

# Battery energy storage systems with grid-connected solar photovoltaics

A technical guide

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#### Note to readers

This guide was originally published as *Batteries with solar power: a technical guide to the use of energy storage with grid-connected solar photovoltaic systems*. This current version supersedes the original, which has now been withdrawn.

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# Executive summary

This guide covers battery energy storage systems for domestic or small commercial grid-connected solar photovoltaics (PV). It is intended for two audiences:

- Customers. Information is provided to enable the benefits of energy storage systems to be assessed. The pros and cons of different system types are discussed, as well as the implications of different system sizes and operating regimes.
- System designers and installers. Information is provided to enable the safe and effective design, specification and installation of energy storage systems.

This guide focuses on grid-connected solar PV systems, although some principles also apply to other forms of energy generation. Systems that make use of any 'spare' storage capability available from an electric vehicle are not covered.

The guide looks at the design, sizing and specification of energy storage systems that use established battery technologies to store solar surplus for use later in the day. Typical operating patterns and characteristics of these systems are also examined. Examples are given of how such systems can be configured and connected within a building, and the process for sizing batteries and other system components is examined.

## Customer information

Items of particular interest or importance to customers are highlighted in boxes.



# 1 Introduction

Adding energy storage to a grid-connected PV system is considered for many reasons. However, for domestic or small commercial system owners in the UK, two main reasons predominate: storing surplus solar PV energy for use later in the day; and providing a back-up power supply in the event of a power cut.

## 1.1 Storing solar surplus

For many systems there will be times during the year when the power being generated by the solar PV system is greater than the power requirements of the building that it is connected to. During those periods, for a system without storage, all the surplus electricity is exported to the grid. For systems with storage, some of the energy that would otherwise be exported can be retained for use later in the day – an operation sometimes called ‘time shifting’.

Without a good understanding of the scale of the available solar surplus, it is very difficult to properly design and specify a storage system. Also, some sites may have a solar surplus that is so small or infrequent that adding storage is simply not justified.

## 1.2 Providing a back-up power supply

The provision of a back-up power supply is particularly relevant for sites that suffer regular power cuts (although this is fairly infrequent for most locations in the UK), or for sites that need to guarantee they can run a critical load at all times.

In most customers' minds, the addition of battery storage generates an expectation that the system will then be able to provide power during a power cut. However, for many systems on the market this is just not the case, as they have not been designed to fulfil off-grid functionality.

Additionally, the size/capability of battery storage systems will limit what can be run during a power cut. For systems that are designed to provide a back-up power supply, the size of the battery, inverters and ancillary equipment is dictated by the load the system needs to run when the mains (grid) is unavailable. In particular, two main load characteristics need to be considered: the combined size of the loads to be run in kilowatts (kW); and the length of time each of the individual loads is expected to operate.

There are other reasons for adding storage to a grid-connected PV system, which are discussed later. However, the two listed above predominate in the UK, particularly for smaller systems. While the design and sizing of a storage system is influenced significantly by its intended purpose, there are a number of key safety factors that apply to all systems; these are covered in Section 6 of this guide.

### Box 1: Off-grid operation

Just because a system has a battery, it does not necessarily follow that it is able to provide off-grid power. Many grid-connected PV storage systems cannot provide power during a power cut. Also, if a system can provide off-grid power, its power capability (kW) will be limited. Ask your supplier what your system can provide.



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