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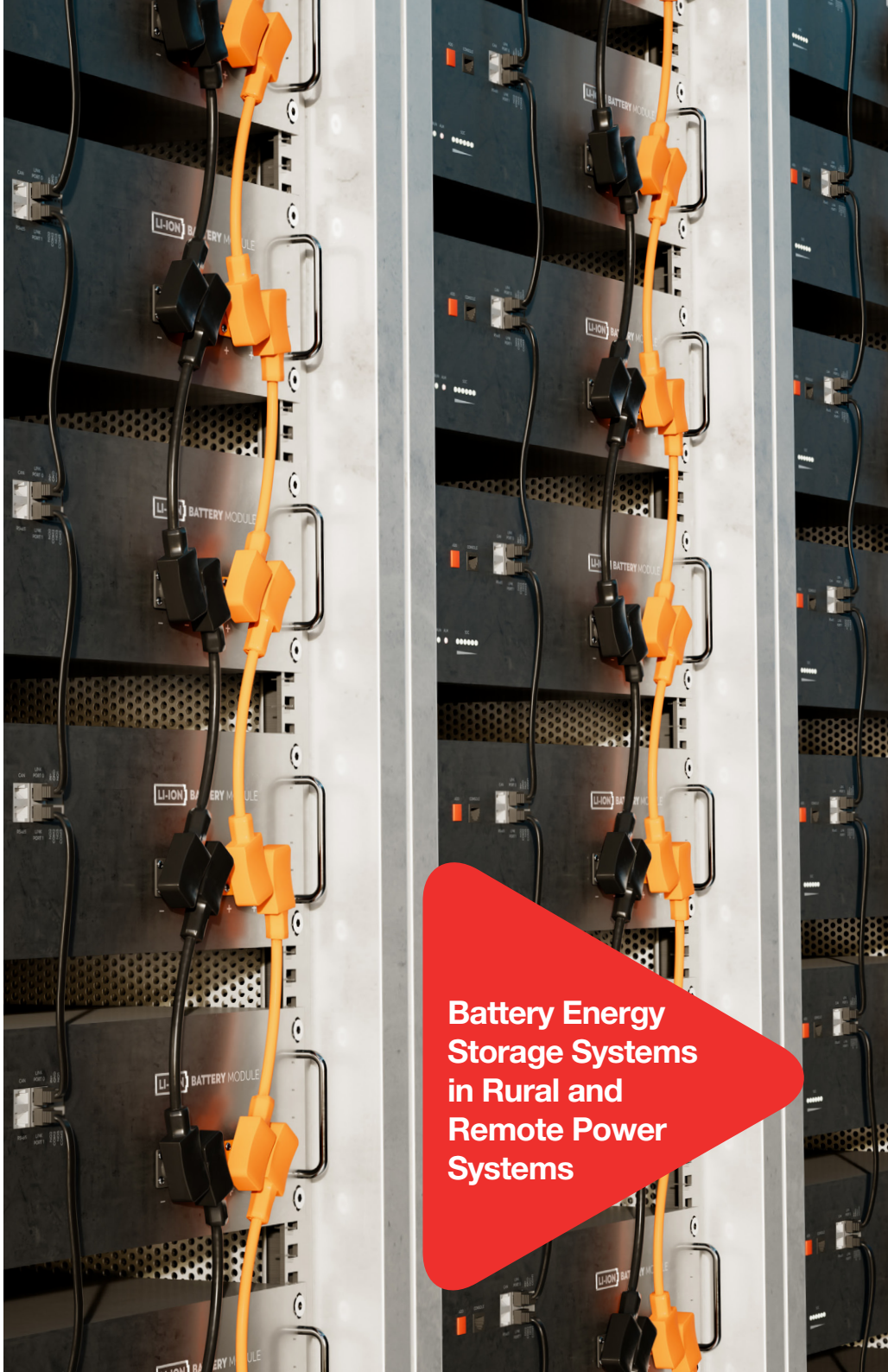


Battery Energy Storage Systems in Rural and Remote Power Systems

Whitepaper

Overview of Rural and Remote Power Systems

Providing reliable and resilient power to remote locations such as islands, farms, indigenous communities and isolated villages presents unique challenges and opportunities. These areas often lack access to centralized power grids, making them heavily reliant on diesel generators, which are expensive and difficult to fuel, environmentally harmful, and can be logistically challenging to maintain.

Whether it's an island in the middle of the Pacific Ocean, a resort in the Gulf of Mexico, or an isolated village in rural Myanmar, access to secure and reliable electricity not only enables lighting, refrigeration, and connectivity but also allows for significant economic and social development of these communities.

Addressing the energy needs of rural and remote communities is crucial for fostering economic development, enhancing quality of life, and mitigating environmental impacts.

Energy Challenges in Rural and Remote Power Systems

Limited Grid Connectivity

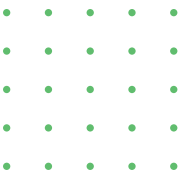
Islands, villages and farms can be located at the edge of, or completely isolated from, a mains electricity grid. So reliable power is not as easy as connecting to the grid and flicking a switch. Islands especially have a difficult situation in often being hundreds of kilometres from their nearest island neighbours, so mains connection is not possible, and even if it was, would be vulnerable and unreliable.

Reliance on Diesel Generators

Relying on diesel generators for power generation in remote and isolated areas poses several significant issues. The logistics of diesel fuel delivery to these areas are often complex and costly, with the risk of supply chain disruptions due to adverse weather conditions or natural disasters, and even the fluctuation in price of diesel fuel and delivery costs adds additional, and unpredictable, OPEX costs.

Diesel generators also emit harmful greenhouse gases, which are damaging to the environment on both a micro and macro level including contributing to climate change.

There is also the often-forgotten issue of how noisy diesel generators are. They require costly soundproof housing, or specialist isolation from the load source to ensure that users are not adversely affected by the noise output by the generators. A relaxing island resort is hardly as tranquil with the roar of a diesel generator in the background.



High Costs of Energy Infrastructure

Sites that can be connected to the grid, such as edge of suburban communities, farms, and tourist resorts may find that the costs of having their site connected to the grid is prohibitively expensive. Many locations now require power infrastructure to be installed underground which adds additional costs on top of the normal connection and construction charges.

It is sometimes just not cost effective for a site to be connected to the grid at all, leaving them to find their own source of reliable power.

A BESS as part of a power generation system in an isolated school in rural Australia.

Battery Storage Systems

Battery Energy Storage Systems (BESS) are pivotal in modern energy infrastructure, providing a versatile solution for storing and managing electrical energy. In brief, a BESS is a bank of batteries, (of which there are many different chemical compositions including lithium-ion, lead acid, and others) which can store energy generated by a power source for discharge later. They usually feature their own control system, and are integrated into a local microgrid, or a utility scale grid to provide dischargeable power to the network.

The Role of Battery Storage

BESS store excess energy generated during periods of low demand and release it during peak demand, effectively balancing supply and demand. This capability is particularly valuable for integrating renewable energy sources like solar and wind, which are intermittent by nature. BESS can also provide ancillary services such as frequency regulation, voltage support, and backup power during outages.

Reducing Energy Costs

A BESS can reduce energy costs by optimising the use of generated power by storing energy and discharging it when the price is higher. For example, if the BESS is charged by the mains, it would be charged when the tariffs are at the lowest price, (so in the early hours of the morning) for discharge later in the day when demand is highest and therefore so are the tariffs. Or if the BESS is charged by photovoltaics, it would be charged during the day when demand for energy is lower, and the sun is shining, and then discharged later during the evening and night, when energy demand is higher, and so are the tariffs.

A BESS can also reduce energy costs by eliminating the need for new mains infrastructure investment, (power transmission lines etc) and also enhancing the power delivery capabilities of the current grid.

A power generation system incorporating a BESS on Cape Barren Island, Australia.

A BESS as part of a power generation system on Cape Barren Island in Australia.

Enhancing Efficiency

A BESS can enhance energy efficiency by helping to provide grid stability and frequency regulation. A power grid must maintain a constant frequency of 50 Hz or 60 Hz depending on the location. If there are imbalances between the supply, and the demand the frequency can fluctuate, which can destabilise the grid leading to blackouts. A BESS, due to its ability to discharge power quickly and efficiently is able to release power into the grid, or store power from the grid, ensuring that the frequency remains steady. This helps prevent blackouts and provides a more stable and reliable power supply.

Easier Integration of Multiple Energy Sources

A BESS supports frequency regulation, voltage stabilization, and grid synchronization, which are critical when incorporating multiple energy sources with different generation profiles. By acting as an intermediary buffer, BESS simplifies the coordination of energy sources, improves microgrid efficiency, and enhances overall grid stability.

Advantages of BESS

Cost Savings

A BESS allows for energy to be stored when it is produced at its cheapest price, and discharged when it is at its most expensive. For example, a mains connected BESS can be charged when the energy tariffs are at their lowest (in the middle of the night) and then discharged when the tariffs are at their highest (during the early evening). This saves money by only using electricity when it is at it's cheapest price.

A similar situation would be when a BESS is connected to a renewable energy source. The BESS would be charged during the day, when electricity use is lower, and then discharged during the night, when the energy use is higher. Providing essentially free energy (once the initial BESS and renewable source costs have been repaid).

Local Economic Development

Local economic development is especially important for rural and remote communities, and a source of reliable power is a key drive for economic development. Even after the initial job creation and economic stimulation from the site preparation and installation, operation and maintenance of the power system, (even though the BESS requires very little intervention) will create jobs.

But once the area has a reliable source of power, the benefits become much greater. Depending on the site, tourism can increase, investment in businesses (both large and small) can rise and the reliable energy can allow local governments to provide additional services and support to people living in the area.

A power generation system incorporating a BESS on Gilford Island in Canada.

Social Benefits

In certain communities, access to reliable power is crucial for maintaining population stability. In remote areas where the power supply is unreliable or unstable, residents may be compelled to leave due to limited business investment and a lack of opportunities, particularly for younger generations. However, a stable and dependable energy infrastructure can attract business investment, create local economic opportunities, and help retain residents, thereby supporting population growth and stability in the area.

Reliable power also allows for increases in reliable healthcare, education, and employment opportunities in a community. A hospital, for example, obviously needs reliable power, and a BESS provides that, enhancing the living standards of the community and attracting people to move to the area, increasing the population – further benefitting the community at large.

Environmental Benefits

Reduction in Greenhouse Emissions

Diesel generators release harmful greenhouse gas emissions including Carbon Dioxide, Methane, Carbon Monoxide and Nitrous Oxide as well as particulate matter. By simply reducing their use, (or using them sparingly) the overall reduction in greenhouse gas emissions is significantly better for the environment.

Increased Use of Renewables

Storage of the energy produced by the renewable sources allows them to be used more efficiently as any surplus power that is generated is stored rather than being lost. A BESS can also be upgraded to provide more storage, should more renewable sources be added later.

Reduction Noise Pollution

The operation of a BESS is virtually silent, with the only noticeable noise coming from its HVAC system, which ensures proper cooling. This contrasts sharply with diesel generators, which can produce noise levels of up to 85 decibels. In environments such as remote resorts, for example, this significant noise disturbance can disrupt the tranquil, peaceful atmosphere that resort guests expect and value during their stay.

Challenges with BESS

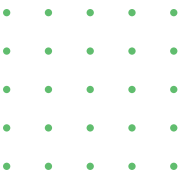
Initial Capital Expense

The initial capital expense for a BESS can be extremely high. It is dependent on the type of batteries in the BESS, the load that the BESS is needed to supply, and the location that it is to be situated, amongst other factors. A small 5-10 kWh BESS can cost around €5000, but a BESS that is designed for utility scale power can cost into the billions. The largest planned BESS in the world is in India and it is estimated to cost €2.5 billion when it comes online towards the end of the decade. However taking into account the overall cost of ownership, the cost can be considered lower depending on different financial factors.

Reduction in Capacity and End of Life Concerns

Any battery technology will eventually degrade due to the effects of charge cycles and time. They will experience loss of capacity and efficiency the longer they are in use due to the nature of chemical batteries. At the end of its life a battery can only hold a fraction of its initial capacity.

What to do with batteries at the end of their life is a concern. Batteries can be made up of toxic chemicals, and pose environmental risks with improper disposal. They are difficult to recycle because specialist systems are required to separate the components. However, technology is always changing, so recycling batteries at the end of their life may become easier and more efficient in the future.



New Technology

With any new technology, there are always rapid advancements, and the technology used in BESS is no different. This can lead to end users being hesitant about spending the money on a particular type of BESS when a new, better, more efficient technology is always on the horizon.

Unfortunately, this is a fundamental part of being an adopter of relatively new technologies. Technology will always get better, cheaper and more efficient. But it is important to remember that any quality BESS control system can manage energy input from any BESS regardless of the technology used in its storage system. So, upgrading and adding to a BESS when new technology arrives should not be an issue.

A BESS as part of a power generation system
at a Petrol Station in rural Australia

BESS Funding Mechanisms

There are many different funding mechanisms for renewable energy systems available depending on where the installation is located. These can be affected (both positively and negatively) by local governments and policy changes. This can be difficult but there are many agencies that are available to help secure funding for renewable energy projects – especially in developing nations and regions.

Public Financing and Grants

This could be from government subsidies, international development grants (eg the World Bank, Asian and African Development Banks) or clean energy funds.

Private Sector Financing

This could include charities, venture capitalists or banks that provide loans or grants to users.

International Aid

Government foreign aid programs allow for funding for developing nations to develop their power networks. Multilateral agencies such as the United Nations can also have funding available.

Community Based Financing

Small scale loans (microloans) or cooperative models (a community bands together to purchase a BESS) or even crowdfunding can provide financial support.

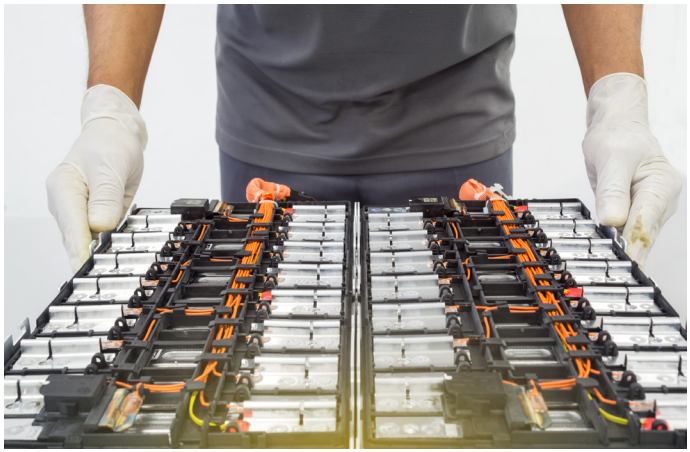
Partnerships

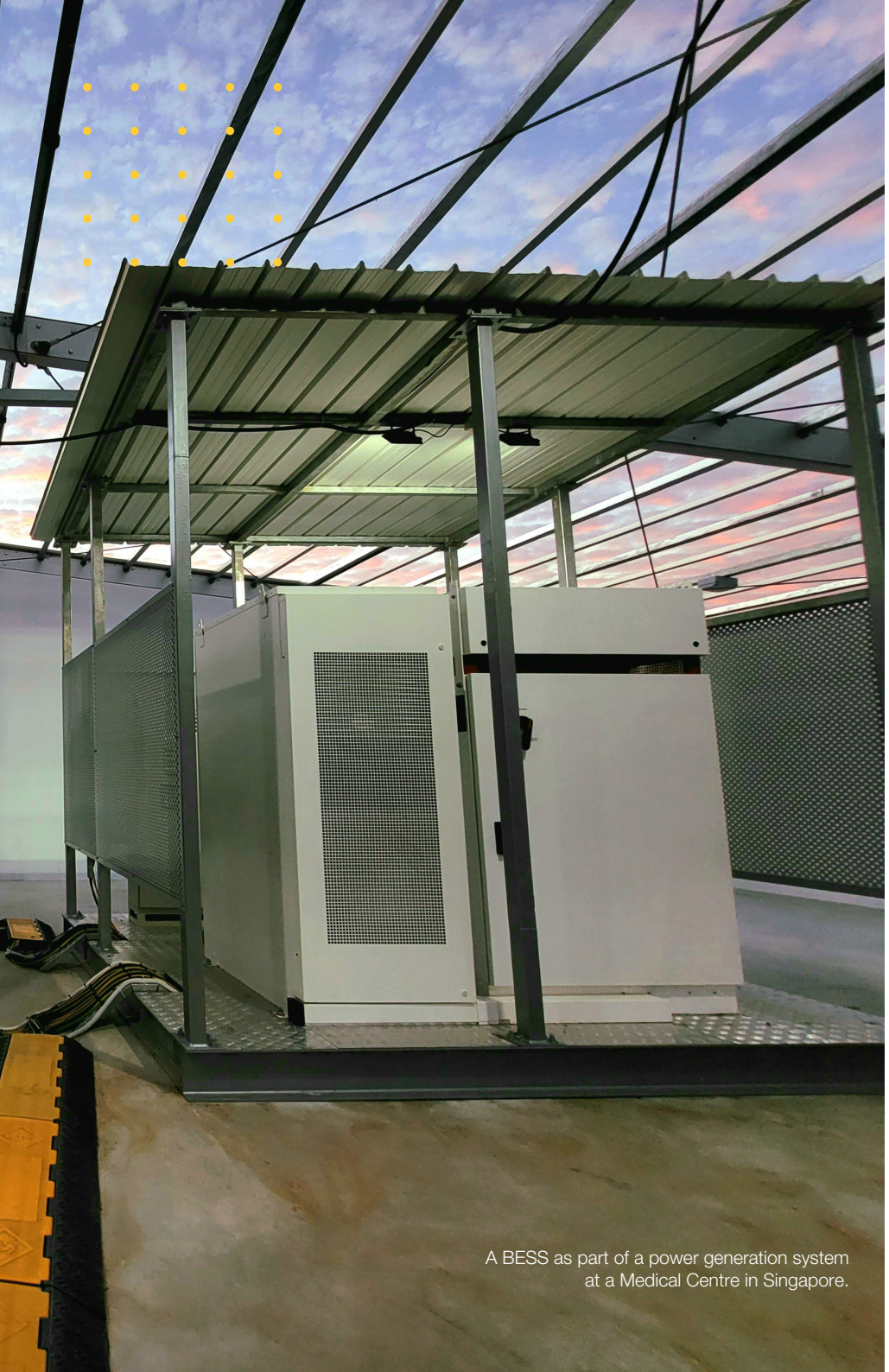
Partnerships between private and public sectors, including (for example) governments, charities and banks can provide financing.

Conclusion

In conclusion, addressing the energy needs of rural and remote communities is crucial for fostering economic development, enhancing quality of life, and mitigating environmental impacts. Battery Energy Storage Systems (BESS) offer a transformative solution to the challenges posed by geographic isolation, unreliable power supplies, and the environmental and economic costs of diesel dependency.

By enabling efficient energy storage, supporting renewable energy integration, and reducing greenhouse gas emissions, BESS provides a sustainable pathway for reliable and cost-effective power. While initial costs and technological advancements present challenges, the long-term benefits—ranging from local economic growth to environmental preservation—underscore the importance of investing in and adopting this technology. With diverse funding mechanisms available, BESS has the potential to transform energy access in remote and underserved regions, paving the way for a cleaner and more equitable energy future.





A BESS as part of a power generation system
at a Medical Centre in Singapore.

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For more information about how ComAp can help you with BESS integration, design, installation and commisioning, please scan the QR code or email us at the address below.

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