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Stationary Energy Storage to Transform Power Systems in Developing Countries

THE BOTTOM LINE

Versatility, ease of deployment, modular design, and falling costs make stationary energy storage systems appealing for integrating renewable electricity into grids. Their most common uses are in hybrid power plants at utility scale; as a replacement for diesel-fueled backup generators; as a source of ancillary services for main grids; and as a component in mini- and off-grid systems deployed to expand access to electricity. But challenges remain to scale up energy storage sustainably in developing countries. The World Bank's new Energy Storage Partnership is addressing those challenges.

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Why do the World Bank's clients need energy storage?

Greater use of renewable energy is key to increasing access to electricity in developing countries—and energy storage is key to raising the share of renewables in power systems

Energy storage is essential to integrating variable renewable energy (VRE)—such as wind and solar photovoltaics—into power systems (de Sisternes, Jenkins, and Botterud 2016), especially in areas where grids are weak, electricity supply is unreliable or intermittent, and other sources of power system flexibility are unavailable. Storage has also transformed international efforts to achieve universal access to electricity in an environmentally responsible way. The result? Half a billion people living in remote and rural locations have gained access to electricity (ESMAP 2019). Energy storage can also make grids more resilient as disasters and extreme climate events intensify. In this context, accelerating the development and deployment of reliable, safe, and affordable energy storage can be a game changer for the power sector in developing countries.

One-quarter of the world's greenhouse gas emissions are associated with the generation of electricity and heat. The clean energy transition that is needed to minimize climate change and its effects is well underway in the power sector, where renewables are rapidly displacing fossil fuels—particularly in the industrialized world. The pace of transformation is much slower in the least-developed countries, where inadequacies in grid infrastructure, limited power system flexibility, low technical capacity, and the lack of sound institutional and regulatory frameworks make it impossible to integrate more VRE capacity and take full advantage of its falling costs.

But under the right enabling conditions, energy storage can strengthen power systems by making them more flexible. And flexible power systems can accommodate larger shares of renewable energy.

For stable operation, power systems must be flexible enough to match electricity supply and demand at all times. Conventional power systems are designed and operated to accommodate daily and seasonal changes in demand. However, adding wind and solar power to the generation mix increases the complexity of operating the system because wind and sun are variable resources: they impose variability in *supply*. The output of a solar photovoltaic (PV) plant can change in seconds as a cloud passes by; that of a wind plant can vary instantaneously and from season to season. Solar and wind energy and distributed PV also bring additional variability in *demand*, requiring even more flexibility.

There are many ways to increase system flexibility on both sides of the equation. These include improvements in system operation, curtailment of renewable generation, flexible conventional generation, demand response, grid modernization, and expanded transmission networks (including cross-border interconnections), all of which have long been part of the repertoire of sophisticated system operators. To this toolbox, energy storage has now been added. In fact, for smaller developing countries and those with weak power systems, energy storage (particularly batteries[1]) offer an opportunity to bypass other flexibility options that may be too difficult or too

1 This Live Wire is focused on stationary energy storage. It does not cover mobile energy storage, such as the batteries used in electric vehicles.

Accelerating the development and deployment of reliable, safe, and affordable energy storage can be a game changer for the power sector in developing countries. Energy storage can make power systems more flexible. And flexible power systems can accommodate larger shares of renewable energy.

costly to deploy. Building new transmission capacity, for example, could take decades. Access to flexible generation, such as hydropower or natural gas, may not exist. Demand-side management may be difficult to implement. Storage offers a partial solution, as we shall see.

Stable grid operation also requires "firm resources"—that is, generation resources sufficient to guarantee that demand can be met at all times. Historically, those resources are provided by a combination of backup generators or, where available, easily regulated hydropower plants. But in recent years the pool of firm resources has expanded: Geothermal energy, bioenergy, and renewables in combination with long-lived forms of storage (such as hydro reservoirs and green hydrogen storage) are examples of low-carbon firm resources that can be operated as a flexible base resource and provide a steady supply of reliable, sustainable, and adjustable power output through the year.

But our focus here is the rapidly evolving field of energy storage.

What are the key characteristics of energy storage systems?

Storage systems vary in their power capacities, the duration of storage, and where they can be installed

Energy storage systems are available in power capacities ranging from kilowatts to gigawatts, with storage durations ranging from seconds to weeks or longer. Some systems are versatile in terms of where they can be installed: at the end user's site ("behind the meter"), at various points in a transmission and distribution grid, or at the renewable energy generation site. Mini-grid systems can include battery storage to help ensure high-quality, reliable electricity and minimize the use of diesel generators.

Some 1.5 billion of the world's people live day-to-day with faulty electricity grids, experiencing blackouts for hundreds and sometimes thousands of hours a year (IEA, IRENA, UNSD, World Bank, WHO 2020). Energy storage deployed at the grid level can help remedy this problem by providing ancillary services such as fast frequency response and power reserves. It can also help manage network congestion by shifting the time at which load and black-start capabilities are activated.

Energy storage technologies can be selected and adapted to meet operational requirements, including discharge hours, discharge current, depth of discharge, number of daily cycles, number of days of operation per year, and so on. The selection and adaptation will be determined by the specific technical needs of a power system, its institutional setup, and its policy, market, and regulatory framework. Some common applications of various energy storage technologies are illustrated in figure 1. Some require short periods of storage and discharge, varying from milliseconds to days, while others require longer periods. For a given application, storage size (MW) and discharge time must obviously be compatible with the storage capacity required (MWh).

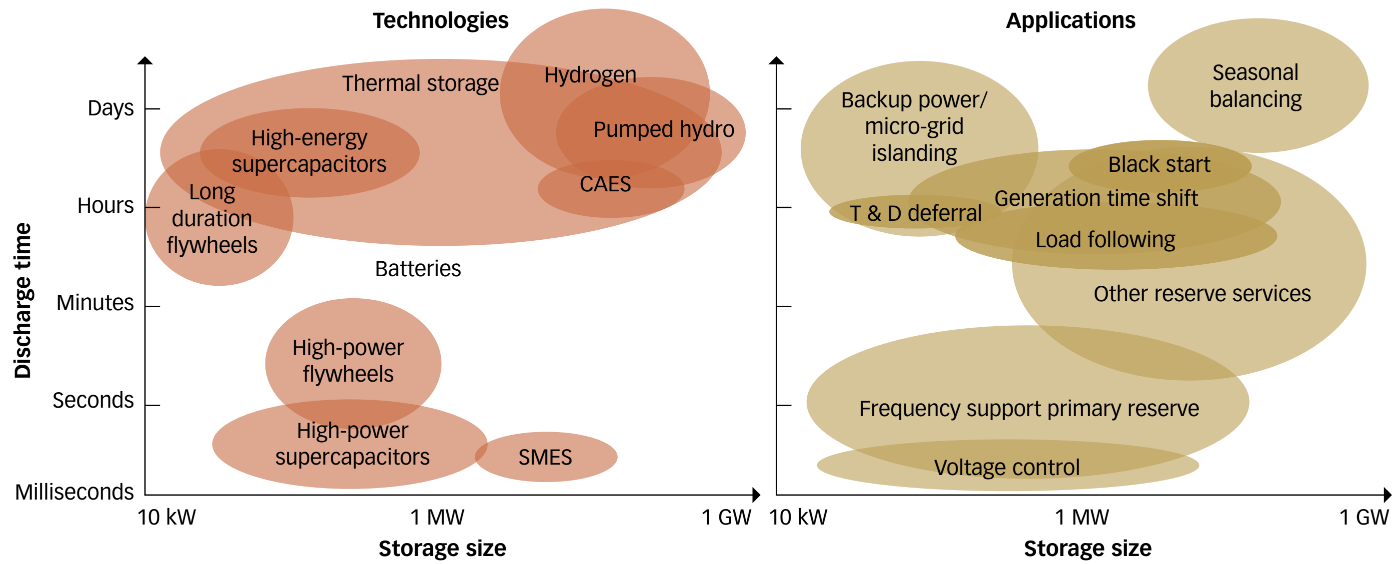
Globally, total storage capacity stood at just under 200 GWh in 2019 (IEA 2020a). The major types of storage are **mechanical** (chiefly pumped hydro), **electrochemical** (batteries), and **thermal**.

Pumped hydro, wherein water is pumped and stored upstream of a hydroelectric generator for release when needed, accounted for 91 percent of global installed capacity in 2019. Batteries accounted for 5 percent and thermal technologies for 3 percent. Several other technologies—notably hydrogen, compressed air, and gravitational—are on the rise but for the time being remain at a much smaller scale.

Pumped hydro has been used in electrical grids for decades. In 2019, it accounted for between 153 and 158 GW of the 183 GW of installed storage capacity (REN21 2020; IEA 2020a). Of course, this technology is useful only in locations where hydro resources are available—both presently and in the future, as climate change exerts its effects.

Thermal storage is most efficient—and holds the greatest promise for reducing emissions—in situations where the end use is thermal energy, as for heating or cooling buildings, or when the energy supply is a thermal source. The potential for thermal storage to curtail the use of fossil fuels is vast, particularly in Europe and Central Asia. Currently, it is most widely deployed in utility-scale concentrating solar power plants, but it could also be used in smaller

Figure 1. Energy storage technologies and applications



Source: Original compilation by World Bank Energy Storage Partnership.
Note: CAES = compressed air energy storage; SMES = superconducting magnetic energy system.

Electrochemical batteries are the fastest-growing form of energy storage today. The market for stationary electrochemical batteries is still a very small part of the global battery market, which is dominated by batteries for electric vehicles, consumer electronics, and appliances. But stationary batteries have a particularly significant role in integrating VRE into grids and thereby accelerating decarbonization in developing countries. Battery-based solutions are modular, easy to deploy, quick to respond, and falling in cost.

distributed systems to power factories, hospitals, and other facilities. Electro-thermal energy storage is also being explored to provide long-duration storage in locations with low-cost variable renewables.

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Stationary electrochemical batteries will be the focus of the rest of this brief.

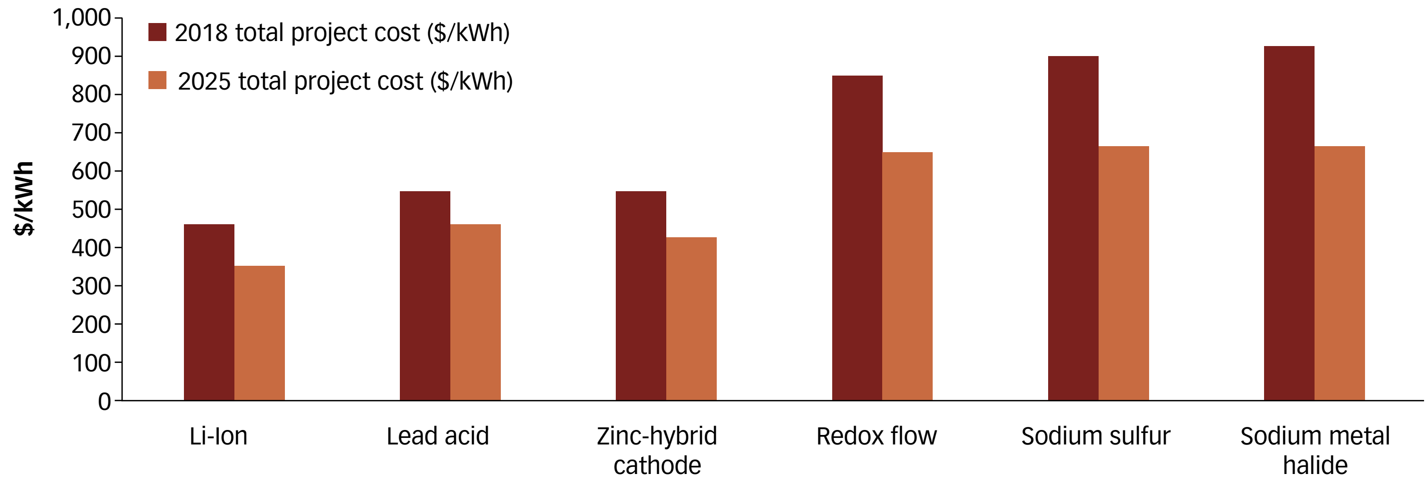
What are the opportunities and challenges of battery storage in developing countries?

Battery storage systems are an appealing solution for developing countries because of their versatility, wide range of durations, modular design, and falling costs—but challenges remain

The costs of lithium ion (Li-ion) batteries, in particular, are plummeting. Since 2010, the cost of a Li-ion battery pack fell by 87 percent to $156/kWh. The cost is expected to fall to close to $100/kWh by 2024 (BNEF 2019). Drivers for the decline include economies of scale (larger order sizes), growth in electric vehicle sales, technology improvements, new pack designs, and falling manufacturing costs.

Other electrochemical storage technologies not based on Li-ion chemistry could bring distinct benefits; these, too, are falling in cost. They include flow batteries (long duration), compressed air

Figure 2. Projected reductions in installed costs of battery storage systems, 2018–25



Source: Authors, based on PNNL 2019 data (https://energystorage.pnnl.gov/pdf/PNNL-28866.pdf).

Under the Sustainable Development Scenario in IEA's World Energy Outlook 2020, battery storage capacity could reach 550 GW by 2040, up from 6 GW in 2019.

energy storage (long duration), and flywheels (fast response). The International Renewable Energy Agency (IRENA 2019) estimates that by 2030 the total installed cost of flow batteries (still very much in development) could drop by two-thirds; high-temperature batteries by 56–60 percent; flywheels by 35 percent; and compressed air energy storage by 17 percent (figure 2). Such cost declines, if realized, combined with expected performance improvements, would make these new battery storage systems cost-competitive for more applications, particularly ones involving longer discharge periods. Of course, cost per kWh is not the only factor in the economic evaluation of a given technology in a given place. Other parameters—roundtrip efficiency, minimum state of charge, and asset life—can have an impact on the total system cost and on the value the storage technology can bring to the power system. A detailed discussion of how these technical parameters can affect the economic evaluation of energy storage can be found in World Bank (2020).

In the wake of cost reductions, projects combining solar generation with storage are spreading quickly all over the globe. In Africa, the World Bank is helping The Gambia and the Central African Republic to develop solar-plus-storage hybrid projects with a view to eventually building utility-scale plants. Nigeria issued a tender for a 15 MW solar project with a 5 MW battery storage system consisting of a battery pack, inverter, switch gear, energy management system, and software (Bellini 2019). In India, the World Bank is supporting an innovative wind-solar hybrid system with battery storage to address grid-management challenges posed by higher shares of VRE.

Behind-the-meter systems are also benefiting from cost reductions and have become cost-competitive with diesel generators. A BNEF study found that hybrids combining solar, batteries, and a genset can replace diesel generators with a savings of 28–36 percent (per kWh)—a boon for countries where grid failures are frequent and prolonged (Faraday Institution 2019). The same study estimated that the global installed capacity of forms of stationary energy storage other than pumped hydro was 9 GW/17 GWh in 2018. By 2040, that figure is expected to reach 1,095 GW/2,850 GWh (BNEF 2019).[2]

2 In the same year (2018), the World Bank found roughly 4.5 GWh of cumulative installed battery capacity, mainly in mini-grids and island applications.

In the developing world, the most common current uses for stationary battery storage are as a component of hybrid power plants powered by VRE; as a replacement for diesel-fueled backup generators; as a provider of ancillary services to support main grids; and as a component in mini-grids deployed to expand access to electricity.

But after almost a decade of growth, annual installations of new energy storage actually fell in 2019. Utility-scale storage installations dropped 20 percent, while behind-the-meter storage held steady, adding 1.8 GW as in 2018. The dip indicates that storage remains in the early stages of deployment and is still heavily dependent on policy support (IEA 2020).

Globally, the largest battery storage deployments are in the Republic of Korea, the United States, Europe, and China (figure 3), chiefly to provide fast-response ancillary services. Although the battery storage market is still nascent in developing countries and limited largely to pilot projects in middle-income countries (including China, India, and South Africa), the market is poised to grow substantially as more VRE is added to power systems.

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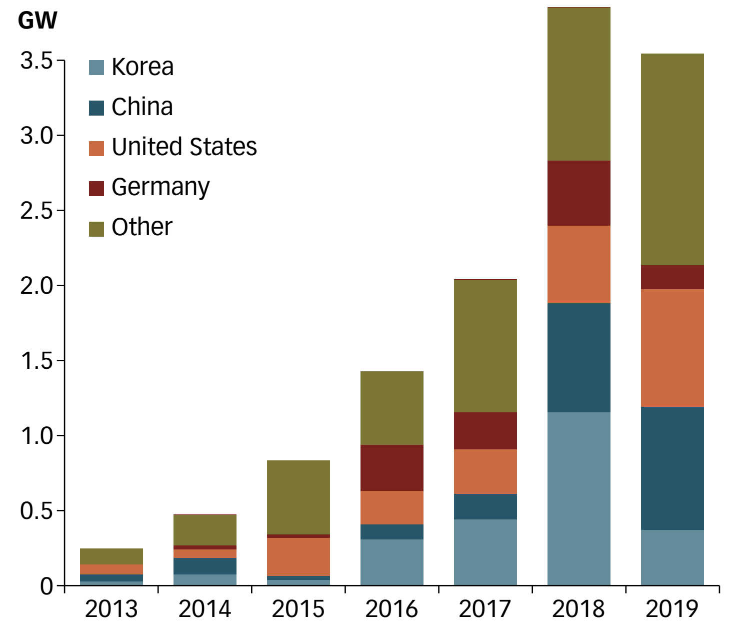
- Renewables-fueled power plants coupled with storage can offer a clean, affordable, and sustainable alternative to fossil-based generation. Solar-plus-storage hybrid plants can be cost competitive with newly built gas plants in nonbaseload applications.
- For energy consumers large and small, batteries are a quickly deployable and affordable alternative to diesel generators to provide backup power in the event of grid failures or interruptions in VRE supply.
- For grid operators, battery storage solutions can serve as grid assets, providing services such as frequency control, voltage control, and black-start capability—all of which improve grid reliability, stability, and power quality. They are also a competitive way to meet peak demand. As the penetration of VRE increases, long-duration storage—such as flow batteries—will be needed to guarantee that power is available at all times.
- In areas where mini-grids and off-grid systems are deployed to provide access to electricity, batteries can be added to ensure that power is always available. Batteries build redundancy in the power system, reducing the risks of interruptions in the supply of electricity. They also diversify the energy mix away from fossil fuels, protecting against disruptions in the fuel-supply chain.

Figure 3. Combined utility-scale and behind-the-meter deployment of stationary batteries in selected countries, 2013–18



Source: IEA 2020a.

Yet the challenges of scaling up battery storage in developing countries are not insignificant. Among them are poor regulatory, legal, and policy environments, which discourage investment; the difficulty of valuing the benefits that storage can bring to the power system; and the paucity of readily available commercial solutions suited to developing country contexts (de Sisternes et al. 2019).

The regulatory, legal, and policy environment is critical. Energy storage systems are capital intensive and require a regulatory framework that guarantees cost-recovery. Most new projects are developed in well-functioning ancillary services markets, where it is possible to stack revenue from different energy services. With the right regulatory framework and enabling environment in place, energy storage projects can be successfully remunerated under any power sector market structure—vertically integrated, single-buyer, Advanced modeling tools are needed to accurately assess the value of energy storage at the project and system levels and to compare flexibility options for the power system. The World Bank has developed guidelines for conducting economic analysis of battery storage systems as a step in project appraisal

or fully liberalized. Even so, energy storage poses an enormous challenge even for the most progressive regulators, as projects can offer a variety of services and constitute distinct grid elements in their own right. This, in combination with issues of asset classification and licensing, explains why the regulatory framework for battery projects remains underdeveloped in most developing countries. Another challenge is to design contracts compatible with environmental and operational needs. Provisions must address ownership and operation, risk allocation, performance guarantees, standards for safe operation, and sustainable end-of-life management.

Another obstacle to the large-scale uptake of batteries is the difficulty of valuing the benefits they bring to the power system. Although batteries provide a range of services, their value cannot be captured easily, owing to limited data and the complexity of evaluation, which often requires detailed modeling. Advanced modeling tools are needed to accurately assess the value of energy storage at the project and system levels and to compare flexibility options for the power system. The World Bank has developed guidelines for conducting economic analysis of battery storage systems as a step in project appraisal (World Bank 2020).

Planning is crucial for the growth of energy storage. Because battery storage is a new addition to power systems (and because of the daunting technical challenge of linking flexibility needs with investment decisions in planning models) many grid planners and operators still do not give adequate weight to storage in their planning and investment operations. Some system planners, however, are slowly incorporating battery storage in planning studies, with the long-term objective of integrating more VRE and reducing emissions.

India is one example. In a recent internal analysis commissioned by the World Bank, ICF Consulting used an integrated planning model to assess the potential implications of introducing battery storage in the country's electricity market (World Bank 2018). The finding is significant: Although battery storage reduces the cost of producing and delivering electricity by just 1 percent, *it substantially changes the composition of generation capacity*. Adding storage could make it possible to add 240 GW of new renewable energy capacity by 2041. Storage enables renewables to displace 130 GW of new coal-powered capacity, thereby reducing national CO_2 emissions by 16 percent (before carbon pricing) and local air pollutants by more than 10 percent. India's Central Electricity Authority suggests an optimal system uptake of 34 GW/136 GWh of battery storage through 2030 (Government of India 2019). This recommendation underestimates the value of storage, since it does not take into account the role of batteries in allowing transmission upgrades to be deferred. The Central Electricity Authority assumes that India will reach targets for 300 GW of solar power and 140 GW of wind power by 2030, driving further investment in storage.

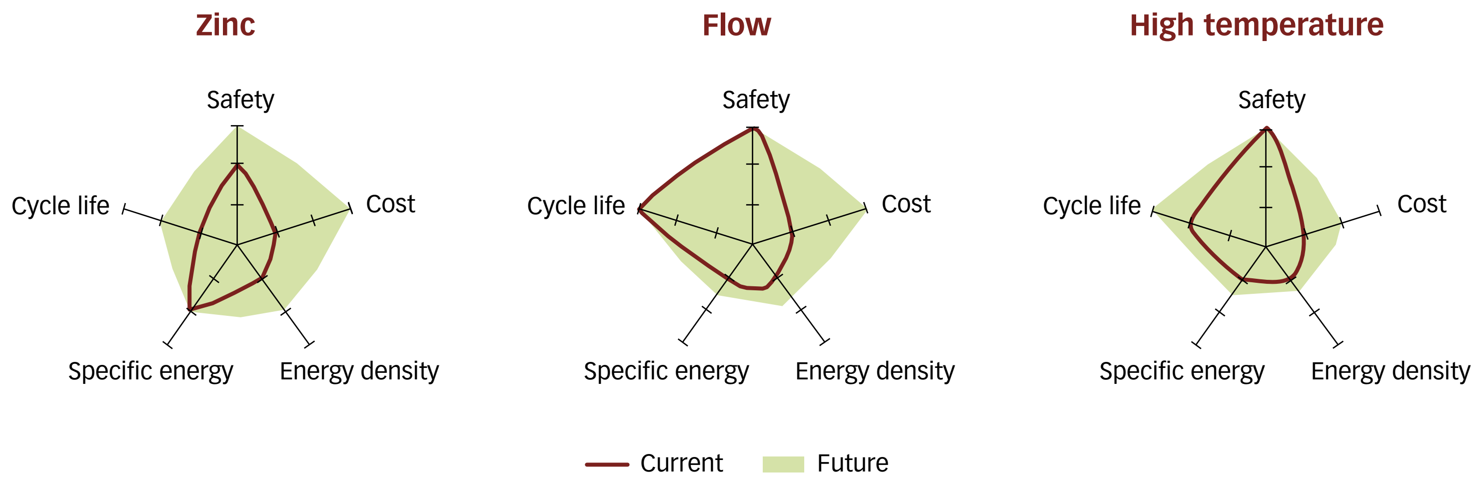
To sustainably scale up battery storage in developing countries, the following attributes need to be prioritized in commercial solutions: duration, robustness, operability, safety, recyclability, and low toxicity. For example, batteries used to firm up renewable power to meet peak demand will need to exhibit output of long-duration; batteries deployed in high-temperature environments will need to be safe, stable, and robust under demanding conditions; and batteries deployed in low-capacity environments will need to demonstrate steady operability and require maintenance only at long intervals.

Long-duration storage, in particular, will become increasingly used over time as applications aimed at fully replacing fossil fuel–based generation become economically attractive. Examples of such applications in developing country contexts include backup for critical infrastructure such as healthcare facilities and data centers, which currently rely on diesel backup.

Zinc-based, flow, and high-temperature battery technologies are emerging as candidates for a larger share of the future market. These technologies can provide long-duration storage at relatively low cost. The trade-offs are their limited track record and production capacity, both of which are much less than that of Li-ion batteries. The relative performance attributes of the three technologies are summarized in figure 4.

- In zinc batteries, zinc-based anodes are coupled with low-cost cathodes (such as air) to create an inexpensive battery. Future zinc-batteries could use solid-state electrolytes.
- Flow batteries use externally stored fluids to generate energy as they flow past each other. Some can compete and win against Li-ion batteries in use cases where long duration is essential.
- Liquid-metal high-temperature batteries could provide low-cost, long-duration grid balancing based on their safety, long life, and suitability for active cycling, similar to traditional generators.

Figure 4. Attributes of zinc, flow, and high-temperature batteries



Source: Tyson and Bloch 2019.

In 2018, the World Bank launched Accelerating Battery Storage for Development, an investment program that will mobilize $5 billion in financing to support developing countries seeking to deploy batteries at scale while creating enabling conditions for private sector investment in energy storage.

How is the World Bank helping to scale up energy storage in developing countries?

The Bank's Energy Storage Partnership seeks to remove obstacles to energy storage in the developing world

In 2018, the World Bank launched Accelerating Battery Storage for Development, an investment program that will mobilize $5 billion in financing to support developing countries seeking to deploy batteries at scale while creating enabling conditions for private sector investment in energy storage. The program aims to finance 17.5 GWh of storage to catalyze 200–400 GWh of additional generation in developing countries by 2025. It has already mobilized $400 million through the Climate Investment Fund's Clean Technology Fund and other sources of concessional climate finance.

Since its launch, the program has provided support for utility-scale, renewables-based mini-grid projects in island locations such as Zanzibar and the Maldives, where storage will enhance system resilience by reducing reliance on fossil fuels and increasing the role of locally produced renewable electricity. In both projects, the proposed financial structure combines a mix of concessional loans to support grid upgrades and reinforcements, financial guarantees to reduce off-taker risk and protect investors against country-specific risks, and grants for technical assistance. The concessionality of the loans is essential to leverage commercial capital for innovative battery solutions in situations where the resulting electricity price could be prohibitive if the underlying finance came at commercial rates.

These World Bank investments in battery storage will enable quick harvesting and dissemination of project lessons related to technological innovation. Quick lessons are essential, given the need to ensure the sustainable scale-up of battery storage projects. To comply with this important requirement, the Bank has convened research labs, academic organizations, private sector companies, and industry associations around a set of goals and deliverables for a global initiative known as the Energy Storage Partnership.

Through the Partnership, the Bank is working with 36 organizations to develop and adapt storage solutions tailored to the needs of developing countries. The goal is to redirect some of the ongoing

Partnering with the Global Women's Network for the Energy Transition, the Energy Storage Partnership has launched a first-of-its-kind mentoring program to empower women from developing countries in the energy storage sector.

global research and development in storage to address deployment challenges in growing developing-country markets (de Sisternes et al. 2019). The partnership's work is characterized by its technology neutrality vis-à-vis storage solutions (including innovative technologies), provided those solutions meet the duty cycles for typical applications in developing countries and comply with the Bank's environmental and social guidelines and standards.

The Energy Storage Partnership is organized into seven working groups addressing the barriers that limit the scale-up of energy storage in developing countries. Each working group is described briefly below.

Power systems. This group has produced updated guidelines for safe storage in power systems, reflecting conditions found in developing countries. It has recently offered guidance and good practices for tailoring warranties for power system applications (notably battery energy storage systems) in developing countries, with an emphasis on flexibility of operation, clarity and ease of implementation of warranties, and correct operation and maintenance of the storage system to keep the warranty valid (ESMAP 2020a).

Testbeds and testing protocols. How storage technologies behave under the challenging conditions of some developing countries is not well understood, and local capacity to design and operate storage projects is typically lacking. By deploying testbeds to monitor battery performance, host countries with difficult climatic conditions can contribute to global knowledge while also developing local capacity to design and operate storage projects. India, Morocco, and South Africa are exploring opportunities for hosting testbeds.

Mentoring and capacity building. The Energy Storage Partnership strives to harness talent to accelerate the deployment of energy storage in developing countries. Women have traditionally been underrepresented in the energy sector, accounting for only 32 percent of the renewable energy workforce (IRENA 2019). Partnering with the Global Women's Network for the Energy Transition, the Partnership has launched a first-of-its-kind mentoring program to empower women from developing countries in the energy storage sector.[3] The program combines a training program with networking in Partnership events, webinars, and study tours.

Flexible sector coupling. Storage facilities consist almost entirely of capital expenditure, in contrast to some thermal generation technologies, where operating expenses dominate the investment equation. Maximizing the use of these assets is therefore critical to ensure bankability. Flexible sector coupling offers the possibility of using storage simultaneously in multiple sectors, thereby increasing utilization. The working group is exploring opportunities in developing countries, identifying use cases and devising strategies around them.

Decentralized energy storage solutions. Selecting the optimal storage technology and system size for mini-grid projects is not a simple matter. The working group is developing an open-source model to support these decisions and to take stock of the current market for mini-grids in developing countries. The World Bank's Energy Sector Management Assistance Program has developed an online tool (https://storagesizing.energydata.info) to support the sizing of solar-plus-storage hybrid plants to meet a predefined demand profile.

Enabling policies and procurement frameworks. Most developing countries still lack polices, regulations, and procurement frameworks to support the adequate remuneration of energy storage investments. The working group has identified policy and regulatory practices to ensure successful storage projects, including standardized power purchase agreements and service agreements to foster technology neutrality and project sustainability. A new report from the Partnership provides guidance on determining the value of storage solutions from a system perspective and on policy, market and regulatory considerations to facilitate storage deployment, particularly in countries that still lack regulatory frameworks capable of unlocking the benefits of energy storage (ESMAP 2020b).

Recycling systems and standards. Recycling procedures and standards for battery technologies must be developed to ensure the sustainability of battery projects in developing countries. The working group has identified best practices for recycling major battery types and for extracting rare metals (ESMAP 2020c).

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3 https://www.globalwomennet.org/announcing-the-participants-of-the-women-in-energy-storage-mentoring-programme/.

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As a last word, energy storage has a particularly important role in fighting the COVID-19 crisis, providing clean solutions to power healthcare facilities and the cold chain needed for the distribution of vaccines. The World Bank helped to develop the HOMER Powering Health Tool, which simplifies the process of sizing hybrid renewable generation systems to meet the firm power needs of hospitals and clinics. The tool calculates least-cost combinations of batteries, distributed solar PV, and diesel generator sets (https://poweringhealth.homerenergy.com).

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The *Live Wire* series of online knowledge notes, an initiative of the World Bank Group's Energy and Extractives Global Practice, offers rich insights from project and analytical work done by the World Bank Group. The series is edited by Jonathan Davidar (jdavidar@worldbankgroup.org).

Every day, Bank Group experts apply their knowledge and expertise to solve practical problems in client countries. *Live Wire* captures the rich insights gained in the field, allowing authors to share their findings with other practitioners, policy makers, and planners.

Shouldn't you be connected to Live Wire?

Since 2014, the briefs in the series, now numbering more than a hundred, have dealt with vital topics such as energy demand and supply; renewable energy; energy efficiency; energy policy; economic growth; environmental protection; climate change mitigation; power systems; rural and urban development; access to energy; infrastructure economics; private sector participation; access to finance; and regulation.

- **Topic briefs** offer technical knowledge on key energy issues.
- **Case studies** highlight lessons from experience in implementation, often with insights from private sector engagement.
- Briefs on **global trends** provide analytical overviews of key energy data and developments.
- **Bank views** portray the Bank Group's energy and extractives sector activities.

The format is accessible, rigorous, and concise enough to be easily shared. The 6–12 pages of each brief make ample use of graphics. Briefs are peer-reviewed by seasoned practitioners within the World Bank Group and professionally edited and produced. While their main channel of dissemination is online, Live Wires are available in print-ready files for specific client needs.

Live Wire briefs are designed for easy reading on the screen and for downloading and self-printing in color or black and white.

For World Bank Group employees: Professional printing can be done on a customized basis for meetings and events by contacting GSDPM Customer Service Center at (202) 458-7479, or sending a written request to cgsdpm@worldbank.org.

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Please visit the World Bank Group's Open Knowledge Repository to browse the Live Wire collection and download the issues important to you: www.worldbank.org/energy/livewire

OKR OPEN KNOWLEDGE REPOSITORY

An invitation to World Bank Group staff

Contribute to Live Wire

Do you have something to say? Say it in *Live Wire!*

Those working on the front lines of energy and extractives development in emerging economies have a wealth of technical knowledge and case experience to share with their colleagues but may not have the time to write for publication.

Live Wire offers prospective authors a support system to make it easier to share their knowledge:

- Staff from the Energy and Extractives Global Practice are available to assist operations staff in drafting Live Wire stories.
- User-friendly guidelines help authors mold their contribution to the expectations of the Live Wire audience.
- A professional editor ensures that the writing is punchy and accessible.
- A professional graphic designer assures that the final product looks great—a feather in your cap!

Since 2014 the Energy and Extractives Global Practice has produced more than a hundred Live Wire briefs under the bylines of 300 staff authors. Live Wire briefs have been downloaded thousands of times from the World Bank's Open Knowledge Repository and circulated in printed form for countless meetings and events.

Live Wire aims to raise the profile of operational staff with practical knowledge to share—wherever they are based.

If you can't spare the time to contribute to *Live Wire* but have an idea for a topic or case we should cover, let us know!
We welcome your ideas through any of the following channels:

Via the Communities of Practice in which you are active

By participating in the Energy and Extractives Global Practice's annual Live Wire series review meeting

By communicating directly with Jonathan Davidar, executive editor of the Live Wire series (jdavidar@worldbankgroup.org)