Battery Storage

WHY INSTALL A BATTERY?

There are two main reasons for installing a battery system in a commercial building:

To reduce peak electricity costs and charges. Some businesses have energy contracts which have expensive peak rate electricity tariffs and there can be other charges passed through from the supplier which make it expensive to draw large quantities of power from the grid at certain times. With a battery storage system, it is possible to charge up the battery using grid electricity when it is at its cheapest and then use the stored electricity the next day when electricity costs are high again. This is sometimes called load shifting.

If your building has solar PV, you will sometimes produce more electricity than you use. This surplus generation is exported to the grid, and you receive a modest amount of revenue from it through the Smart Export Guarantee (SEG). By installing a battery, you can use more of the generated electricity in your own building. When the battery system is providing electricity to the building it reduces the amount of electricity you have to purchase and it is said the self-consumption from the solar PV system has been increased. The imported electricity costs more than the value of exported electricity so savings can be made.

For load shifting and increasing self-consumption of solar PV there are a growing number of commercial grade battery energy storage systems coming onto the market. They are often called “behind the meter batteries” to distinguish them from grid scale battery storage plants.

BACKUP POWER

In some circumstances, batteries may also be installed as a backup power supply for use in the event of a power failure. The most common application has been in large commercial buildings where centralised lead acid battery stores are kept on standby to power emergency lighting in the event of a power cut. There is a growing trend towards installing LED lighting with self-contained batteries that maintain lighting in emergencies rather than using a centralised battery store. For buildings with bigger loads and a need for completely reliable power, it's more common to for diesel generators to be used.

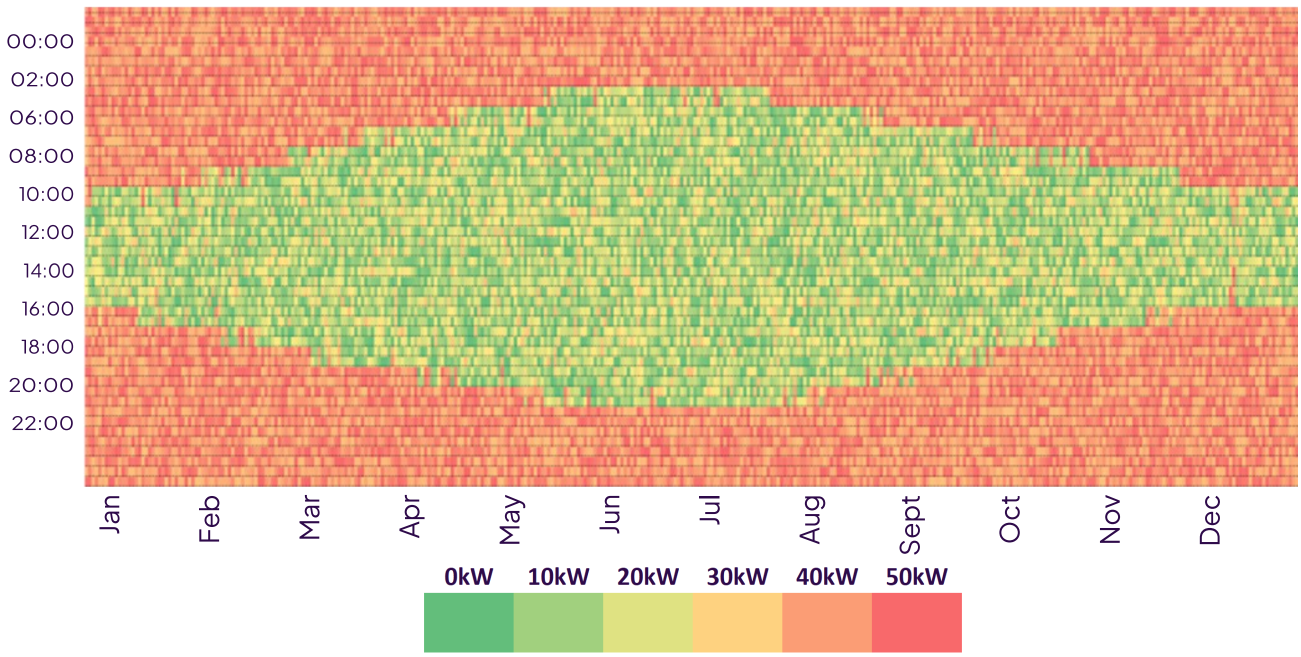
FEASIBILITY ASSESSMENT

If you don't already have a good-sized source of renewable electricity generation, it's unlikely that a battery energy storage system will be commercially viable due to the high cost of batteries. If you do generate your own electricity, it may be worth investigating battery energy storage further.

To work out if a battery is likely to provide any financial benefit to your organisation, you need to have a detailed understanding of your electricity consumption. By analysing your half hourly electricity consumption data over a year, you can see how your consumption varies depending on the time of the day, day of the week and time of the year. It is then possible to compare this to your solar PV generation allowing you to identify when you have a surplus of electricity that could be stored.

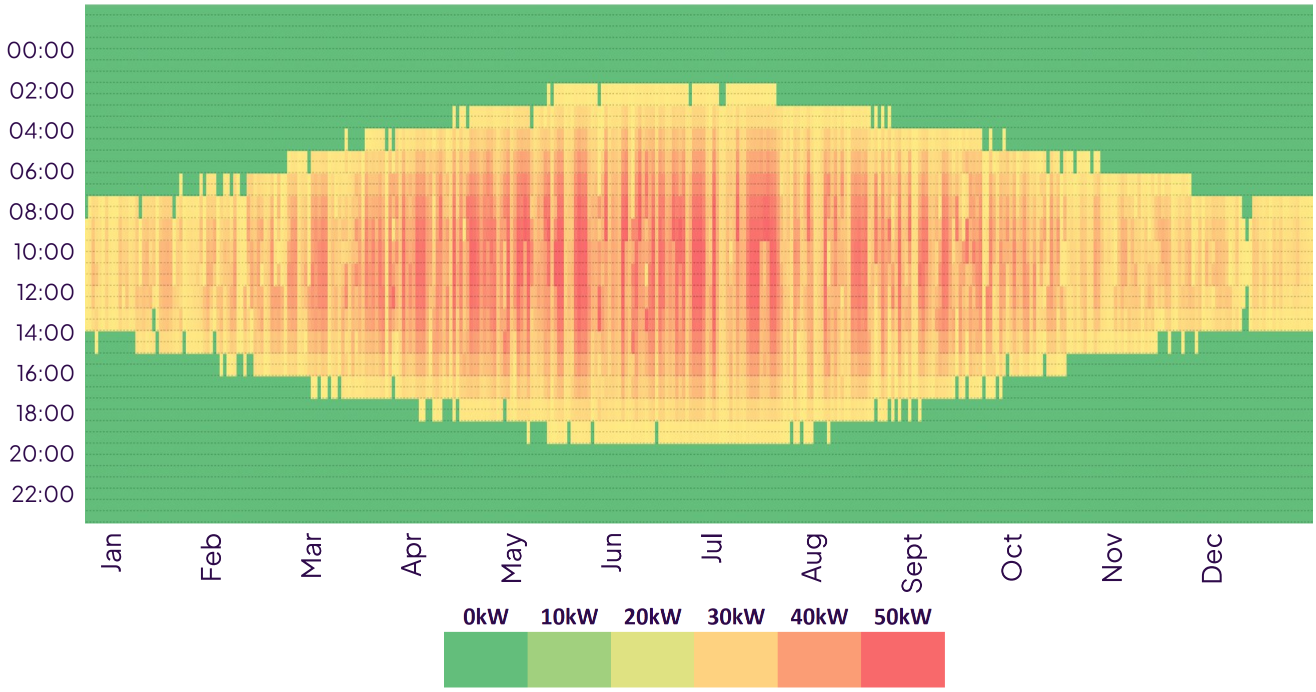
The plot below gives an example of a yearly energy consumption profile for a warehouse building which operates 24 hours per day. The days of the year run left to right and the hours of each day run top to bottom from midnight to midnight in half hour segments. The green areas of the plot represent periods of very low electricity consumption and the red areas represent the peaks of consumption.

YEARLY ELECTRICITY CONSUMPTION PROFILE FOR THE WAREHOUSE



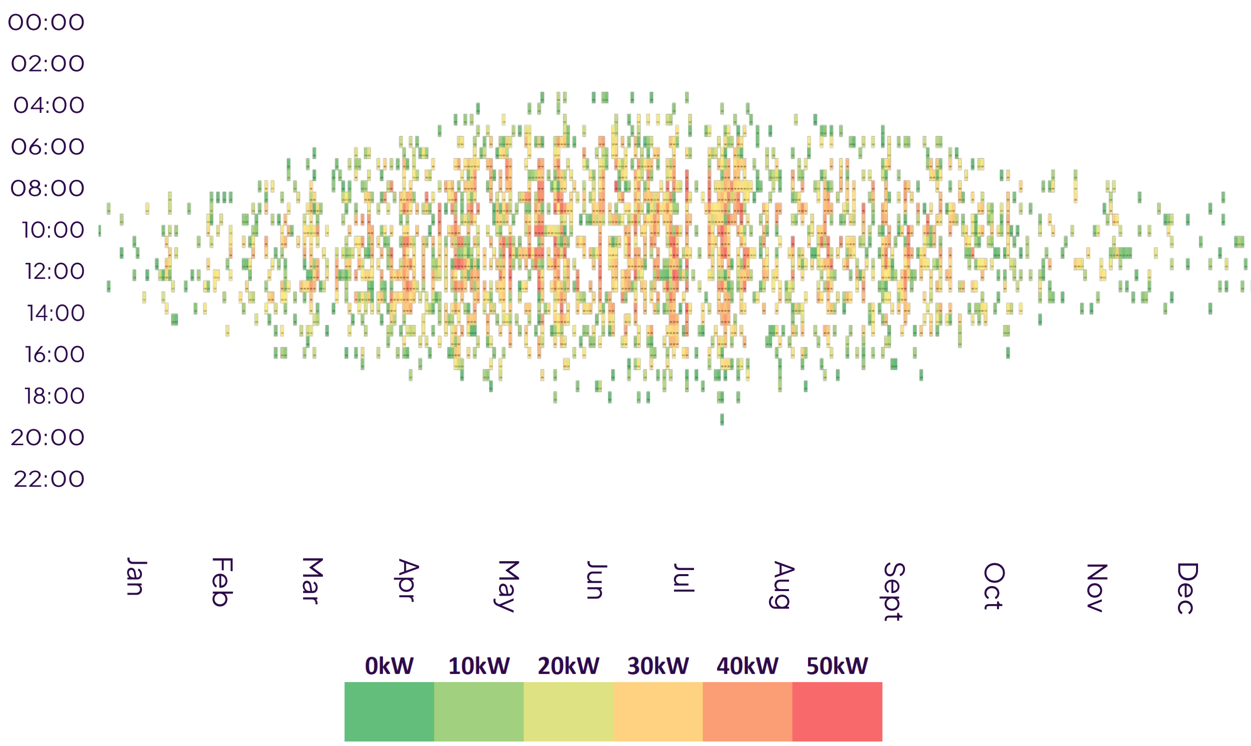
A 40kWp solar PV array is proposed for installation on the building. The forecasted generation profile from the solar is shown in the plot below :

FORECAST SOLAR PV ARRAY ELECTRICITY GENERATION PROFILE



The plot below shows the remaining energy generated by the solar PV array once the instantaneous demand has been met. This electricity would be exported to the grid, reducing the benefit of the solar system.

ELECTRICITY GENERATION FROM THE SOLAR PV ARRAY IN EXCESS OF INSTANTANEOUS DEMAND



STORAGE CAPACITY

It's helpful to understand the basics of how battery systems are sized. Manufacturers usually quote the storage capacity of the battery in kWh (e.g. 400kWh). Larger batteries are often quoted in MWh. A 400kWh battery is equivalent to a 0.4MWh battery.

POWER RATING

Unlike power that is supplied directly from the grid, battery systems have a finite capacity for delivering power to the loads in the building. If your building has high peak loads (e.g. from machinery) a battery system may not be able to provide enough instantaneous power to supply it and some of the power would still need to be drawn from the grid. The power rating of a battery is usually given in kW or kVA.

Some manufacturers describe their battery system size by the power rating and a discharge duration. For example, a 100kW/4hour battery would have a storage capacity of 400kWh and a power rating of 100kW. Most commercially available battery systems are modular so it is possible to configure bigger or smaller systems from the basic building blocks offered by manufacturers.

SYSTEM SIZING

Financial models can be very sensitive to system sizing so it's really important make a thorough assessment. Consultants use modelling algorithms to analyse building energy consumption profiles and solar PV generation profiles whilst taking into account any time-of -day import and export tariffs. The algorithms are used to determine the most appropriate battery storage capacity so as to optimise the financial value of a battery system. Decerna can provide expert advice and financial models to suit your business needs.

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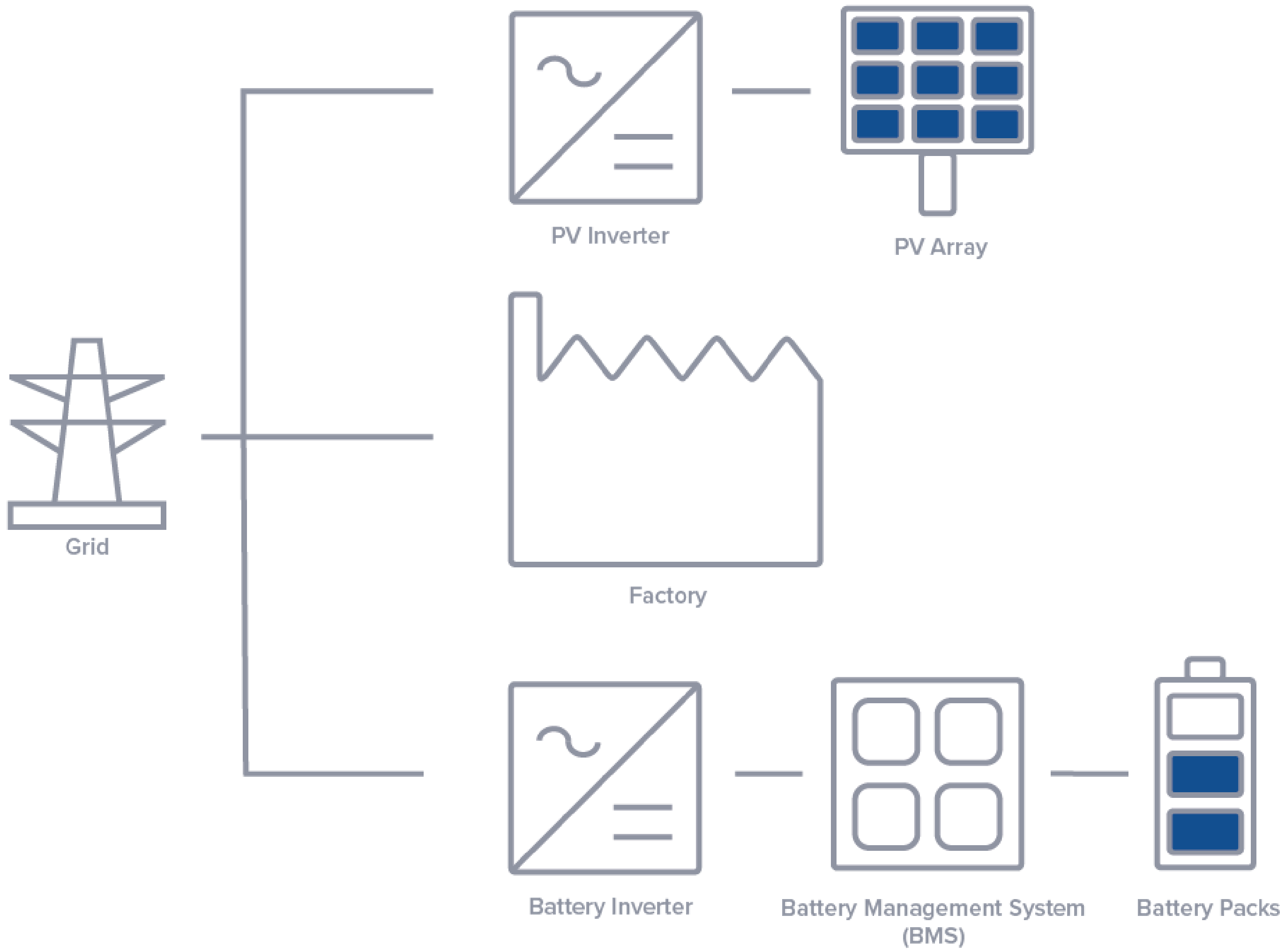
COMBINING BATTERIES WITH SOLAR PV

When combined with solar PV, battery energy storage systems typically have 3 modes of operating:

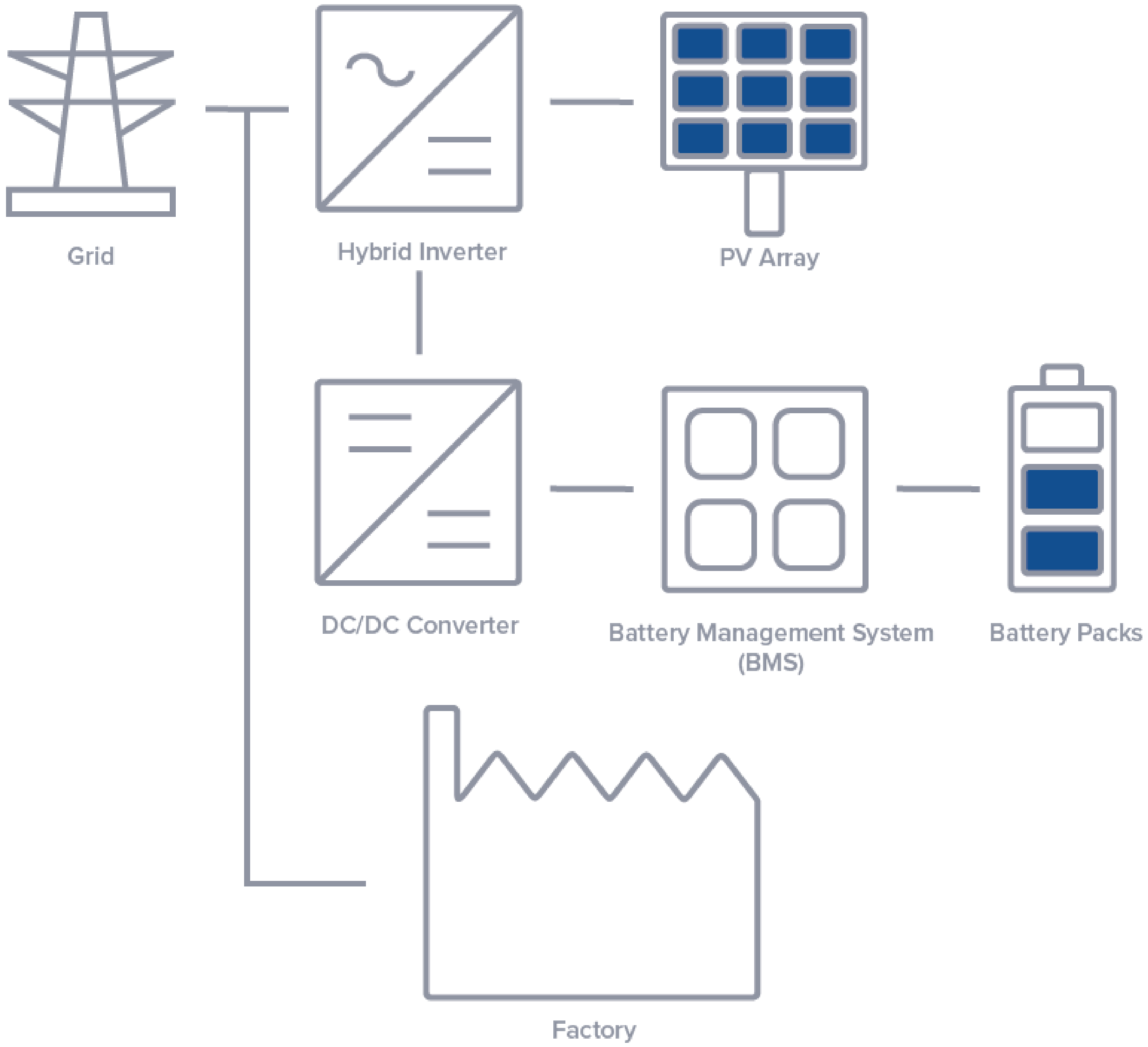
1. Charging the battery from the solar PV array—used when there's a surplus of solar energy.
2. Charging the battery from the grid— used when grid electricity is cheap.
3. Supplying power to the building directly from the battery—used when grid electricity is expensive.

AC OR DC COUPLED?

There are two common configurations for using batteries with solar PV. In an AC coupled system, a conventional grid tied inverter converts DC power from the solar array to AC and synchronises it to the grid. The battery is connected to the grid in a similar way. This is shown in the schematic below.



With a DC coupled system, the battery is connected to the DC side of the inverter using DC/DC converter. DC coupled systems are slightly more efficient because there are fewer conversion steps between DC and AC but they offer less flexibility in terms of operating modes and are less suitable when the building already has solar PV.



FINANCIAL CONSIDERATIONS

In some cases, battery energy storage will not be economically viable using load shifting and increasing solar self-consumption alone. There are, however, a growing number of alternative ways in which a battery system owner can get financial benefit. If you can make your battery available to the National Grid for some of the time, it is possible to receive various payments.

There are a number of different grid benefit programmes for battery system owners including STOR (Short Term Operating Reserve), BM (Balancing Mechanism) and Firm Frequency Response (FFR). Most of these incentives however are only accessible to owners of very large batteries or generators.

Organisations known as aggregators can act as intermediaries and take control of multiple batteries within a portfolio big enough to gain access to these grid services. However, these service providers also have fairly high minimum battery size requirements. For example, an aggregator might require a minimum portfolio of battery storage systems of 1MW/1 hour capacity, but this could be met over a number of batteries in different buildings on the same campus or local area. Aggregators can sell your energy to the grid when demand is high and increase consumption when energy prices are favourable. They are able to dynamically adjust the mixture of financial incentives they are using your battery for at any given time to get the best overall financial yield. This is known as revenue stacking.

SAFETY AND MAINTENANCE CONSIDERATIONS

Modern lithium-based batteries require little in the way of maintenance but they must be installed, commissioned properly and regularly monitored to ensure they remain safe and efficient.

Lithium battery fires are extremely difficult to extinguish, so it is vital that proper fire risk assessments are undertaken and appropriate control measures are put in place. Many operators choose to specify that their battery systems be located outside of occupied buildings as an additional precaution. Where they are located in car park areas or loading bays it is also sensible to provide perimeter security fencing and vehicle impact protection.

Commercially available battery systems have sophisticated battery management systems (BMS) which ensure batteries are safely managed and do not overheat during charging or discharging. The BMS system also help ensure the batteries are never discharged completely as this can have a damaging effect on them.

UTILISING ELECTRIC VEHICLE BATTERIES

The latest generation of electric vehicles are beginning to support "Vehicle to Grid" technology, allowing the vehicle's battery to be used as electrical energy storage. A business with a small fleet of electric vans that are used during the daytime could potentially benefit from the electricity storage capacity from the van batteries.

ENVIRONMENTAL ISSUES AND RECYCLING

There are serious concerns linked to the life cycle of batteries. The most popular chemistry used in behind-the-meter battery storage systems is lithium-ion. Most lithium-ion batteries use a small quantity of cobalt to improve the battery performance. There are numerous supply chain issues, including health risks to workers in poorly regulated mines. Some organisations are using Life Cycle Assessment (LCA) techniques to quantify the level of benefit and harm caused by these technologies.

Reuse and recycling are lithium-ion batteries from commercial systems is possible but there is limited recycling capacity for batteries in the UK. Large scale lithium-ion battery recycling centres are beginning to emerge across Europe, so the situation is improving.

SECOND-LIFE ELECTRIC VEHICLE BATTERIES

Batteries in electric vehicles gradually degrade and once their performance is no longer adequate for vehicle use, they can be re-purposed for other applications such as behind-the-meter battery storage systems. This can achieve both a reduced reliance on raw materials as well as a lower capital cost compared with using newly manufactured batteries. Companies are beginning to offer the option of second life EVs in commercial battery systems.

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Decerna provides a wide range of consultancy and development services, to ensure that the right decisions are made, to support our customers in the whole journey, from initial concept through to implementation of low carbon systems and infrastructure. Please get in touch to find out how we can help your organisation to de-carbonise.

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