WHITEPAPER

How is artificial intelligence advancing battery energy storage for renewable plants?

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The Future of Energy demands more efficient Battery Storage Systems

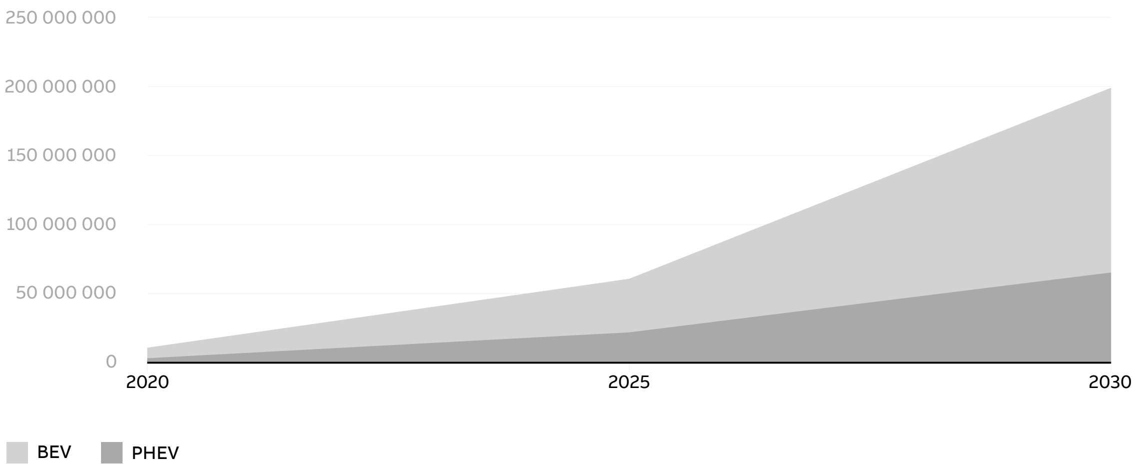
The energy demands of the 21st century are changing. Traditional energy generation methods that rely on finite resources like fossil fuels are becoming increasingly expensive. In addition, they pollute and destabilize the environment. With more of this awareness, consumers are demanding clean energy at lower prices and increasing capacity.

To meet this demand, energy providers have to shift to cleaner and more efficient sources. This, in turn, is driving the demand for low-cost, long-life energy storage with larger capacities and higher energy density. Unfortunately, the current electrochemical energy storage technology has its limitations in meeting that demand.

Although research and development in energy storage materials have yielded some improvements, the development process is not swift enough to support the growth of top-demanding industries, such as the electric utility and e-mobility industries.

In 2020, there were over 10 million EVs on the road globally. By 2030, IEA estimates that there will be up to 30 times more [1]. This poses a challenge for utilities on which EVs depend, as charging EVs can potentially double the home's load.

EV stock, cars, World, SDS scenario 2020–2030



BEVs are battery electric vehicles. PHEVs are plug-in hybrid electric vehicles. EVs refers to all electric vehicles (BEVs +PHEVs).

Source: IEA. Data

In addition to this, utilities need to produce 92% of power from renewable technologies to meet net-zero emissions by 2050[2]. To support this demand with renewable energy, utility companies need to invest in Battery Energy Storage Systems (BESS), which require optimization to realize a higher return on investment.

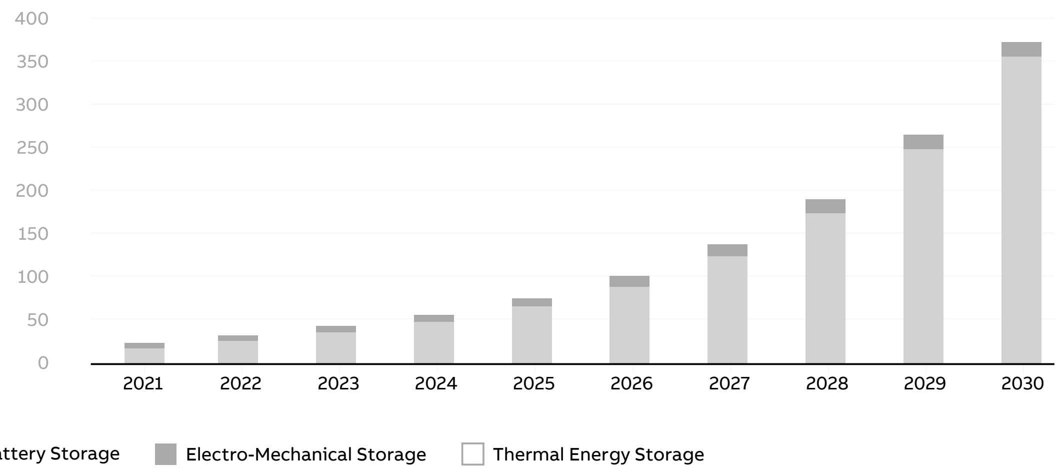
Megatrends in the Future of Energy: The 3D's

Devices such as sensors, robotics, handheld computers and additive manufacturing, coupled with software advances, including artificial intelligence (AI), virtual reality (VR), and augmented reality (AR), bring digitalization to equipment design, operation and maintenance.

For example, the utility industry is increasing its adoption of digitalization strategies to boost business revenue, as well as reduce costs via optimization and efficiency. In the U.S., specifically, utilities are investing in grid modernization to improve reliability and are on track to install 4.7GW/13.1GWh of energy storage projects in 2021[3]. This is four times more than 2020 additions.

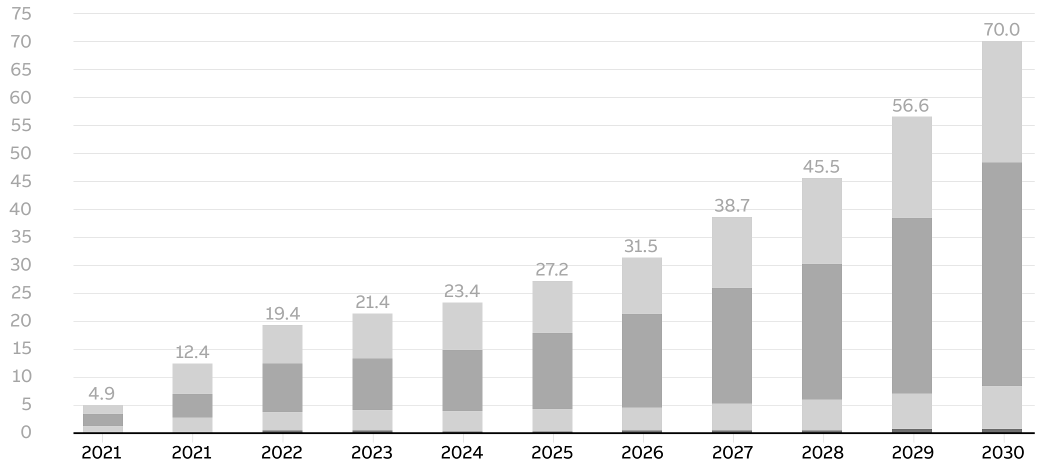
According to GlobalData and Wood Mackenzie, the global energy storage industry is expected to reach a cumulative capacity of more than 350GW and cumulative energy installed of 950GWh by 2030. The industry will experience a compound growth rates of 30% in capacity additions and 35% in energy additions until 2030.

Cumulative installed capacity (GW) by technology in major markets 2021–2030



Source: GlobalData

Global energy storage annual capacity, GW



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Source: Wood Mackenzie

One major driver for this growth is the decrease in the cost of solar. Another is going to be the e-mobility industry, because the increasing load on the grid will follow EV trends[6]. As people use more EVs with longer ranges and faster charging times, there will be more medium voltage (MV) and low voltage (LV) grid connections with energy storage to support fast charging requirements and resolve grid constraint issues.

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The time is now to leverage these opportunities to improve the competitive position and consider additional business models. — Alexandra Goodson, Global Product Marketing Manager, Energy Storage Solutions at ABB.

These changes are powering the megatrends globally that are defined by the 3D's: decentralization, decarbonization and digitalization.

Decentralization
Today, we are seeing more on-site generation – making customers active elements in the grid. There is also a rise in microgrids being powered by the growth in solar and wind integration. Although this boosts response to energy demand, a lot of coordination is required to ensure stability and alignment between generation and demand.

Decarbonization
In our effort to limit global warming and lower CO2 levels, our energy generation and consumption habits are adjusting to a low-emission strategy. However, decarbonization puts additional pressure on the grid. This results in more renewable energy penetration, which can help meet 90% of the carbon emission goals and the adoption of electrification in transportation. Although renewables can augment these increased peak demands, their variable supply does not allow for total dependence.

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Smart is new green

Digitalization
Smart is the new green. To meet our decarbonization goals, we have to allow real-time automated communication and operation of energy systems. This helps us make the most of our resources by tailoring generation, supply and storage around our habits and other external patterns. According to the World Economic Forum, the electricity sector will capture over $1.3 trillion of value from digitalization.

Adapting to the Future of Energy

In order to adapt to the future of energy, energy storage can be used to balance the increasing peak demands and support the variability in renewables. It can also help to postpone investments in grid upgrades and support modern business models.

Grid modernization and digitalization with energy storage are the keys to achieving low-carbon emissions targets, and in the process, make 50% of renewables viable by 2050.

Through digitalization, ABB's AI solution provides an optimal operation of battery energy storage for increased battery life and return on investment.

Digitally Enabled Battery Energy Storage System (BESS)

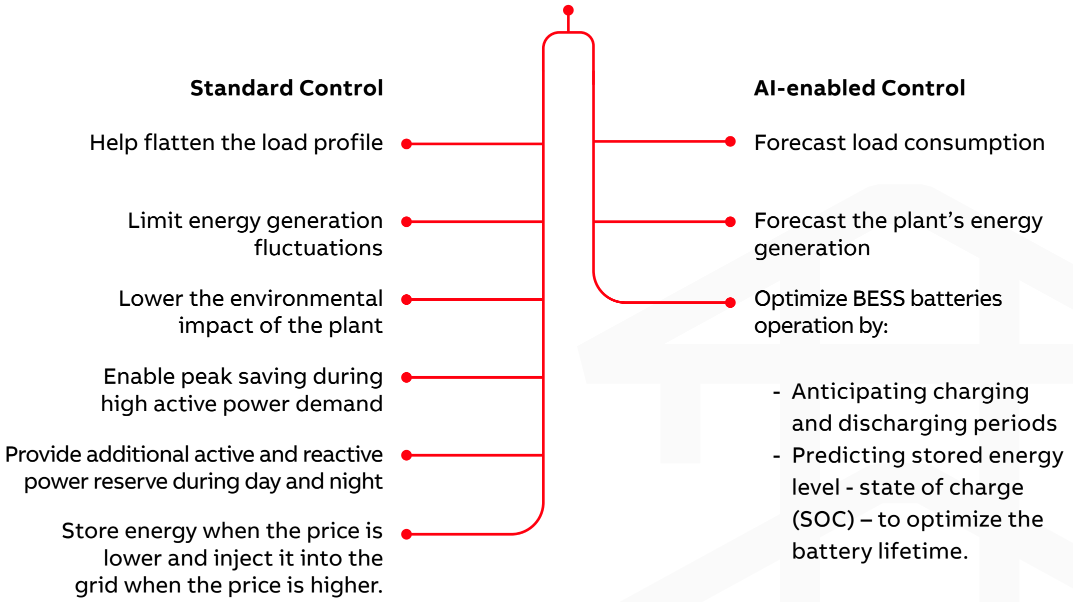
A Battery Energy Story System (BESS) is a generic industry name for equipment (or a collection of that equipment) that stores energy in batteries for later use. These systems include batteries, a battery management system, an inverter, switchgear, a transformer and a control and protection system.

BESS is integrated with renewable energy sources in storing energy during peak production and supplying the stored energy when it is needed.

A digitally enabled version of this system is equipped with an energy management system (EMS) and monitoring and diagnostics systems that are available via on-premise, edge and cloud solutions.

Digitalization brings grid support, substation automation and multi-energy optimization to these systems. Data management is hosted on either private clouds or corporate clouds to allow for analytics and reports, artificial intelligence and cybersecurity.

BESS integrated with renewable power plant



AI for BESS: where it starts

To predict energy consumption, we start with true data collected from the field on the original power profile. We can then calculate the energy demand by summing up the power over time. This is going to be the key factor for training and making the predictions through machine learning. With this, it is possible to generate the energy profile, as well as the power profile. These all go into producing accurate predictions via agile calculations.

Energy forecasting

With AI, you can obtain real energy consumption predictions for the next 24 hours and also investigate data seasonality. With weather data added, it forecasts multivariate time series and can verify the correlation between them.

Considering the amount of data induced, it is important to be careful to minimize information loss by opting for hybrid data. We have to feed long-term sequences into these machine learning or statistical models, such as monthly sequences, but it is most critical to model extreme events like anomaly detection, such as in a hurricane or a temperature sensor failure.

Battery aging and storage capacity optimization

We need to predict and increase the battery's lifetime based on its operation under optimal conditions. The mechanism of battery aging is of two types: calendar aging and cycle aging. Calendar aging is impacted by the state of charge of the batteries, while cycle aging is impacted by the C-rate, that is, the rate of discharge or charge as compared to the capacity of the battery.

At ABB, we characterize the cells in our laboratories to understand their calendar and cycle aging behavior before they are deployed to the site. All that real data is used to train our AI system to recommend the optimal BESS operating conditions. We can also use this to calculate more accurate operating capacity in future installations.

How do we incorporate AI

The AI is designed to be fully modular and fit into different applications easily. It outputs the recommended operating parameters for the BESS. The AI module is made up of the data acquisition module, prediction module, simulations module and optimization module. It is enabled with remote access or cloud connectivity for updating, retraining or supervision by an external operator if needed.

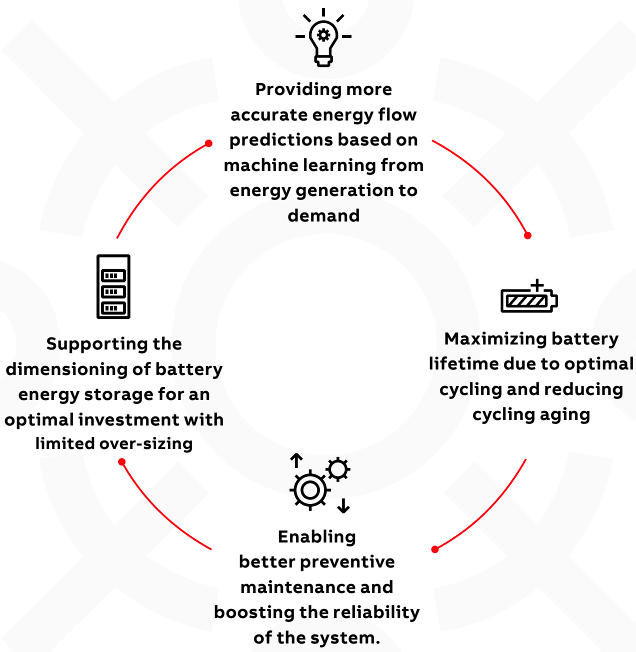
With this module, we've developed an application for sizing the battery energy storage and running optimization in real-time. Its operating process involves:

- Creating daily event lists based on default settings or customized setting
- Calculating daily load profile based on daily events (by automatically converting single event files to time vs power domain)
- Generating future events by neural networks based on the event list generated in the first step.
- Producing histogram data (the cumulative characteristic for selecting the most representative load profile), and finally,
- Simulating the BESS optimal operating conditions.

Summary

Tools like the one mentioned above can be used to simulate the BESS capacity for any renewable energy plant. The input data can come from a similar plant and be applied through the AI module to find the optimal configuration of the system. This helps achieve the best sizing of the battery energy storage systems in the plant.

Incorporating AI into the battery energy storage industry is game-changing!



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Ultimately, artificial intelligence is vital to improve the return on investment in energy storage as we position to support the future of energy - Carlos Nieto, Global Product Line Manager, Energy Storage at ABB.

References

1. "Global EV Outlook 2020 – Analysis". IEA, Jun 2021. https://www.iea.org/reports/global-ev-outlook-2020

2. "Theme Report On Energy Transition – Towards the Achievement of SDG 7 and Net-Zero Emissions". United Nations, 2021. https://www.un.org/sites/un2.un.org/files/2021-twg_2-062321.pdf

3. "2H 2021 Energy Storage Market Outlook, Leap ahead". BloombergNEF, 28 Jul 2021.

4. "2020 Long-Term Energy Storage Outlook". BloombergNEF, 14 Dec 2020.

5. "2H 2021 Energy Storage Market Outlook, Leap ahead". BloombergNEF, 28 Jul 2021.

6. "Energy Storage System Providers 2021: Key Trends, Overview and industry trends". Kou, Helen and Li, Daixin, BloombergNEF, 28 Jun 2021.

7. "Electricity: Uncovering Value through Digital Transformation". World Economic Forum, Global Competitiveness Index 2017–2018

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