

HONEYWELL FLOW BATTERY STORAGE



Honeywell

KEY TRENDS DRIVING THE NEED FOR ADVANCED ENERGY STORAGE AND DIGITALIZATION

The global electricity demand is expected to grow substantially by 2050, driven by population growth, urbanization, industrialization, and electrification of end-use sectors. At the same time, the global energy system is undergoing a fundamental transformation as countries pursue low-carbon and sustainable development goals and increase their share of variable renewable energy sources (VRES), such as wind and solar, in their generation mix. These trends pose significant challenges and opportunities for the design and operation of the electricity grid, which needs to ensure a reliable, affordable, and secure power supply while integrating high levels of VRES, managing peak demand, and enhancing resilience to extreme events and cyberattacks.

FIGURE 1

Historical and Projected Wind and Solar Generation through 2050

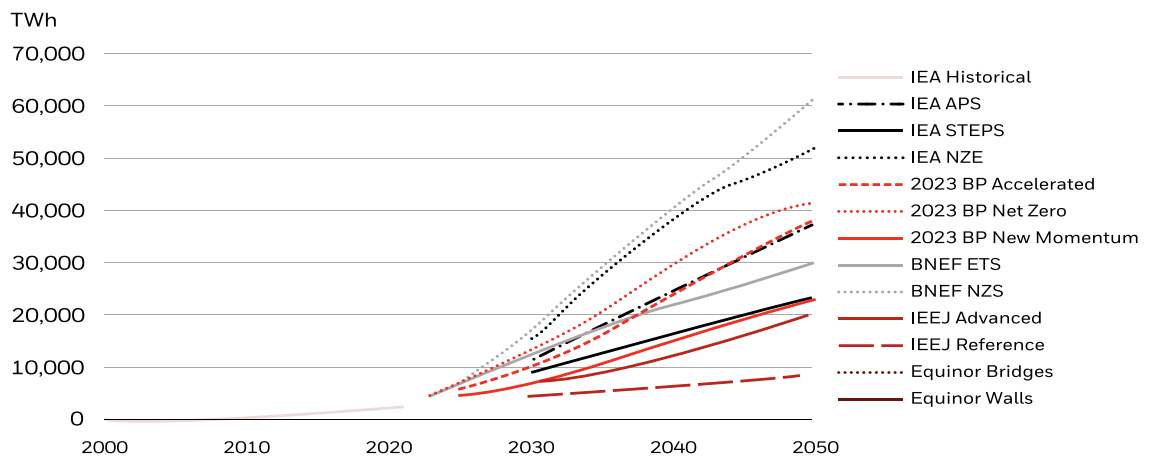
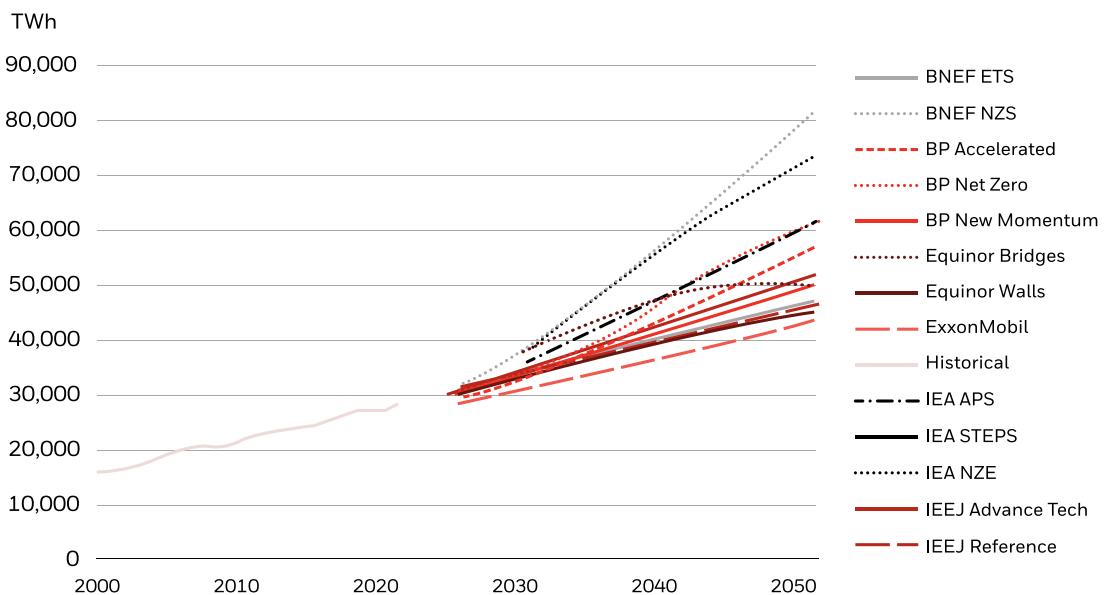


FIGURE 2

World Electricity Generation, All Sources



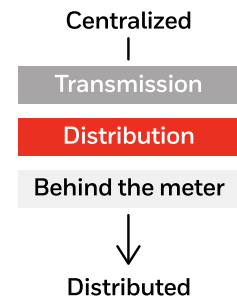
Energy storage is a vital enabler of this transition, as it can provide various services to the grid, such as frequency regulation, voltage support, ramping, reserve, peak shaving, load shifting, renewable integration, and resilience. Energy storage can also create new revenue streams for grid operators, utilities, and customers by participating in wholesale, ancillary, and capacity markets and providing behind-the-meter and off-grid solutions. However, not all energy storage technologies are suitable for all applications, as they differ in terms of their technical characteristics, such as power rating, energy capacity, discharge duration, round-trip efficiency, cycle life, and cost.

FIGURE 3

Battery Storage Use Cases



Batteries can provide up to 13 services to three stakeholder groups



As we navigate the complexities of the 21st century's energy landscape, several converging trends underscore the urgent need for enhanced energy storage solutions and the digitalization of energy systems. Honeywell, at the forefront of innovation, identifies these trends as critical to shaping the future of sustainable energy management.

INCREASING RENEWABLES AND DEMAND FOR CLEAN ENERGY

The penetration of renewable energy sources is increasing at an unprecedented pace. As society gravitates towards cleaner energy, decarbonizing commercial, industrial, transport, and heat sectors becomes imperative. This shift reflects a commitment to environmental stewardship and aligns with the evolving regulatory frameworks and consumer expectations demanding sustainable practices.

GREATER FLEXIBILITY NEEDED

The energy sector is transforming, characterized by an influx of renewable sources and a decline in traditional

synchronous machines on the grid. This evolution calls for greater flexibility in energy systems, prompting utilities to explore alternative models for procuring flexibility services. Moreover, the need for innovative energy solutions that can provide such flexibility without compromising reliability is becoming increasingly apparent.

TECHNOLOGY ADVANCEMENTS

Technological advancements have dramatically reduced the cost of lithium-ion (Li-ion) batteries over the past decade, making them more accessible. However, the industry is exploring alternatives to Li-ion batteries, particularly for long-duration energy storage solutions. Software advancements are pivotal in unlocking

the real value and flexibility of energy assets, demonstrating digitalization's integral role in maximizing the potential of energy storage technologies.

RELIABILITY/RESILIENCY

Grid stability and reliability continue to be significant global concerns, affecting both developed and developing regions. The need for robust and resilient energy storage solutions becomes critical as energy systems become more complex and interconnected. Ensuring continuous and reliable power supply in the face of varying demand and generation capacities is a crucial driver for developing and implementing advanced energy storage systems.

HONEYWELL'S INNOVATION IN ENERGY STORAGE: THE FLOW BATTERY

Honeywell introduces an advanced approach to energy storage with its flow battery technology. Honeywell's flow battery combines efficiency with environmental consciousness and is designed to meet the demands of modern energy systems.

ACCELERATE THE PROFITABLE SHIFT TO CLEAN ENERGY

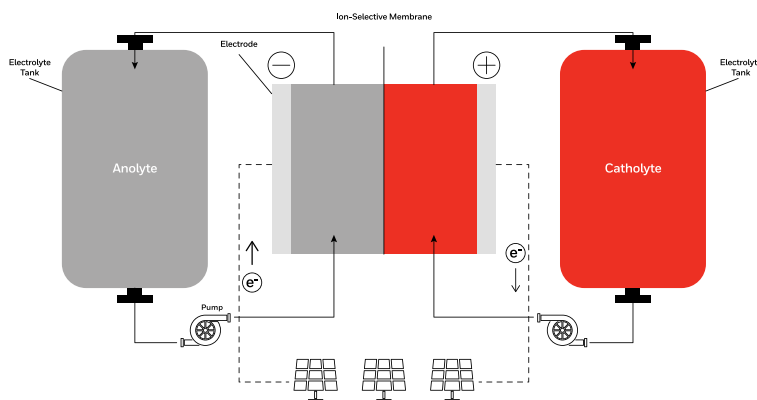
In a world that strives to be more energy-efficient, finding the proper energy storage solutions has become a top priority for companies and customers across the globe. The stakes are high, and so is Honeywell's determination to become a pioneer in the field and establish a new benchmark. UOP's expertise in chemistry and materials science allowed us to develop an innovative battery technology that uses more economical and readily available materials.

BENEFITS

- Sustainable
- Profitable
- No Stack Capacity Degradation
- Non-Flammable
- Decoupled
- Bankable
- 24/7
- Long Duration
- 20 Years Calendar Life
- Modular
- Scalable
- Easy to Source Materials
- On-Demand Monitoring

HONEYWELL UOP LONG DURATION ENERGY STORAGE
Addresses the intermittency of wind and solar and increases grid resiliency

- 100+ YEARS IN CHEMISTRY
- 40+ YEARS IN MEMBRANES
- 2,000 ENGINEERS AND SCIENTISTS
- 4,500 ACTIVE PATENTS AND APPLICATIONS



THE TECHNICAL PROCESS

Electricity from external sources is used to induce a reversible chemical reaction within the flow battery. This reaction occurs in two separate tanks containing electrolytes with dissolved active materials. When energy is needed, the electrolyte flows from these tanks into a cell stack, where the electrochemical reaction is reversed, releasing stored energy as electricity.

HONEYWELL'S PROPRIETARY TECHNOLOGY

Honeywell's flow battery features a nonflammable electrolyte, prioritizing safety and sustainability. The system uses recyclable components and materials that are easy to source, reducing the environmental impact.

A proprietary membrane, a central component of Honeywell's flow battery, is optimized to work with an advanced electrolyte system, enhancing the overall efficiency of the energy storage process.

ADVANTAGES OF HONEYWELL'S FLOW BATTERY

Honeywell's flow battery technology offers several compelling benefits, including:

Long Duration: The flow battery's design allows for extended hours of operation, providing flexibility to meet varying energy demands. Honeywell is targeting 8-12 hour range.

High Cycle Frequency: It can be cycled multiple times per day, making it ideal for applications with high energy turnover.

Modularity: The system is decoupled and modular, allowing for scalability and ease of maintenance.

Durability: With a lifespan of over 20 years, Honeywell's flow battery offers longevity, reducing the need for frequent replacements and lowering long-term costs.

Cost Effectiveness: It improves the Levelized Cost of Storage (LCOS), offering a more economical storage solution over time.

Safety and Sustainability: The nonflammable electrolyte and lack of degradation enables safe operation and consistent performance without capacity loss.

HONEYWELL AND ESS INC.: FORGING THE FUTURE OF ENERGY STORAGE

Honeywell has partnered with ESS Inc. in a groundbreaking collaboration that aims to redefine the energy storage sector. This strategic alliance is poised to accelerate the advancement of iron flow battery (IFB) technology, marking a significant step towards sustainable and reliable energy solutions. The collaboration between Honeywell and ESS Inc. is more than a technical alliance; it is a collaboration that supports the global transition to a low-carbon, sustainable energy future. By advancing IFB technology and integrating it with state-of-the-art controls, this collaboration drives innovation in the energy storage space, offering a scalable, safe, and sustainable solution to meet the world's growing energy demands.



STRATEGIC COLLABORATION

At the heart of the collaboration is a commitment to advance IFB technology through concerted technical and R&D collaboration. Honeywell and ESS Inc. are working together to fast-track the deployment of these innovative storage systems. By combining Honeywell's IFB know-how, membrane capabilities, sophisticated controls and remote operation capabilities with ESS Inc.'s cutting-edge technology and cell fabrication capability, they are setting new standards for energy storage solutions.

SCALABILITY

A successfully demonstrated long-duration flow battery at 75 kW (400 kWh) is in place and advancing toward larger-scale (MW) energy solutions. The new modular design is intended to scale up to over 100+ MW, using 200 kW modules to meet the growing demands for substantial, reliable energy storage.

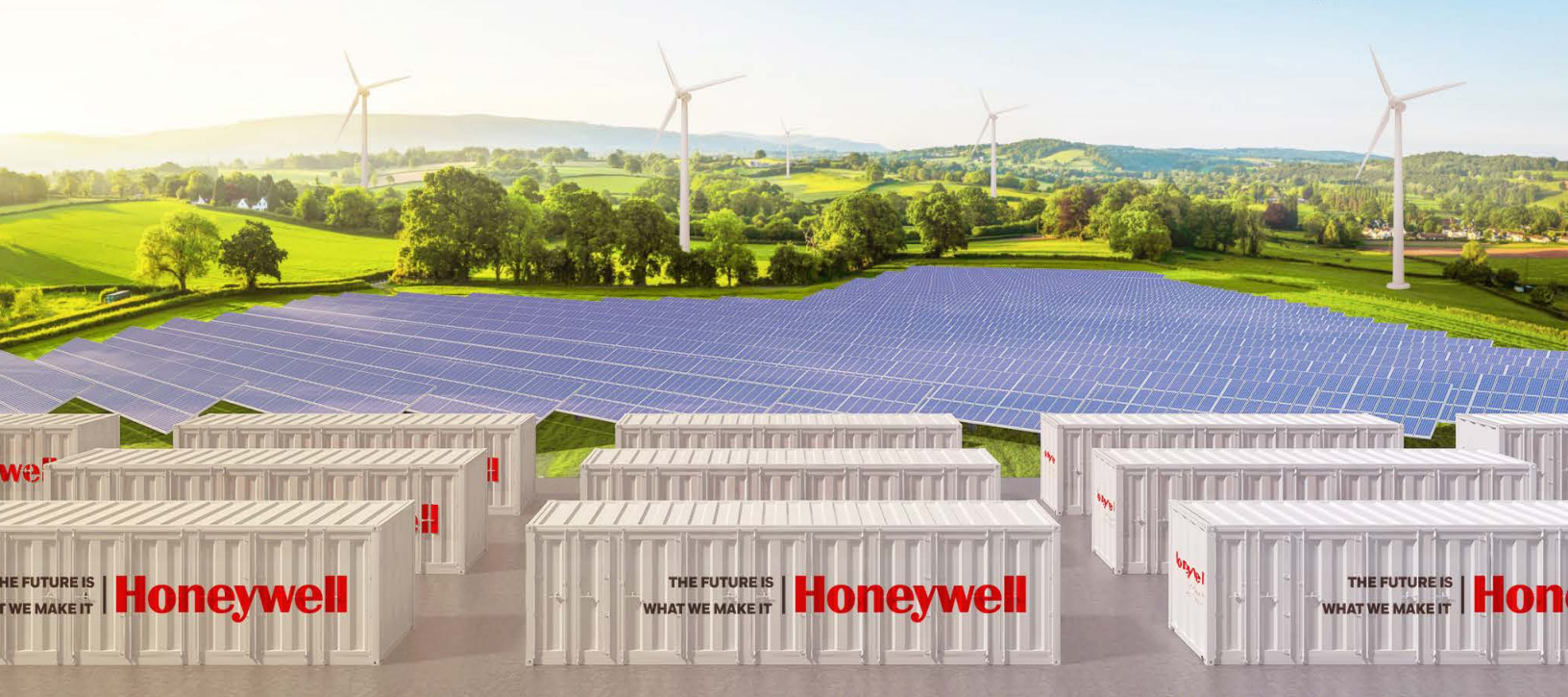
SUSTAINABLE AND SAFE TECHNOLOGY

The collaboration strongly emphasizes sustainability and safety. IFB technology utilizes abundant materials like iron, salt, and water, which are more sustainable and offer a safer energy storage option compared to traditional batteries. This focus on environmentally friendly materials underscores Honeywell and ESS Inc.'s commitment to eco-conscious innovation.

SOPHISTICATED CONTROLS AND REMOTE OPERATIONS

A cornerstone of this collaboration is the integration of sophisticated control systems and the ability to operate these energy storage systems remotely. Honeywell's expertise in controls and automation is leveraged to enhance the efficiency and reliability of ESS Inc.'s iron flow batteries, providing a seamless interface for energy management.





HONEYWELL'S COMPREHENSIVE END-TO-END BATTERY STORAGE SOLUTIONS

Honeywell's suite of energy solutions exemplifies a holistic approach to energy storage, providing an end-to-end service encompassing the entire project lifecycle from initial consulting to post-project support.

THE HONEYWELL OFFER

Honeywell's comprehensive offering provides clients with a complete end-to-end energy storage solution that meets their needs.

Power Conversion: State-of-the-art power conversion systems that enables the reliability and efficiency of energy storage solutions.

Safety and Security: Integrated fire/gas detection and fire suppression systems, physical security, and HVAC to protect assets and enable operational safety.

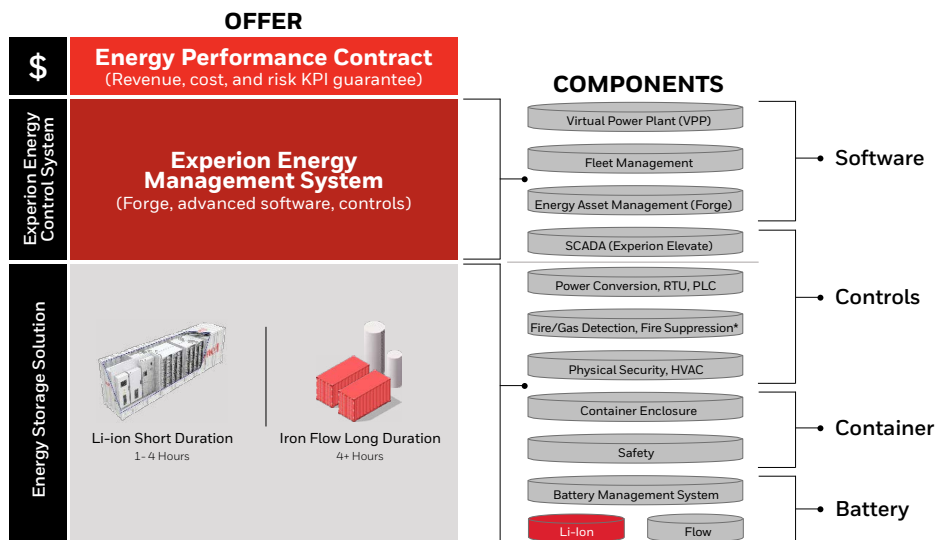
CRITICAL COMPONENTS OF HONEYWELL'S SOLUTIONS

The solutions are built on a foundation of advanced components tailored to enhance energy storage systems:

Virtual Power Plant (VPP): Leveraging software to manage and aggregate diverse energy assets for improved efficiency and grid support.

Fleet Management: Advanced tools for managing a fleet of energy assets, ensuring optimal performance and longevity.

SCADA (Experion Elevate): A scalable supervisory control and data acquisition system that elevates energy systems' control and monitoring capabilities.



Battery Management: Sophisticated battery management systems that monitor and manage the health and efficiency of Li-ion and flow batteries.

Honeywell offers two types of battery technologies:

Li-ion Batteries: Ideal for short-duration storage needs, typically less than 4 hours.

Flow Batteries: Suitable for long-duration storage requirements, extending beyond 4 hours.

Hybrid batteries: combines the efficiency of lithium-ion batteries for short-duration energy storage with the capacity of flow batteries for long-duration applications. This integration optimizes grid performance by addressing quick fluctuations, short-term demand spikes, and providing reliable backup during prolonged energy demands or peak usage times.

PHASED APPROACH TO PROJECT DELIVERY

Honeywell's approach to project delivery is segmented into three distinct phases:

PRE-PROJECT (CONSULTING)

The journey begins with a thorough understanding and auditing of client needs, which includes:

Needs Assessment: A detailed evaluation to understand the client's specific requirements.

Site Assessment: Comprehensive site analysis to evaluate suitability for energy storage solutions.

Conceptual Design: Crafting the initial design that aligns with the client's energy goals.

Business Case Development:

Establishing a solid business rationale for the energy storage project.

PROJECT EXECUTION

Honeywell takes charge of the full spectrum of project execution, which includes:

Whole System Design: A complete energy storage system design tailored to client specifications.

Integration with EMS: Seamless storage system integration with Honeywell's Experion Energy Control System, including applications like microgrids and VPPs.

POST-PROJECT

After project completion, Honeywell offers comprehensive ongoing support.

O&M Packages: Long-term operation and maintenance packages for sustained system performance.

Remote Monitoring: Continuous remote monitoring capabilities to enable system health and efficiency.

Warranty and Maintenance: Comprehensive warranty packages coupled with maintenance services.

ABOUT HONEYWELL

Honeywell has a century of experience developing ready-now solutions, to support environmental, safety, security and productivity objectives. We are helping customers develop energy storage through innovative batteries that fully leverage the generation capabilities of renewable energy sources. Advancements in grid-scale BESS effectively supports the introduction of higher levels of renewables into the mix. Honeywell is a technology company that delivers industry specific solutions that include aerospace products and services; control technologies for buildings and industry; and performance materials globally. Our technologies help everything from aircraft, buildings, manufacturing plants, supply chains, and workers become more connected to make our world smarter, safer, and more sustainable.

For more information

www.honeywell.com

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THE
FUTURE
IS
WHAT
WE
MAKE IT

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