

CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA



Renewcell

- Klang, Malaysia
- Energy Storage and Efficiency
- www.renewcell.com.my
- Analysis period: 2018-2023

Battery Rejuvenation for Circularity and Energy Efficiency in Energy Storage

Business Spotlight

Renewcell implements circular economy principles in the energy storage and energy efficiency sectors for lead-acid and nickel-cadmium batteries used in industrial applications such as power generation, utilities, building backup energy storage, rail transportation, the oil and gas sector, lifting equipment, and marine and defence equipment. Since 2018 Renewcell has been using a 30 kVA desulfation technology to double the lifespan of old batteries, revitalising and extending their usability through a combination of different business and service models to reuse, repurpose, share, and/or redistribute rejuvenated batteries. This approach not only reduces the need for mineral mining but also significantly decreases waste generation. Renewcell provides good-quality recovered batteries at a reduced price. By giving a second life to used batteries and improving their efficiency, Renewcell minimises premature battery disposal and reduces the need for new batteries, while also improving energy efficiency in successive energy storage cycles. The company aims to promote the deployment of rejuvenated batteries and repurpose them into affordable energy storage solutions. Reconditioned batteries can be rented or sold at a 70% to 80% discount compared to new batteries. Renewcell plans to expand service

centres nationwide, collaborate with MacBatec Spain for next-generation battery solutions, and enhance the battery monitoring platform to better serve the growing energy-storage market.

Keywords

Battery regeneration, Energy storage, Energy efficiency

Innovation

Use and maintenance, End-of-life management, Resource circularity, Resource efficiency



Context and baseline

The Malaysian battery market was valued at around MYR 6.4 billion in 2023 (approximately EUR 1.33 billion) and is expected to grow due to the increasing reliance on electricity and fluctuating renewable energy as part of the sustainable energy transition. Batteries are inherently circular products, as they can be charged and recharged. However, as the energy storage capacity of a battery declines over time due to degeneration, batteries need to be replaced and disposed of. Renewcell addresses the significant problem of end-of-life battery disposal and resource depletion by regenerating the lead-acid and nickel-cadmium batteries used in industrial applications such as forklifts, buggies, uninterruptible power systems (UPS), solar installations, and trains.

With proper regeneration and monitoring, the battery is restored to a 'like-new' status, allowing for reuse, repurposing, sharing and/or redistribution. Battery regeneration reduces the need for manufacturing new ones, eliminates the associated mining for minerals, and decreases overall waste generation. The idea for this circular solution arose from the urgent need to minimise the environmental impact of battery disposal and the declining efficiency and storage capacity of batteries over their lifetime. Recognising the potential in recovering lost energy efficiency and in extending battery life, Renewcell developed innovative battery monitoring applications and maintenance services to give used batteries a second, and expanded, life.

The development and implementation of this circular solution has been supported by key partnerships with small and medium-sized enterprises (SMEs), industrial users, and technology providers. These collaborations have enabled the establishment of integrated battery maintenance service centres and monitoring platforms and ensured comprehensive solutions for battery maintenance, all the while promoting sustainable, energy-efficient and cost-effective battery-energy storage.

Innovation

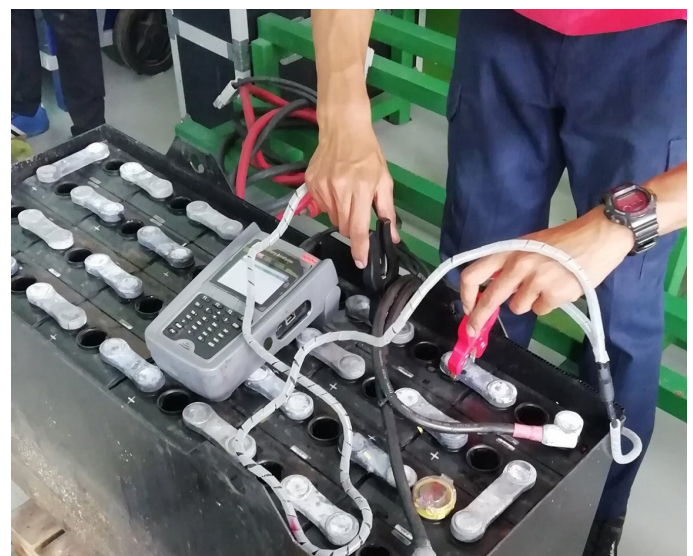
Renewcell contributes to the circular economy by regenerating lead-acid and nickel-cadmium batteries used in various industrial applications, thus restoring battery capacity and extending their lifespan. Renewcell uses international MacBatec technology¹, which deploys carefully controlled current pulses to break down the lead sulfates formed during consecutive battery charging and discharging cycles. Sulfates reduce battery performance and increase

the resistance of the battery, which in turn reduces the energy efficiency of the battery. The technology can be used at set intervals as a maintenance service, or as a one-time full regeneration service.

In the maintenance mode, regeneration is performed when the battery still has at least 80% of its charging capacity, typically at 12- to 24-month intervals. This process can double the lifespan of traction or mobile batteries and triple the lifespan of stationary batteries. Full regeneration, on the other hand, is performed on end-of-life batteries that have lost 20-60% of their charging capacity. In these cases the regeneration process can recover half of the lost energy storage capacity, extending the battery's lifespan by at least another 50%.

The key innovation lies in battery reconditioning, a well-known technology that addresses the use and end-of-life stages of the traditional battery-energy storage system, and provides an extended or second life for used batteries that would otherwise be discarded. Additionally, Renewcell offers comprehensive battery maintenance solutions, including Internet of Things (IoT)-enabled battery monitoring for specific applications. For example, BuggTrac is a GPS-enabled real-time monitoring system for buggies that reduces battery and energy costs for fleet owners.

Renewcell is innovative within the sector and the country with its full-service solution for battery monitoring, optimisation and rejuvenation. The company positively influences the battery value chain by fostering collaboration with existing and new suppliers and service providers. Through its integrated battery maintenance centre and holistic monitoring solutions, Renewcell improves the customer value proposition, reduces end-of-life battery waste, improves energy efficiency in battery-energy storage, and diminishes the environmental footprint across the battery value chain.



1 <https://www.macbatec.com/en/>

Circular Economy impact

Renewcell contributes to the circular economy by regenerating end-of-life batteries for extended use, reuse and/or refurbishment (resource circularity), and by enhancing the monitoring and preventive maintenance of in-use batteries, improving their energy efficiency and extending their lifespan (resource efficiency). Since 2018, Renewcell reconditioned more than 12,000 industrial batteries, and diverted 480 metric tonnes of end-of-life batteries from disposal, thus preventing an estimated 360 tons of CO₂ emissions.

Resource circularity is obtained by fully regenerating a battery using an advanced electronic process that recovers 50% of the lost energy capacity and thus extending the battery's lifespan by at least half of its normal duration. In theory the battery lifespan is increased by 50%; however, actual results depend on usage and maintenance scenarios. Regeneration thus has the potential to reduce both new battery manufacturing and end-of-life battery disposal by one-third each, with corresponding reductions in material and energy use, waste generation, and associated greenhouse gas (GHG) and other emissions.

Resource efficiency is achieved through battery monitoring, preventive maintenance, and regeneration, serving multiple purposes, and in particular:

- extending the lifetime of batteries twofold (for batteries used in mobile applications) to threefold (for stationary batteries), by preventing overcharging, over-discharging, heat stress, and/or through preventive regeneration
- optimising battery performance (for charging and discharging)
- enhancing energy efficiency by minimising losses due to self-discharge and internal resistance.

The doubling to tripling of battery lifespan reduces new battery production and waste management by 50% to 66%. The scale of efficiency benefits is highly dependent on battery design, usage, and maintenance scenarios. The increase in energy efficiency during consecutive battery charging and discharging cycles contributes further to resource efficiency in battery use.

Business and market impact

The adoption of 30 kVA pulse regeneration technology allows Renewcell to extend battery life by up to twice (mobile batteries) or even three (stationary batteries) the original duration, significantly reducing the need for new battery

purchases. Reconditioned batteries can be rented or sold at a 70% to 80% discount compared to new batteries, thus expanding market reach and providing affordable and sustainable battery-energy storage solutions in underserved areas.

By reconditioning batteries at a fraction of the cost of new ones and implementing Battmama.com for real-time battery management, Renewcell has achieved substantial reductions in battery maintenance costs and improved battery performance for its customers. This approach not only lowers operational expenses for customers, it also boosts sales for Renewcell by providing cost-effective battery solutions and maintenance services to a broader and expanding energy storage market.

Renewcell plans to expand its services by establishing additional battery service centres to enhance the collection, regeneration, and distribution of used batteries. The company is preparing for the deployment of the next evolution of battery technology in collaboration with MacBatec Spain. Plans include developing a platform for monitoring battery parameters with a 'trouble ticketing' system that dispatches technicians immediately to sites where alarms are triggered. This system could also be integrated with building management systems for enhanced monitoring.

Renewcell recognises the need to reduce transit times for battery services, especially for government-linked companies (GLCs) and multinational firms with nationwide operations. Consequently, immediate plans include establishing battery centres in Johor Bahru and Penang, followed by expansion to Kemaman, Kota Kinabalu, and Bintulu. This strategic expansion is designed to support growing demand and improve nation-wide service delivery across Malaysia.

Stakeholders

SMEs, industrial users, and technology providers have significantly contributed by supplying used batteries for regeneration. For example, CRRC Dalian Batu Gajah, contracted for the refurbishment of locomotives, successfully regenerated over 800 nickel-cadmium batteries, which not only resulted in substantial cost savings but also prevented approximately 40 metric tonnes of CO₂ emissions. The circular approach benefits the energy-storage market by providing affordable, efficient, and sustainable battery storage solutions. Regenerated batteries are more cost-efficient than new ones, because extending their original lifespan costs less. For non-repairable batteries, Renewcell takes responsibility as a waste generator and coordinates

their disposal with regulated recycling partners, acting as the de-facto waste generators for their environmentally sound disposal in accordance with applicable hazardous waste policy and regulations in Malaysia.

Renewcell's collaborations have had a positive influence on employment within the firm by creating specialised roles in battery maintenance and monitoring services, which in turn has enabled the upskilling of younger workers to qualify as trained battery technicians and specialists. Another positive result is that SMEs can access lower-priced batteries, which they can use for extended periods to support their operations and growth.

Implementation

The growing demand for sustainable battery solutions and evolving environmental policies has prompted the company to develop cost-effective, eco-friendly battery management systems. Unfortunately, an entrenched 'procure, use and dispose' culture and mindset, combined with high initial setup costs and logistical challenges in battery collection and regeneration (as a result of their size and weight, among other factors), have created significant obstacles in this business. To overcome the barriers, the company aims to establish additional facilities nationwide to reduce transit times, and is actively collaborating with new partners to address technical challenges and enhance service efficiency.

Scaling up presents opportunities to enter new markets and expand services to underserved regions, increasing both market reach and environmental impact. One potential solution is the deployment of a mobile regeneration unit, which could provide on-site battery regeneration services, reducing

logistical costs and extending access to remote areas. However, key challenges remain, including the need for substantial investments in infrastructure and technology to support mobile units, as well as adapting the business model to align with the applicable regulatory requirements and market conditions that often still prioritise a linear 'procure and dispose' approach.

Takeaways

Renewcell offers an initiative for regenerating and reusing batteries, reducing hazardous waste generation and providing operational cost reductions for battery users that will contribute to achieving the Sustainable Development Goals, particularly SDG 9 (covering industry, infrastructure and innovation) and SDG 12 (covering sustainable consumption and production). Renewcell can provide a carbon reduction report for each battery unit that is rejuvenated. Furthermore, its digital battery monitoring application allows batteries to be monitored for maximum energy efficiency during successive battery charging and discharging cycles.

Cities can establish designated collection centres for used batteries and give consumers the opportunity to purchase regenerated batteries. Every city can potentially promote energy- and cost-efficiency in battery-energy storage, under the umbrella of 'Battery Circularity for a Better Environment and Reduced Costs'.

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