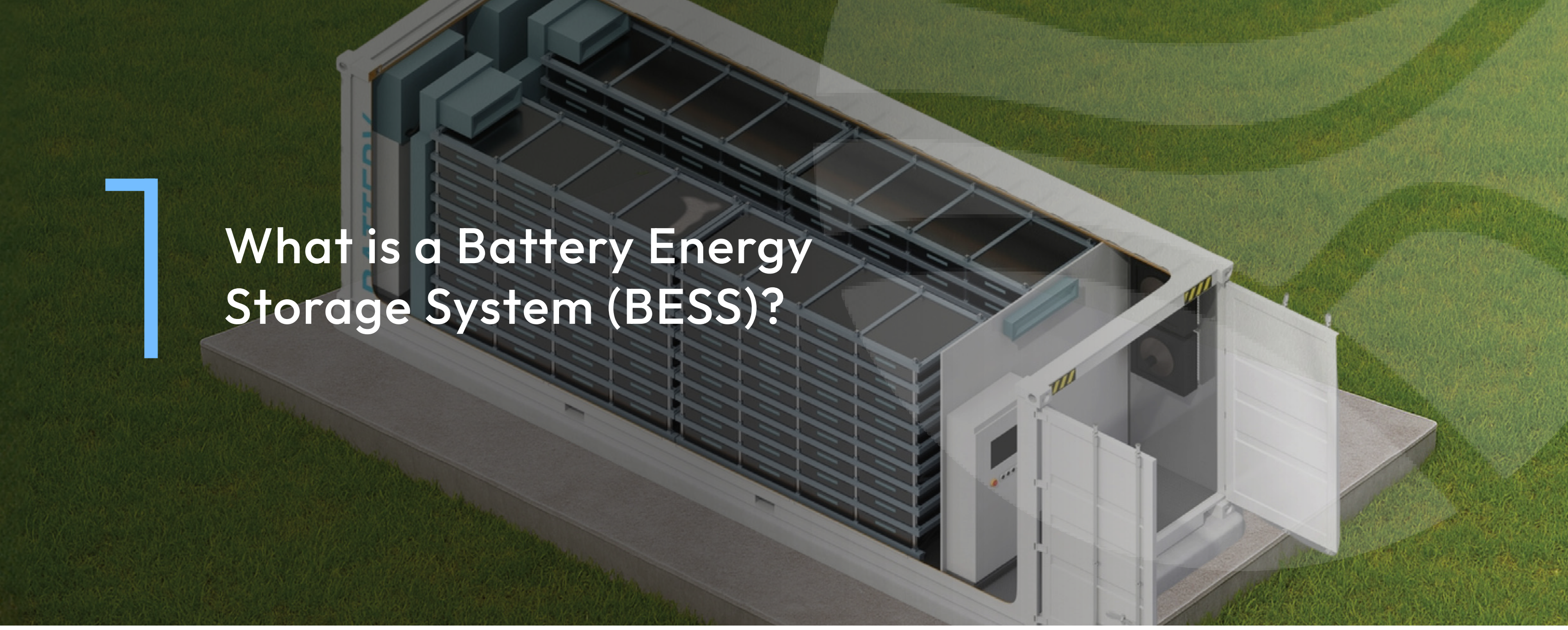
Frequently Asked Questions

VOYAGER RENEWABLES

BATTERY ENERGY STORAGE SYSTEM (BESS)



1 What is a Battery Energy Storage System (BESS)?

What is a BESS?

A Battery Energy Storage System or "BESS" is a technology that stores electrical energy, often from renewable sources like solar or wind, for later use. It works by using batteries to capture and store energy when there is a surplus (for example, during sunny or windy periods), and then releases it back into the grid when demand is high, or energy supply is low.

Energy storage plays an important role in balancing the supply and demand of electricity across our complex national and regional grids. Traditionally, this service has been provided by hydro-electric plants and gas peaker plants. While these technologies will continue to play a part in electricity networks, recent years have seen significant improvements in battery technology while at the same time the cost of batteries has dramatically decreased. As a result, battery systems often now present the most cost-effective, reliable, and technologically capable solution to the energy storage needs of Australia's electricity grid.

Why is energy storage needed?

Electricity demand is the amount of power consumers require at any given time, which fluctuates throughout the day and across seasons. Electricity supply is the amount of power that is available from generation plants, which fluctuates based on time of day, season, weather, as well as the operating condition of individual power stations. Energy storage helps to balance out differences between demand and supply.

WIND

Wind energy generation depends on wind speed, simply put, the stronger the wind, the more electricity a turbine can produce. When the wind is calm, turbines produce less energy.

SOLAR

Though very predictable, solar panels produce a large amount of energy in the middle of a bright, clear day and less in the morning, dusk and evening.

DEMAND

Demand is influenced by factors like:

- Time of day, e.g. peak demand is often in the evening when people return home and use appliances.
- Weather conditions, e.g. heating in winter, cooling in summer.

Electricity demand is relatively predictable and follows known patterns, but it can peak at certain times, requiring additional generation capacity.

As Australia's electricity generation shifts more to renewables resources like wind and solar, power supply doesn't always align with when demand is highest.

By introducing BESS projects into the grid, the excess electricity generated by wind and solar can be stored in batteries for use later when generation is low, or demand is high. In this way, BESS projects help to ensure a consistent power supply, and stabilise the grid, so that homes and business can rely on electricity to be available.

How do batteries work?

Batteries store electrical energy in the form of chemical energy, which can be converted back into electrical energy as needed. Unlike most energy sources, this process is reversible, which means the battery can be charged and discharged repeatedly. When a BESS is "charging", an incoming electrical current causes one component of the battery to store electrons. When the BESS is "discharging", the battery releases those electrons, which provides a flow of electricity back onto the grid.

Batteries are made up of a complex mix of materials, separated into discrete layers. The mix of materials in a battery is typically referred to as its "chemistry". Some common chemistries are explained below:

LI-ION

Lithium ion batteries are the most common type of rechargeable battery. These are the same kind of batteries used in devices like smartphones and laptops, but on a much larger scale. Li-ion batteries have a high energy density, meaning they can store a lot of energy in a compact space, but a shorter life cycle than flow batteries.

X FLOW (VANADIUM REDOX)

Flow batteries use two liquid electrolytes, stored in external tanks to charge and discharge through redox (reduction oxidation). Although flow batteries have a lower energy density than Li-ion, they have a longer life cycle, leading to less wear and tear on the system.

MEGAWATT (MW) OR MEGAWATT HOUR (MWH)?

A BESS is typically defined by two parameters: its **power** capacity and its **energy** capacity:

Power Capacity

How much power a BESS can deliver at one given time -> the maximum instantaneous power. Power is measured in megawatts (MW).

Energy capacity

The total energy a BESS can store and deliver over time -> total energy storage capacity. Energy is measured in megawatt-hours (MWh).

As an example: a BESS rated at 100MW power capacity that is designed to charge or discharge for up to 1 hour would have an energy capacity of 100MWh. If the same 100MW BESS was designed to charge or discharge for up to 2 hours, it would have an energy capacity of 200MWh.

A good way to think about BESS capacity is to compare it to your car. The power capacity (MW) is like the car's top speed. The energy capacity (MWh) is like the car's range. Your car can only drive at full speed for a few hours before it runs out of gas – just like a BESS will run out of charge after a few hours at maximum power.

2 What is in a BESS project?

A utility-scale BESS consists of several key components:

- Battery racks
- Balance of system
- Substation and grid connection

Further details on each are provided below.

Battery enclosures

In a modern utility-scale BESS, thousands of individual batteries are combined in repeating units, to form a utility-scale solution. From the outside, each of these units looks like little more than a steel box, but what's packed inside is incredibly complex.

Individual batteries (each called a "**cell**") are stacked together into "**modules**", and then modules are stacked together into "**racks**". Rows of battery racks are installed inside steel containers, also called "**enclosures**". The net result is thousands of cells stacked together, such that each enclosure can hold a phenomenal amount of energy.

Modern BESS enclosures look a lot like shipping containers, but in fact are custom designed for the battery system inside. Each enclosure contains critical control systems and a battery management system, to manage the charging and discharging processes and ensure the BESS operates optimally.

The enclosures also have specially designed fire protection systems, and thousands of sensors constantly measuring the condition of the components, to ensure the project operates safely.

INVERTERS

A Power Conversion System ("PCS"), commonly referred to as an "inverter", is needed because batteries produce direct current (DC electricity whereas the national electricity grid carries alternating current (AC electricity). The PCS's function is to take AC electricity from the grid and convert it into DC electricity to charge the batteries, and vice versa to take DC electricity produced by the batteries when discharging and convert it into AC electricity that can be exported onto the grid.

The PCS is sometimes integrated within the battery enclosures, depending on the equipment manufacturer. Alternatively, it is often housed in its own separate container, next to the battery enclosure.

TRANSFORMERS

These adjust the voltage of the electricity for efficient distribution across the project and onto the grid. Typically each battery enclosure has its own medium-voltage transformer, often housed in a container together with the PCS.

THERMAL MANAGEMENT

Finally, each battery enclosure has an HVAC system (heating, ventilation, air-conditioning). This regulates the temperature of the battery racks and modules and prevents overheating, which is key to ensuring optimal performance and safety.

ELECTRICAL CABLES

A utility scale BESS will have many battery enclosures and PCSs, arranged in rows throughout the site. All of these are connected by a network of medium-voltage electrical cables. However, in most projects these are buried underground, and cannot be seen.

PROJECT SITE

To house all the complex electrical equipment described above, a BESS needs a safe, dry working space. BESS project sites tend to be flat, gravel surfaced, and surrounded by security fencing. The battery enclosures and major electrical equipment sit on flat concrete pads.

There will typically be one main access gate, with internal roads through the project allowing access to all the enclosures. There will likely be a small operations and maintenance building, though most projects are not permanently staffed.

Substation and grid connection

The substation is the central point where the electricity from all the battery enclosures is collected. Here, the voltage is typically stepped up to higher levels for transmission to the grid.

The project substation is typically located at one end of the BESS site, close to the grid connection point.

From the project substation, a high-voltage connection is made to the selected grid connection point. Transmission lines can be overhead or underground, with a range of designs available depending on the size of the project and the local environment.

3 The development process

How are BESS sites selected?

There are several criteria that makes certain sites a prime candidate for a BESS.

DISTANCE TO A TRANSMISSION SUBSTATION

This is a critical factor. Building transmission lines and related infrastructure to connect a BESS far from the grid is costly. Keeping installations close to grid infrastructure reduces the need for extensive transmission lines.

ACCESSIBILITY

The chosen site needs to be accessible by road to enable ease of construction and maintenance.

TERRAIN

BESS sites are best suited to a flat, non-vegetated areas of land. Flat areas are generally easier for construction, whereas complex terrain like steep hills and rocky outcroppings can be very difficult for construction. Heavily vegetated areas require clearing, which is not ideal and may not be allowed by local permitting rules.

ENVIRONMENTAL, SOCIAL, AND HERITAGE VALUES

When designing the project, Voyager aims to minimise the impact on the environment, the area's heritage values, and the local community. Voyager will conduct detailed surveys of flora and fauna, distance to receptors and heritage sites, etc to ensure we avoid any impacts. We will also interact extensively with the local community to understand their concerns.

GROUND CONDITIONS / WATERWAYS / FLOODING

BESS infrastructure requires a concrete foundation that is designed specifically for the site. Voyager will need to assess the ground conditions (e.g. soil type, rock) throughout the site via geotechnical investigations, which typically involve boring test holes at sample locations.

Given the complex electrical equipment involved in a BESS, it is also key that the site is not at risk from flooding. Voyager will study the local waterways and drainage/flooding patterns.

SET BACK FROM RESIDENCES AND SENSITIVE RECEPTORS

BESS are set back an appropriate distance from properties (both within the project area and on neighbouring land) to ensure that any noise and visual impacts experienced at those properties are mitigated.

Do I have a role in where the BESS is located?

Yes! We work with landowners to make sure the final location will have minimal impact on day-to-day farming / land operations, and that the site will have minimal visual or sound impacts on those living nearby.

How much land is needed for a BESS?

Utility-scale BESS projects typically cover an area of around 2-10 hectares. A larger area means that more BESS containers can fit into the design, and therefore a higher energy storage capacity is possible.

Will I be able to hear the BESS from my house?

BESS are relatively quiet, which is well suited to agricultural areas where minimal sound disturbance is preferred. Standing next to a BESS, you'll hear up to 70db or about the same amount of sound from a household washing machine. They won't be heard from the home at all as they'll be set back a reasonable distance.

How long does a BESS project take to build?

Stage 1: Development and Planning
We will have specialists supporting us with comprehensive studies to ensure risks are mitigated including fire and other hazards, as well as managing environmental constraints and technical considerations.

Stage 2: Construction
Once a project is approved, the implementation and construction period is expected to take 12-18 months.

4 Voyager in the Community

Community engagement

Voyager are dedicated to collaborative engagement with communities and landowners, and maintaining active communication throughout every stage of a project, from site origination to decommissioning. Anyone interested in staying informed can contact us through email or phone call, or find our website where we have more details about our BESS projects.

What are the typical community benefits?

Community benefit sharing is about sharing the outcomes of renewable energy development with local communities and relies on creating a positive and long-term connection with the hosting area. It is designed to be community-specific by understanding the community need, flexible, transparent and mutually beneficial.

Some examples of community benefits (including neighbours) are:

- Sponsorship and grant initiatives
- Local jobs, local training (including local education) and local procurement
- Local contracts to support long-term business growth, with electrical and civil work companies for instance
- Secure energy supply for remote and isolated communities
- Enhancement of Cultural Heritage jointly with Traditional Owners
- Community co-ownership and co-investment via crowdfunding
- Biodiversity offset

5 Common FAQs

Safety

BESS facilities hold huge amounts of energy – each container stores enough energy to power a small town for several hours! The lithium-ion materials within the battery cells can produce flammable materials that can lead to fire and explosion, if they are damaged by overheating or overcharging. As a result, BESS have multi-layered safety systems:

Prevention: Each battery enclosure has an integrated Battery Management System (BMS) that is constantly monitoring the battery racks to check for abnormalities. The BMS directs the HVAC system to cool or heat the battery enclosures, as needed, to keep them in a safe temperature range. If any concerning signals are detected, the BMS can limit the operation of one or more enclosures, to prevent damage or overheating.

Detection: Battery enclosures are fitted with sensors such gas and smoke detection systems, to provide the earliest possible warning of events like fires, gas leaks, or damage to the batteries. These systems will automatically contact the local fire service and project operations personnel.

Containment: In the unlikely event the detection mechanisms fail, BESS enclosures come equipped with a range of fire suppression systems, such as water sprinklers or pressurized aerosols, to prevent and extinguish fires, as well as water storage and fire fighting equipment on site. Sites often also incorporate chemical absorbent systems to capture spills or leaks. Many modern BESS enclosures are specifically designed with the ability to burn without impacting any other surrounding enclosures.

Safety is a key area of focus for the battery storage industry. Technological improvements continue to make BESS projects safer and safer. If you have any questions or concerns whatsoever about safety, we encourage you to contact the Voyager Renewables team.

How long is the operational life of a BESS?

A BESS is typically designed to operate for a period of around 15 years. Most of the project components can safely operate for much longer than this, but the batteries themselves gradually lose performance over time ("degradation"), such that after 15-20 years the BESS is no longer economical to run. The target operational life of the system is something that will be refined during the development and design process.

Throughout the operational life of the project, operations and maintenance (O&M) crews will perform regular inspections and maintenance, to ensure the operational reliability and safety of the battery and its supporting infrastructure. The O&M teams will undertake vegetation control and ensure the project site remains clean, tidy, and visually unintrusive. As with any complex system, occasionally a part will fail. Generally the components can be switched out as the need arises, to replace parts with new and return the project back to full operations.

Towards the end of the initial 15-20 year operational period, several strategies are possible. In some instances it is possible to augment (add additional) or repower (replace with new) the batteries themselves, and thereby keep the project running for longer. This will be assessed later in the operational life.

What happens at the end of life for a BESS?

Voyager may look to extend the lease term with the host landowner, or work toward the decommissioning of the infrastructure to restore to the site to its original condition.

Decommissioning

When the batteries reach the end of their operation life, Voyager will look to salvage as much material as possible. Voyager will oversee the removal of infrastructure, and rehabilitation of the site to its original condition.

Decommissioning will be carried out in accordance with regulations that govern the safe transport and disposal of equipment and waste. Where possible, materials such as steel, concrete, electronics and valuable materials from invertors and control systems may be salvaged.

Land rehabilitation post operations is also a vital part of the decommissioning process. The land will be returned to a state that is as good as, or better than the original condition.

Decommissioning starts within the 12 month period following the project's end of life and is expected to be completed within 12 months.

How does BESS contribute to a green economy within the energy transition?

1. Shifting global energy mix away from fossil fuels and towards cleaner, renewable sources, in turn, reducing our reliance on fossil fuels and stabilising the grid by providing a source of power that can be dispatched when needed.
2. Reduced reliance on the grid and increased grid stability – especially during power outages or when the grid is unavailable.
3. Increased renewable energy use. Battery storage can enable greater optimisation of intermittent power sources such as wind and solar

We'd love to hear from you.

Please reach out if you have any questions or need more information. We're headquartered in Newcastle in New South Wales with offices around Australia.

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Our goal is to ensure a transparent and mutually beneficial partnership with landowners over the life of the project from inception to decommissioning.

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