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ARENA Australian Government Australian Renewable Energy Agency

Australian Energy Storage Knowledge Bank (AESKB)

MOBILE AND FLEXIBLE MICROGRID TEST PLATFORM

SUMMARY OF APPLICATIONS

The battery storage market and associated technologies are growing exponentially around the world. The aim of our test platform, which includes the mobile microgrid test unit and the test centre, is to accelerate energy storage industry growth in Australia by offering real tests on system components, developing a range of applications, sharing the knowledge gained, and offering training to the future workforce.

There will be an online central repository via the Australian Energy Storage Knowledge Bank website to include case studies, trial and test data, network performance outcomes, storage system level and environmental data, battery level data, links to other databases and projects around Australia and the world, and technical reports and research publications.

This summary of applications aims to inspire potential users of such systems, which vary from local council and smart city applications to network operators.

In summary, the test system:

- can operate both with three-phase balanced and unbalanced AC loads, and can perform a variety of on-grid support and off-grid supply functions.
- can integrate and deliver a 270kVA/270kWh (expandable to 350kVA) battery inverter based microgrid system within a transportable structure deployable to any Class C wind zone in Australia.
- can investigate component interactions, power quality, real-world and in-field operation and response to the environment.
- can integrate a third party battery and additional IoT gateways for characteristic and operational tests.

Potential Network Applications

Battery storage systems (BSS) can respond to short term power variations, voltage fluctuations and power quality issues, as well as help improve the lack of system inertia.

The "voltage source" mode can be used to stabilise and reduce voltage unbalance on weak three-phase rural distribution lines.

<table>
<tr><th>Generation Level</th><th>Transmission Level</th><th>Distribution Level</th></tr>
<tr><td rowspan="2">• Fast-response frequency regulation
• Black start
• Spinning reserve
• Back-up and mission critical power
• Power plant hybridization
• Ramp rate management
• Peak demand management
• Mitigating intermittency (firming)</td><td>• Dynamic line rating support
• Dynamic stability support
• Reducing interconnection cost
• Voltage support of long radial circuits</td><td>• Energy storage for utilities
• Energy arbitrage</td></tr>
<tr><td colspan="2">• Increase asset efficiency and utilization and ancillary services
• Loss reduction
• Voltage support
• Peak-shaving, load and time shifting
• Power quality improvement
• Power reduction in curtailment events to shut down to mitigate issues associated with generator loading, export to the grid, or certain planning conditions.</td></tr>
<tr><td colspan="3">• Renewable integration (wind and solar)
• Asset deferral
• Reactive power control</td></tr>
</table>

Planned "bump-less segregation and re-integration" can be implemented with existing controller functionality to offload embedded microgrid load for maintenance, demand management, or other reasons.

The table above shows the classified applications of BSS in the entire power network.

Configuration Options of the Mobile Unit

The mobile system has standard termination arrangements for interconnecting cables from the battery, smaller distributed controllers facilitating customisation at the battery management system interface, and access to control software and IoT controller architecture.

With suitable software adaptions, the operational modes of the mobile test system may include, but is not limited to, the following configurations:

- Parallel to AC grid only without islanding.
- Parallel to AC grid with islanding of medium voltage (MV) tail section.
- Parallel to AC grid with islanding of low voltage (LV) network section as required.
- Embedded autonomous LV microgrid.
- Isolated diesel-dominant microgrid (for load threshold support, and/or PV integration).
- Peer-to-Peer (P2P) microgrid trials.
- Maximising self-consumption in a microgrid.
- Taming "100% renewable substitution" schemes for embedded microgrids at the network interface
- Testing other energy storage installations:

- Testing absorption or curtailment of excess PV in daytime then provision of load assistance in evening.
- Off-grid system testing ramp-rate control by simulating a PV array with rapidly varying output power levels.

Component Testing

- Individual testing, characterisation and the system performance of batteries, inverters, switchgears, protection relays and controllers.
- Effectiveness of cooling the critical system components and influence of the enclosure.

Other Applications

The test system is an extended version of a modern energy storage system—it can host an isolated microgrid itself—but is also a 'smart grid-ready' system. Therefore it can be used in a range of other applications, such as:

- consumer/prosumer, industrial and system integrator applications
- in grid-forming and grid-following modes
- a Virtual Power Plant to combine street level and regional renewable energy sources
- testing Virtual Power Plant concepts for better power control (4-Quadrant) and voltage regulation
- a distributed, embedded and/or stand-alone power source for houses, apartments, housing trusts, streets, suburbs, farms and campuses
- a power source for islands, which is highly relevant to the Asia region, and to support domestic industry targeting the Asian energy market and using a low-risk, fully functional microgrid structure
- future zero-emission house concepts and in electric vehicle charging system testing.

As a training facility

To train the future workforce, including national and international students, technicians and engineers, in this growing industry. The following microgrid and BSS topics will be covered to advance knowledge and skills:

- Microgrid topologies.
- BSS applications.
- Battery technologies in specific applications.
- Operational aspects of BSS.
- Impacts of weather and temperature on BSS operation.
- Cooling requirements.
- System and component safety.
- Communication and control component selection and BSS system design.
- AC and DC coupling.
- Demonstration of the BSS.
- Power quality issues and harmonics.
- Accurate measurements of voltage, current and AC power.
- Measurement and calculation of rate of change of frequency (ROCOF) principles.
- Energy auditing by network measurement analysis.
- Energy management principles.
- Economics.
- Management and recruitment.
- Future directions and trends.

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To discuss your potential projects or for training or for site visits, contact us via the following details

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For further information refer to ***Technical Specifications*** leaflet.

For detailed information and self-reading about battery storage systems and to access real test data, visit the Australian Energy Storage Knowledge Bank (AESKB) website at www.aeskb.com.au or www.energystorageknowledge.com.au