



## CASE STUDY

# Maximizing Demand Response Returns with BESS Through Smarter Design

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## Background

As power systems integrate higher levels of renewable energy, ancillary services such as frequency regulation, voltage control and spinning reserve play a critical role in maintaining grid stability. In markets such as Taiwan and Australia, growing renewable penetration has significantly increased demand for frequency control services, creating strong revenue opportunities for Battery Energy Storage Systems (BESS).

In Singapore, renewable penetration remains relatively modest, with installed solar photovoltaic (PV) capacity accounting for approximately 8% of total registered generation capacity as of early 2024. Grid reliability indicators such as System Average Interruption Duration Index (SAIDI) and System Average Interruption

Frequency Index (SAIFI) remain among the best globally, reflecting a highly robust power system.

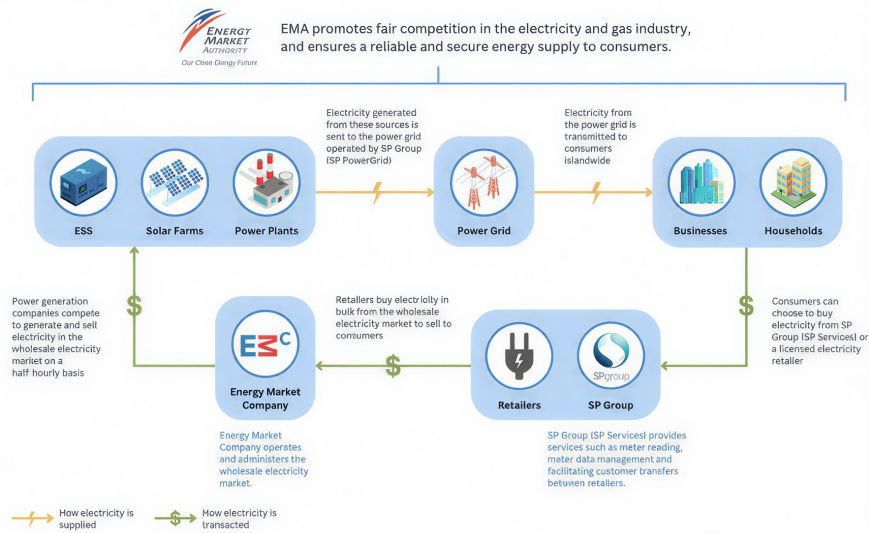
However, as the Energy Market Company (EMC) and Energy Market Authority (EMA) work to stabilise wholesale electricity prices and accelerate energy storage adoption, Demand Response (DR) and Interruptible Load (IL) programmes have emerged as important market mechanisms. These programmes enable consumers to support grid operations while generating new revenue streams.



Photo: iStock.com

Traditionally, participation in DR and IL relied on load curtailment or embedded generation. Today, declining BESS capital costs and improved system performance have made energy storage a commercially viable alternative. Well-designed BESS solutions can provide fast, reliable response while optimizing both technical performance and project economics.

Since early 2024, Delta Electronics has deployed multiple BESS installations supporting Demand Response participation in Singapore. This case study introduces the structure of Singapore's DR market and shares key design considerations and financial insights from Delta's first ESS project for DR application.



## Why Choose Demand Response in Singapore

The Demand Response (DR) programme in Singapore is designed to mitigate wholesale electricity price spikes during periods of high system demand. When activated, participating consumers are required to reduce their electricity consumption at the Point of Common Coupling (PCC), which is the metered interface between the facility and the grid. Each DR event lasts 30 minutes.

Consumers can achieve the required load reduction through three primary approaches including production adjustments, cooling system optimization, and power deployment.

### 1. Production Adjustments

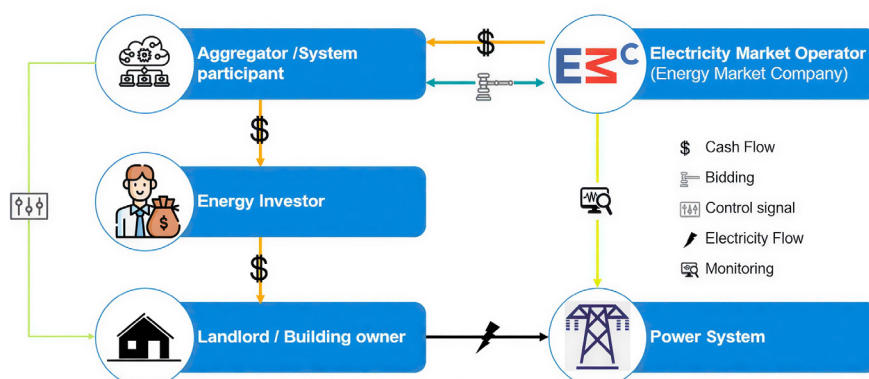
Temporarily reducing or suspending non-critical production processes during the DR window.

### 2. Cooling System Optimisation

Increase the temperature setting temporarily or shutdown the idle HVAC equipment such as chilled water pump, condensers, cooling tower to reduce the power consumption for short period.

### 3. On-site Backup Power Deployment

Operating embedded generation assets such as diesel generators or Battery Energy Storage Systems (BESS) to offset grid consumption.



## Market Participation and Commercial Structure

Participants may register directly as market participants or engage through electricity retailers or DR aggregators. The minimum bid size is 0.1 MW, and performance is verified using metering data provided by SP Services for each 30-minute DR session.

Commercially, DR participants benefit in two ways. They are able to avoid electricity costs during high-price periods, and receive incentive payments equivalent to one-third of wholesale price reduction, capped at the market price ceiling of SGD4,500/MWh.

In some cases, energy investors partner with aggregators to offer leasing or profit-sharing models, enabling building owners or industrial facilities to participate in DR with limited upfront capital expenditure.

Total DR energy quantity: **40MWh**  
**Resulting \$10/MWh** in wholesale price



Total system consumption during the session: 1200MWh  
**The total saving** is  $1,200 \text{ MWh} \times 10/\text{MWh} = \text{\$12,000}$



**One-third of total saving**  
 $\text{\$12,000} \div 3 = \text{\$4,000}$



The **incentive payment to DR participants** is  
 $\text{\$4,000} \div 40\text{MWh} = \text{\$100/MWh}$



## Project Overview:

### Pilot BESS Deployment for Demand Response in Singapore

The objective of this project was to establish a pilot site for participation in Singapore's Demand Response (DR) programme using Delta Electronics' Energy Storage System (ESS) technology. The project aimed to evaluate both the technical performance and the commercial viability of Battery Energy Storage Systems (BESS) for DR applications.

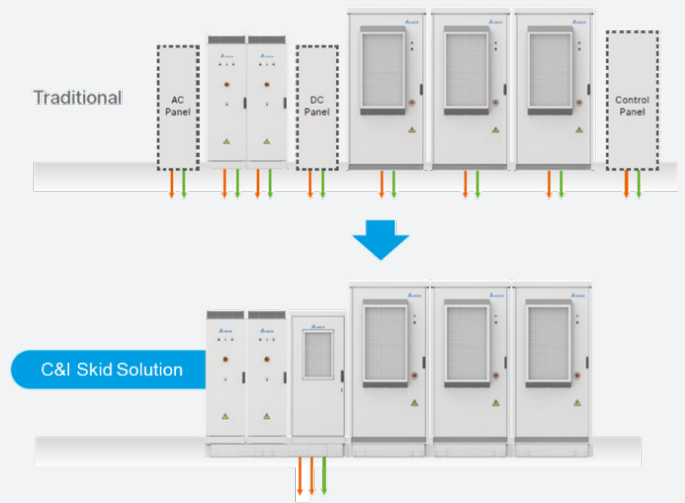
Historically, lithium-based ESS capital expenditure ranged between USD 393–581/kWh, which limited adoption for ancillary service participation. As a result, many energy investors relied on load shedding, cooling optimisation or alternative technologies to fulfil DR commitments. However, since late 2022, significant declines in battery cell prices have improved the economic case for BESS. Investors are now reassessing storage not only for DR participation, but also for broader ancillary services such as frequency regulation and backup power support.

In Singapore, investment decisions for BESS projects are driven by a combination of capital expenditure, operational performance, market price volatility and ancillary service revenue potential. Hence, this project was structured to validate the financial feasibility of BESS under current market conditions.

The customer installed a 200 kW / 315 kWh BESS at an office building, sized according to the site's existing breaker capacity and DR bidding requirements.

The system configuration included:

- Two PCS 100HV units
- One junction cabinet
- One 315 kWh battery cabinet



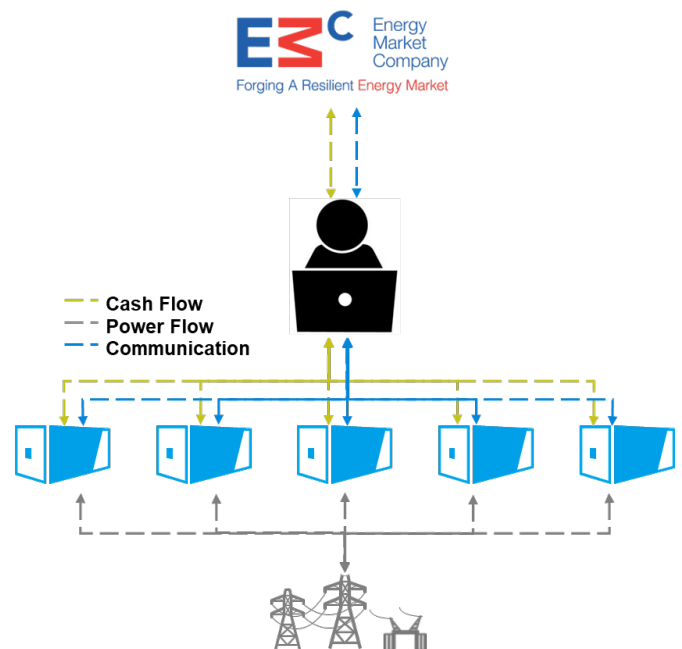
All components are integrated on a single skid platform. This skid-based design streamlines installation by consolidating AC and DC cabling, communication lines and control wiring within a pre-engineered structure. Compared to traditional containerised or distributed BESS layouts, the skid solution reduces on-site wiring complexity, minimises connection interfaces with the existing AC system and shortens deployment time.

This architecture was selected to optimise both installation efficiency and project economics, ensuring that the technical design directly supports return-on-investment objectives.

In this project, the asset owner participates in the DR programme through a system aggregator. DR activation signals and the required discharge quantity are transmitted via the aggregator's IoT control platform.

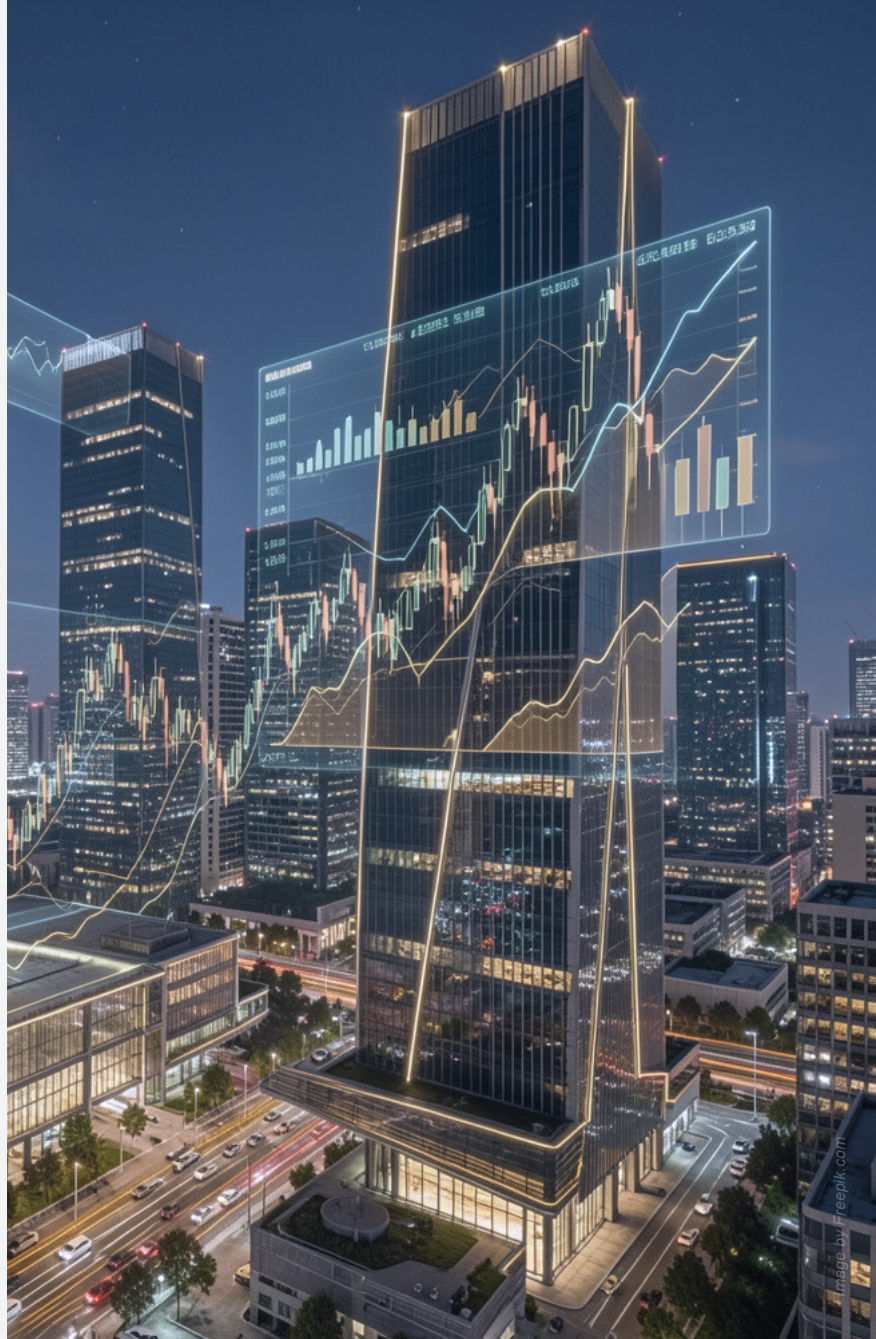
To ensure seamless compliance with dispatch instructions, Delta collaborated closely with the aggregator on firmware integration. This enabled the BESS to respond accurately to external control commands while meeting DR performance requirements. The integration process also demonstrated the system's flexibility and readiness for a high level of customisation, ensuring compatibility with third-party control architectures commonly used in Singapore's DR market.

Today, BESS assets are rarely deployed for a single application. To maximize revenue and shorten pay-back periods, systems are increasingly operated across multiple value streams at different times of the day, such as Demand Response, energy arbitrage and backup support.



As a result, evaluating project feasibility using a single financial metric is no longer sufficient. Multi-application BESS projects require a more comprehensive economic assessment framework. Recent industry studies suggest that robust valuation models should incorporate multiple financial indicators, weighted according to project objectives and market exposure. In addition to conventional metrics such as payback period and internal rate of return, advanced evaluation approaches also account for technical parameters including battery degradation rate, Depth of Discharge (DoD), cycling profile and hybrid charging costs.

By integrating both financial and technical variables, investors can obtain a more accurate representation of lifecycle value and long-term project performance. This holistic valuation approach is essential when designing BESS systems intended to capture multiple revenue streams.



### III. Conclusion

The pilot BESS deployment demonstrated that energy storage can effectively participate in Singapore's Demand Response programme while delivering measurable financial value. By leveraging Delta's skid-based design and flexible control integration with the aggregator, the system achieved reliable performance and simplified installation.

From a commercial perspective, multipurpose operation and optimization across different DR events enabled investors

to capture higher revenue streams and improve payback metrics. The project illustrates how combining thoughtful technical design with robust financial evaluation can maximize the value of BESS assets for both system operators and energy investors. This experience provides a practical reference for future BESS projects in Singapore and similar markets. Highlighting the potential the potential for scalable, multi-use energy storage solutions in modern power systems.

## Reference

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