentially a big battery you can drive. Smart chargers allow the EV to prioritise solar electricity or cheaper rates with a time-of-use tariff. It's unlikely you would have both an EV and a battery, and if reducing emissions is your priority, switching your car to an EV will save far more emissions than installing a domestic battery.

Some EVs can be used to power your home, just like a domestic battery. For this to be possible, the EV and the EV charger will need to be bi-directional charging compatible.

Solar battery sustainability

Although it is often considered more sustainable to use a higher percentage of the solar electricity that you generate and use less electricity from the national grid, this is not always the case. So long as the local grid has enough capacity to transport your excess solar generation to another household that needs it, then that renewable energy is not lost.

On a national scale we do not yet produce more renewable electricity than we can use, though this is likely to happen in the future. When it does, domestic battery storage can play a part in storing this and reducing the need for fossil fuel generation at other times, therefore reducing overall emissions.

There are also greenhouse gas emissions associated with the lifecycle of a domestic battery. These are called 'embodied emissions' and are released during the mining of the raw materials, manufacturing, transport and disposal of the battery. The battery system would therefore have to reduce overall emissions by more than the embodied emissions to result in a net reduction of greenhouse gas production.

As well as the embodied emissions, there are a host of ecological and social impacts associated with domestic batteries which are difficult to quantify and compare. These are primarily the result of mining the primary materials, principally lithium (the most common material used for domestic batteries), but also cobalt and nickel. In response, manufacturers are looking to develop more sustainable materials and processes.

Using a domestic battery to store solar energy for later use could save you money, but is unlikely to have a clear beneficial impact on the environment at the moment.

So, should I get one?

As we've seen number of variables will deterimine whether a battery is a good investment.

The financial and environmental case for domestic batteries may not work for everyone at the moment, but both are likely to improve over time. If your primary motivation is to reduce your emissions, a better foucs would be on reducing your heating demand, installing a heat pump or buying an EV.

What to look for ...

Some pointers on what to look for when buying a battery.

Capacity

This is how much electricity the battery can store in kilowatt hours. An analysis of your electricity consumption is required to work out the optimum size. Your installer should work with you to do this.

Number of 'cycles'

One cycle is a full charge and full discharge, but this rarely happens. Batteries usually partially charge, so a 50% charge and discharge is half a cycle. If you know the number of warrantied cycles (i.e. the number of cycles you are guaranteed to get) you can work out how many kWh the battery will give you over its lifetime, and ensure the battery will pay back the cost within its expected lifespan.

Charge/discharge rate

This refers to the power input and output in kW. Make sure that you have enough power input to match the maximum output from your PV and enough output to run the appliances you want to use.

Back-up power capability

Do you need it?

Price per kWh of storage capacity

There are various batteries available on the market, and at varying prices. If you are trying to decide between similar batteries, then the price/kWh of storage capacity is a useful way to compare different systems.

AC or DC coupling

Solar PV needs an inverter, as does a battery. A system using DC coupling has a single combined inverter, while AC coupling requires separate inverters for battery and panels which has implications for the system's function and efficiency. In general, AC-coupled batteries are probably better if you already have PV as they are easier to retrofit.

DC may be a better option if you install PV and a battery at the same time, as they can be fully integrated. This is typically more efficient and tends to be cheaper, though such a system may not be able to charge from the grid.

A reputable installer

Make sure your installer is certified by the Microgeneration Certification Scheme (MCS).

Back-up power

Bear in mind that not all batteries can deliver electricity during a power cut. Those that are likely to cost you more

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The Centre for Sustainable Energy is a national charity supporting people and organisations across the UK to tackle the climate emergency and end the suffering caused by cold homes.

Our Home Energy Team offers free advice on domestic energy use to householders in central southern and southwest England.

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