VERNE
ENERGY SOLUTIONS

Batteries in South East Asia

“This lightweight, rechargeable and powerful battery is now used in everything from mobile phones to laptops and electric vehicles” the Royal Swedish Academy of Sciences said on awarding the 2019 Nobel Chemistry Prize to John Goodenough of the US, Britain’s Stanley Whittingham and Japan’s Akira Yoshino for the invention of lithium-ion batteries [1].

Map of Southeast Asia

CONTENTS

Introduction to Batteries

The three major types of rechargeable batteries are:

Pb lead-acid	**Ni** nickel-based*	**Li** lithium-ion

* i.e., nickel-cadmium (Ni-Cd), nickel-metal hydride (Ni-MHx)

LEAD-ACID BATTERY

Key features

- Low cost
- Capability of producing high current

Use cases

- Non-portable
- Large-scale stationary applications

Limitations

- Highly dependent on operating temperatures

Photo: Lead-acid batteries. Image from RecycleNation.

NICKEL-BASED BATTERY

Key features

- Improved energy density
- High temperature range
- Higher recycle life
- Long shelf life
- Less maintenance requirements

Use Cases

- Portable devices, e.g., power tools, medical equipment, and toys

Limitations

- Memory effect

Photo: Nickel-based batteries. Image from London Recycles.

Memory Effect

If the battery is recharged when not fully discharged, the battery appears to remember the previous energy delivered and once a routine has been established, it does not want to give more.

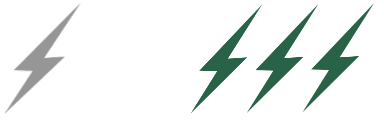
LITHIUM-ION BATTERY

Key features

Highest energy densities of among all the state-of-the-art battery storage technologies

100–265 Wh/kg or **250–670** Wh/L

Can deliver up to 3.6 Volts

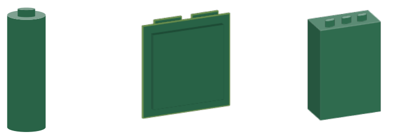


Long lifetime and experiencing very low self-discharge rates

7–12 years

1.5–2% per month

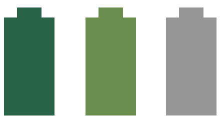
Large choice of cell designs and battery chemistries



Better cycling performances

1000+ charging / discharging cycles

Highly scalable



can be adapted to any voltage, power, and energy requirement

Main challenges

Cost reductions

Lithium-ion battery prices, which were above $1,100 per kilowatt-hour in 2010, have fallen 87% in real terms to $156/kWh in 2019, according to the latest forecast from research company BloombergNEF (BNEF) [2].

Even though Lithium-ion batteries have seen tremendous price reductions, **they are not yet competitive** with fossil fuel alternatives for grid applications, nor allow EVs to be at cost parity with an ICE engine.

Improvements in performance

Li-ion batteries are still around a hundred times less energy dense than gasoline. Higher gravimetric and volumetric energy densities of 700 Wh/kg to 1400 Wh/L are needed to remain competitive.

Improvements in safety

Li-ion batteries have some inherent safety issues mainly due to the use of highly flammable organic liquid electrolytes which can lead to **thermal runaway and combustion**.

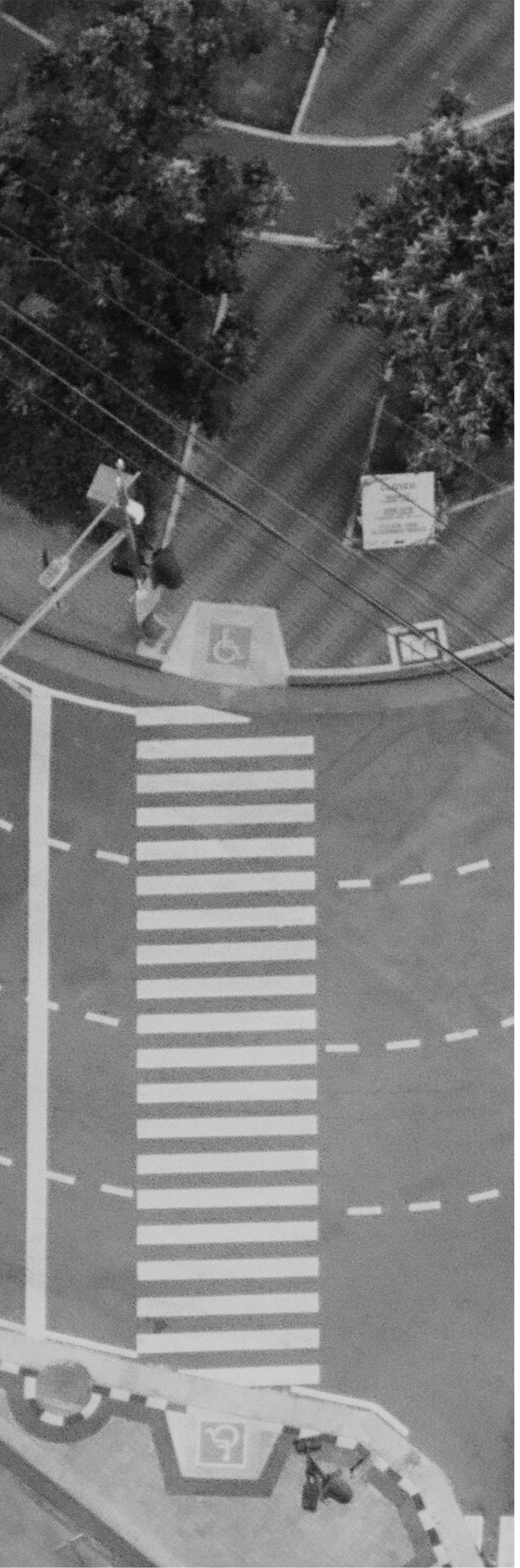
Battery Pricing in Southeast Asia

The past decade has seen the price of batteries plummet at record rates, even faster than the declining prices of renewable technologies such as wind and solar. Between 2018 and 2019 alone, **the Levelized Cost of Energy (LCOE) of battery-based energy storage systems (ESS) has halved**, to a benchmark of $150/MWh at utility-scale [2].

However, the true LCOE of a battery storage system will vary widely across country, region, use-case, and even technology used. **In Southeast Asia, technical and regulatory barriers will likely significantly increase the LCOE of ESS.**

> However, current energy systems in Southeast Asia are both expensive and unstable.

Overall, this still indicates the price competitiveness of ESS, especially in rural or underserved areas that rely on diesel generation. Similarly, peaking plants that are primarily utilized for peak shaving in densely populated urban centers are expensive assets. Open cycle gas turbines (OCGT), the typical technology used for peak shaving, is now more expensive than installing a battery to fit the same purpose.

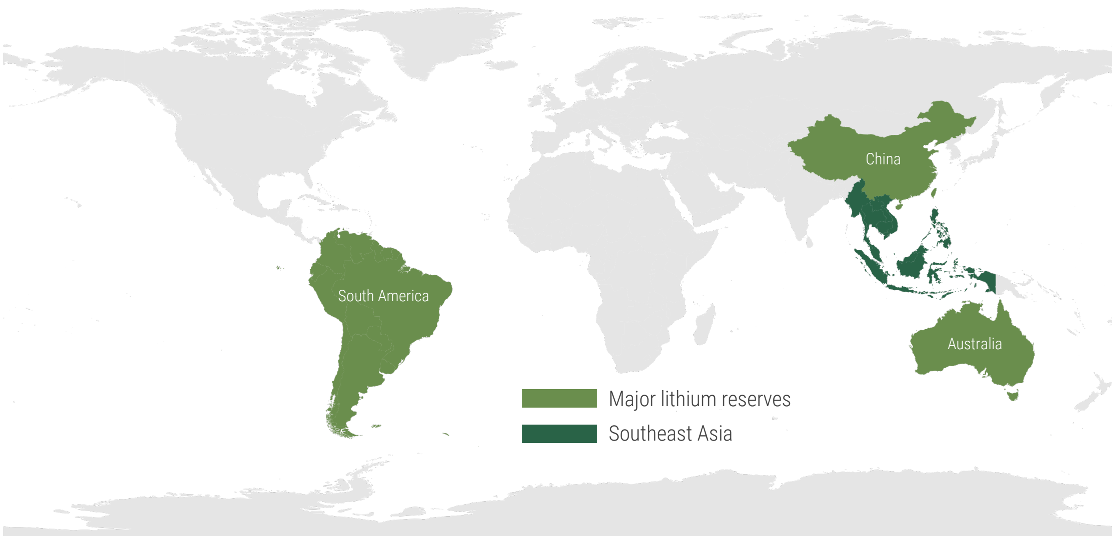


A large driver of this dramatic reduction in ESS prices over the past few years can be attributed to both upstream and downstream contributions. While **economies of scale and technological improvements have simply made ESS cheaper and more efficient** through increased energy density, the **downstream market demand for ESS has similarly grown**.

ESS projects in countries such as the United States and Australia have gotten larger in both megawatt (MW) and megawatt-hour (MWh) capacities. This has been another primary driver in the recent surge in ESS. **Asia Pacific is expected to attract 45% of new capital in the ESS industry**, and this similar downstream demand for ESS technology will likely drive down prices, particularly the LCOE, in the region.

Some forecasts expect **between 31% to as high as 80% further cost reductions by 2050** [3].

Southeast Asia Battery Supply Chain

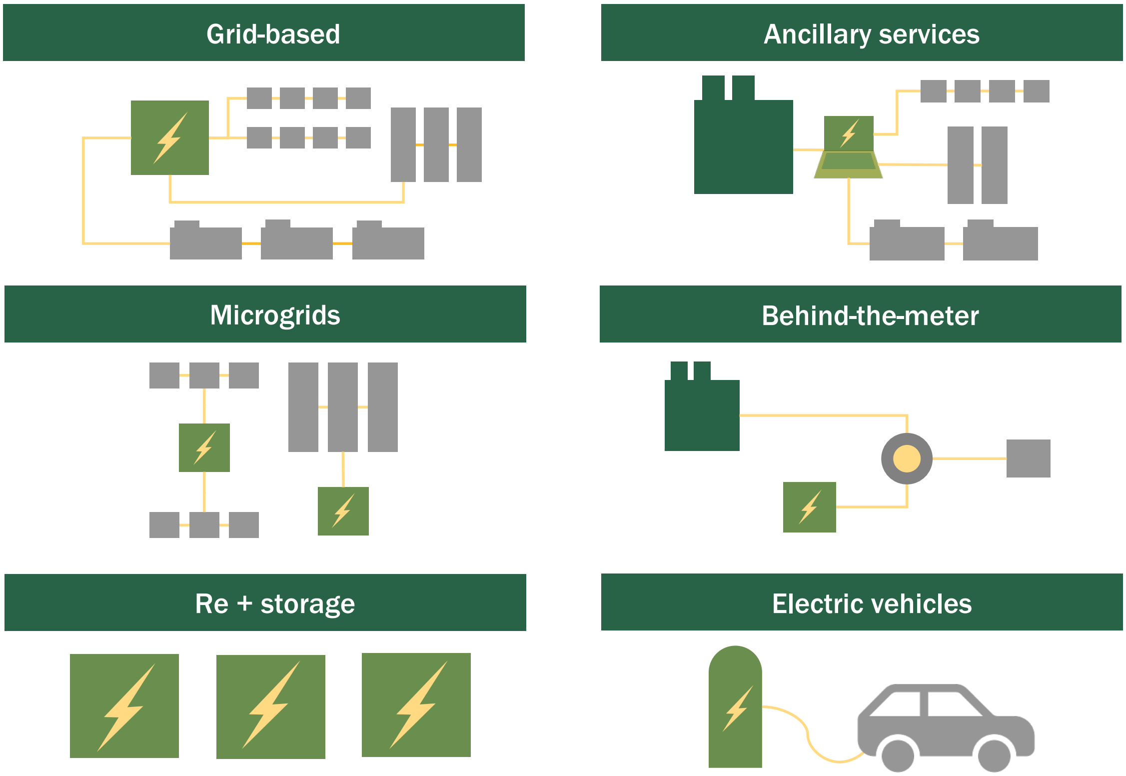


The current frontrunner technology in battery-based energy storage systems for utility-scale purposes is heavily dependent on expensive elements, primarily **lithium (Li)**, **cobalt (Co)**, and **nickel (Ni)**. Lithium in particular has attracted some level of infamy recently with geopolitical tensions arising in Bolivia after issues surrounding their lithium reserves, amidst an attempted coup.

While the largest Li reserves occur in South America, significant reserves also reside in both **China** and **Australia**. This should provide some **level of stability in terms of material supply for ESS production in SEA**. Short-term supply seems to be stable and sufficient to meet growing demand in the region by 2050. Long-term, Li availability may be a serious threat to the entire sector, however [4]. Models highlight the need to simultaneously focus and develop on robust recycling systems in regional and global supply chains in order to ensure the sustainability of Li-based technologies in this century.

Technical capacities in SEA nations may prove to be a barrier in ESS supply chains. **Technology adoption has been sluggish in the region regarding renewables, and a similar trajectory may be possible for ESS development.** It is critical that capacities to scale supply chains alongside growing demand are met, in order to displace traditional fossil-fuel based assets.

Battery Applications



Case Study

In the Philippines, the AES Corporation operates a 10 MW battery-based energy storage array in Masinloc, Zambales serving the Luzon grid. It provides ancillary services such as frequency regulation.

Photo: AES Energy Storage Array in Masinloc, Zambales. Image from Technocrete Trading.

New Technologies

Despite its many advantages and benefits, Li-ion is not the clear winner in the race to power mobility and utility-scale energy storage applications. The need for a variety of fit-to-purpose batteries to satisfy the requirements of a broad range of applications, alongside availability and price issues of Li-ion raw materials have stimulated the research interest and development of other types of batteries.

Some of the promising post-Li and non-Li-ion battery technologies include:

- Solid-state batteries with Li metal anodes
- Lithium-sulfur batteries (Li-S)
- Sodium-ion batteries (Na-ion)
- RedOx flow batteries, including these with organic shuttles (organic RedOx)
- Multivalent ion batteries, based on e.g. Mg^{2+}, Zn^{2+}, Ca^{2+} and Al^{3+}
- Metal-air batteries, including Li-air, Na-air, Mg-air, Al-air, Si-air, Fe-air and Zn-air

> However, the commercialization of a battery storage technology is a slow process. At a minimum, it would be at least six years before they achieve any sort of high-volume production.

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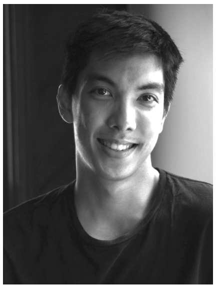
About Verne Energy Solutions

Headquartered in Metro Manila, Verne operates and implements projects all over the Philippines. We specialize in all forms of sustainable energy, from renewables to energy efficiency.

About the Authors



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