IFC Energy
INSIGHTS

EMERGING ENERGY SOLUTIONS

A series on emerging energy trends and opportunities from IFC

The Power of Batteries to Expand Renewable Energy in Emerging Markets

May 2021

IFC | International Finance Corporation
WORLD BANK GROUP
Creating Markets, Creating Opportunities

The global power and transportation sectors of the future will be fundamentally different from today, igniting opportunities for investment in new technologies that can bolster resilience and lower carbon emissions. One of those key technologies is batteries, which are creating increasingly compelling solutions for storing and distributing renewable energy.

SECTOR BACKGROUND

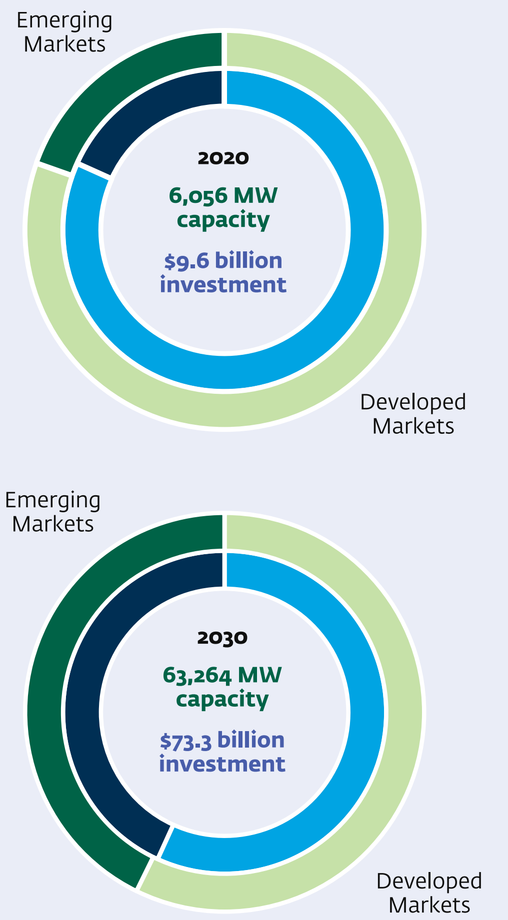
The ability of batteries to store renewable energy and release it at a later point make them a key decarbonization tool. In the automotive sector, growth in the electric vehicle (EV) fleet is accelerating as the cost of producing batteries falls, and as ever-more sophisticated battery technology comes onto the market. Across all sectors, lithium-ion battery pack costs have fallen 89 percent between 2010 and 2020, falling 13 percent between 2019 and 2020 alone. As a result, today's batteries account for 21 percent of the total cost of a battery-powered EV, according to BloombergNEF estimates.

Falling costs also make batteries viable for a range of services beyond the automotive sector. Batteries are the key component in battery energy storage systems (BESS), standalone installations of various sizes (ranging from less than 1 MWh to more than 1000 MWh, or 1 GWh) with multiple applications. Utility-scale BESSs represent a promising solution to large-scale decarbonization. These systems are stationary multi-MWh installations that can be connected to distribution and transmission networks or power generation assets. Examples of the services they provide include the provision of frequency regulation on a minute-by-minute basis to the grid, building in the ability to buy and store power when it is least expensive and release during peak demand when prices are high (time-shifting), and alleviating local transmission constraints.

The turnkey cost of utility-scale BESSs are set to almost halve between now and 2030, due to continued reductions in battery costs. This means that affordable battery-powered energy storage is increasingly viable as providing the missing link between delivering intermittent renewable energy and providing a steady, reliable source of renewable energy in a way that is commercially feasible. This is making batteries—and energy storage technologies in general—a fertile sector for private sector lending.

Importantly, the value provided by energy storage technologies is reflected by an impressive market growth outlook. Between 2020 and 2035, energy storage installations are forecast to grow more than 27 times, attracting close to $400 billion in investment. (See Figure 1.)

FIGURE 1: **GLOBAL ENERGY STORAGE INSTALLATIONS,2020 AND 2030**



Source: Guidehouse Insights

BATTERY BASICS

Benjamin Franklin first used the term "battery" in 1749 to describe a set of linked capacitors through which he conducted electricity, resembling the barrels of an artillery battery. In 1800, Italian scientist Alessandro Volta invented the first true battery as we know it today: the voltaic pile.

Battery technology has come a long way since 1800. In 2019, the Royal Swedish Academy of Sciences awarded the Nobel Prize in chemistry to three scientists for their work developing the lithium-ion battery. Today, lithium-ion batteries are ubiquitous, powering everything from smartphones to EVs.

The modern battery converts electrical energy to chemical energy, stores it, and then converts it back to electrical energy when and where it's needed. The anode and cathode produce a voltage capable of driving enough current to serve an electrical load. A variety of material and chemical processes can produce the necessary current.

Yet not all batteries are made equal. They vary by type, chemistry, battery life and power output. Battery types include lead-acid (best-known as vehicle starter batteries with low lifecycles), flow batteries (which have a long discharge time and can last up to 20 years, but are expensive), zinc-air (which are relatively inexpensive to produce, and don't require cooling, but lose a higher portion of the energy stored than other types of batteries), and lithium-ion. This last type contains rare earth metals (nickel, cobalt, or manganese) that are in high demand due to the EV revolution and other battery applications. While they have a relatively short discharge duration of around four hours and feature relatively high input costs, lithium-ion batteries are good, all-around performers and are expected to remain the most relevant, bankable battery technology for the next five years. Depending on how alternative storage technologies perform in terms of cost and lifecycle, lithium-ion batteries could face competition in the mid-term.

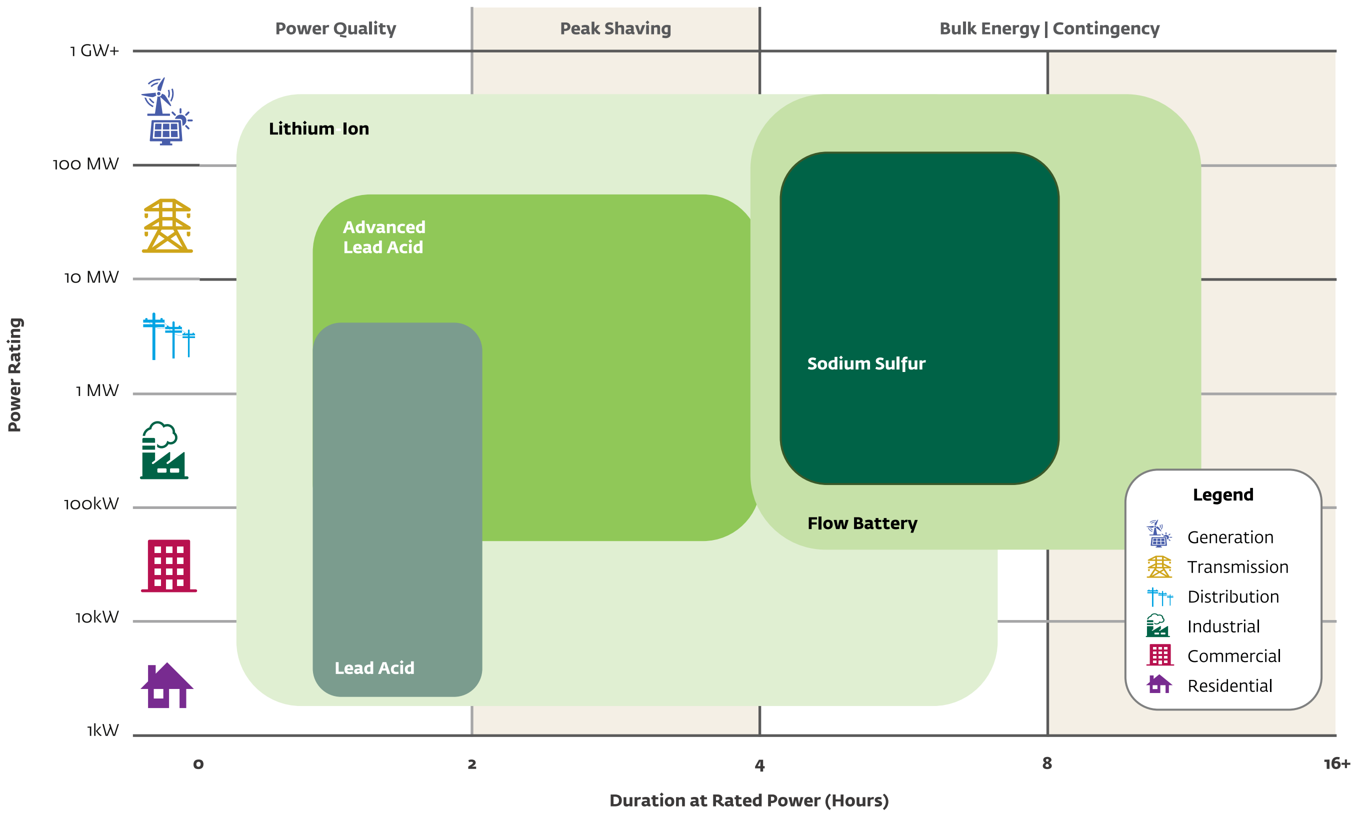
It helps, therefore, to view the battery as a sort of Swiss Army Knife, capable of a range of different functions. In the energy sector, batteries can perform transmission and distribution functions and provide ancillary services, all while simultaneously serving as generators when they release stored energy.

THE BUSINESS CASE

From an investor's point of view, the ability of batteries to multi-task has turned them into a compelling new asset class. And, as the cost of battery technology steadily falls, the focus is shifting toward the types of services that can benefit from battery storage uses.

While the business case for batteries is more complex than for wind or solar, it is nonetheless becoming clear that batteries will become attractive storage solutions

FIGURE 2: **POWER, ENERGY, AND APPLICATIONS BY BATTERY TECHNOLOGY**



in the provision of renewable energy. Batteries are particularly well-suited to supporting renewable energy because their storage capabilities help to smooth out the peaks and troughs in power generated from wind and solar, which are exposed to natural fluctuations in wind and sunshine levels. Demand for energy storage increases with higher levels of renewable energy in a given system, because over-production of solar power during the day results in a need to store the energy generated for use later at peak hours (usually in the evening). Similarly, the production of more wind energy leads to frequency fluctuation on the grid, increasing demand for frequency regulation services.

BATTERY COSTS ARE FALLING

Today, about half of current BESS costs are attributable to battery cells. Individual battery cells are assembled into battery modules housed in racks, which are installed in cabinets, or containers, or dedicated buildings, depending on the size of the system. A battery management system manages the performance of the battery and keeps it within its operational envelope to avoid harm to the battery. The rest of the cost comes from packing cells into battery packs, adding cooling and software control systems, plus any remaining balance of plant costs.

But with technology improvements, manufacturing scale, competition between manufacturers, greater product integration ahead of installation, and more overall industry expertise, costs will continue to fall.

Estimates indicate that the battery's share of the overall cost of a large, four-hour, utility-scale BESS will fall from 50 percent today to 40 percent by 2030, contributing to an almost halving in the cost of the entire BESS by the end of the decade. To put some hard numbers on this, the average capital cost of a large, four-hour, utility-scale BESS was over $500/kWh in 2017. It fell to $299/kWh in 2020 and is expected to break the $170/kWh threshold before the end of the decade, according to a BloombergNEF report.

As costs have fallen, BESSs are getting bigger as the economics become more and more viable. The first 10 MWh project was built at the start of the 2010s and the first 100 MWh project was built in 2016. Today the largest project in operation is the 1.2 GWh Moss Landing installation in California, USA, while the largest announced project is the 4 GWh SolarQ Gympie installation in Queensland, Australia.

Emerging markets lag behind developed markets by about four years. The largest projects in emerging markets (excluding China) to date are in the tens of MW. They include the 24.5 MW Hunts Bay project in Jamaica and IFC client Aura Solar III's 10.5 MW project in Mexico, both operational as of 2019.

CHALLENGES

Yet, as the industry matures, the path to lower prices will not always be linear or smooth. Temporary mismatches in supply and demand can cause temporary supply constraints. Some input materials undergo supply and demand cycles that have ripple effects on battery cell costs. For example, cobalt prices have triggered the industry into re-designing cobalt chemistries to function with lower concentrations. As cobalt demand waned, attention moved to nickel, which is also needed for EV motors—and could be the next bottleneck in raw materials.

Fortunately, none of the input materials for lithium-ion batteries are geologically scarce. Any future supply constraints should be temporary at worst. The sensitivity of battery pack prices to input material prices is dampened by all the other costs in the bill of materials so that, for example, doubling the price of cobalt leads to a mere 3 percent increase in battery pack prices.

While in developed markets it has typically been large companies using their corporate balance sheets to finance battery storage projects, this is rare in emerging markets, where access to finance is still in its infancy. Project finance—the basis for financing power projects for the past 40 years—needs to be adapted to cater to various factors in emerging markets. Nevertheless, IFC estimates that annual new installations in BESS in emerging markets will grow from 1.1 GW in 2020 to 27.3 GW in 2030.

Finally, while technology innovations and deployment have progressed, regulatory innovations have not kept up. A supportive regulatory environment ensures that energy storage developers can align their plans with national energy goals and targets (including renewable energy and storage mandates), be compensated for their services, benefit from clear and transparent procurement processes, and legally integrate with other energy assets. In the United States, regulators in California and Hawaii have successfully built regulatory environments that enable storage, as have Australia (particularly grid-scale) and the United Kingdom. Emerging markets can learn from these country experiences and IFC is working to enable that transfer of knowledge.

THE MANY USES OF BATTERY STORAGE

The business case for battery storage can be built on multiple revenue streams and cost savings. We examine below the implications of three applications with significance for IFC's business.

Renewables "time shifting": Batteries can help provide energy when the sun is not shining or the wind is not blowing—times when energy may be most needed and which may be the most valuable point in the day, such as early evening when air conditioning usage peaks in warm climates. The business case rests on carefully assessing the revenue required to build and operate a battery storage system that releases energy in this way over a set investment period – establishing the so-called "levelized cost of energy" (LCOE), or how the cost of electricity generated from a BESS compares with other energy sources.

Peak generation: Power plants that only run at peak usage times—called peaker plants—are the most suitable market segment for storage because they only run for short times, when demand for power is greatest, meaning that the limited run-time of batteries is less of an issue since they are only being drawn upon in short bursts. In the U.S., for example, about two-thirds of peakers have less than four hours of run time.

Hybridization and thermal replacement: As the need for flexible generation that can quickly adapt to a higher level of intermittent renewable resources on the grid increases, batteries can be used to optimize existing gas turbines by helping bridge time lapses between ramp up to full capacity. This also helps to right-size operations and optimize costs, since responding to urgent fluctuations in demand (ranging in minutes, while batteries can respond in microseconds) can stress the turbine and is more emissions-intensive.

Diesel fuel displacement: Batteries can be a good replacement for diesel in emerging markets. While they have a higher up-front cost than diesel-fired generators, their running costs are lower over time. When coupled with renewable generation, they also drastically reduce carbon emissions relative to diesel use.

THE OPPORTUNITY

The vast majority of battery storage development has been in developed markets so far. But the energy sector is globalizing, and IFC can help to catalyze the investment opportunity in emerging markets. IFC analysis estimates that emerging markets could capture more than 40 percent of the global market by 2030, representing $176 billion in investment opportunity. The majority of this growth is likely to occur in East Asia and the Pacific (driven by China), closely followed by South Asia (driven by India). More than half of these investments will be made at the utility-scale level.

The following areas of focus could be helpful in supporting emerging markets to harness this opportunity:

- **Working with the private sector.** Utilities in emerging markets face the prospect of having to invest in upgrading their grids to be able to accommodate renewable electricity. By adopting battery-related energy solutions, such as storage units placed strategically across the grid, they could ease the strain on their working capital, while decarbonizing the grid. This could be done by working with the private sector.
- **Improving regulations.** For a system to charge for multiple services, correct market regulations must be in place. These regulations can make the difference between a BESS being financially viable or not. Most emerging markets lack these regulations, but there are opportunities to learn from the experiences of developed markets, including the U.S., Australia, and the U.K.
- **Increasing market transparency.** The rapid improvement of economics has not been adequately disseminated. Some market actors use battery cost data from a few years ago, and even two years makes a difference.
- **Overcoming skepticism about technology.** There is skepticism that battery technology is robust enough to work in emerging markets. It is important to connect stakeholders with the growing track record of storage projects in operation, to facilitate the sharing of knowledge and best practice.
- **Financing.** There is an urgent need for models to be developed that address the gap between the expectations on the part of commercial operators and investors for returns within two years or less, and the longer payback periods of current projects. Development finance institutions such as IFC can deploy blended concessional finance to address market barriers and gaps and catalyze investor confidence and market creation.

The battery energy storage market is at a critical juncture in its evolution. The technology is now cost-effective for a variety of applications, both on- and off-grid, in countries around the world. However, most of the new project development and associated benefits are found in developed economies. Energy storage is a rapidly evolving sector, with prices and technologies expected to become ever more favorable. Policy and investment decisions made today need to consider the next decade of expected changes, such as energy shifting and additional storage capacity.

Early on, IFC identified the disruptive potential of batteries. Since 2011, IFC has made several venture capital investments in early-stage battery storage ventures, covering both the upstream and downstream parts of the industry. Beyond grid level deployment, additional opportunities include combining battery storage with distributed generation for commercial and industrial customers as well as combining with mini-grids to expand energy access. Our focus is now on accelerating energy storage deployment in emerging markets. At present, we are actively processing investments that combine utility-scale solar with battery storage projects. We are leveraging our technical expertise and sectoral experience in enabling other new forms of emerging energy solutions, as we have done in solar generation by supporting enabling regulation, making early-stage investments, taking equity and financing risks, and working towards creating sustainable, equitable, and low-carbon energy markets.

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