North American Essential Home Backup Industry White Paper

Essential Home Backup (EHB):
Powering Safety, Sustainability, and Smart Living

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FROST & SULLIVAN
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White Paper Key Insights

Definition

- **Essential Home Backup (EHB)** refers to an integrated home energy solution that combines **solar photovoltaic (PV) generation, energy storage systems, and smart energy management**. It seamlessly handles power generation, storage, and usage for emergency backup, daily optimization, and green energy needs.

Core Value

- EHB delivers three core benefits: **uninterrupted power supply during outages**, ensuring energy reliability; **enhanced energy self-sufficiency**, improving cost efficiency; **sustainable living with added advantages** such as property appreciation and financial incentives.

Market Status

- The EHB market is driving steady growth in North American residential energy storage sector. With competitive advantages in **technical efficiency, cost-effectiveness, and system compatibility**, EHB solutions are emerging as critical infrastructure for modern home energy management.

Growth Drivers

- Three key drivers fuel the North American EHB market growth: **power stability concerns, electricity cost pressures, policy incentives, and technological advancements**. These growth drivers are accelerating rapid market expansion across North American EHB sector.

Future Trends

- The North American EHB market is evolving along three key trajectories: **household energy independence, intelligent system integration, and renewable energy convergence**. Energy independence is emerging as a critical strategy for households to address power crises, while AI-driven energy management is optimizing system autonomy.

Benchmark Solution

- As **the global leader in portable energy storage and pioneer of EHB solutions**, **Hello Tech's Jackery brand is redefining the benchmark for EHB systems**. Jackery's product portfolio delivers EHB solutions across all usage scenarios, ensuring reliable power supply for critical household appliances and complete home emergency power needs.

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The power stability concerns and the rising electricity prices makes the reliable and economic energy solutions a key focus in North America

Aging power infrastructure

More than 70% of grid in the U.S. is more than 25 years, rendering it inadequate for the high-load with failure rates rising exponentially over time.

Extreme weather and natural disasters

In recent years, multiple large-scale power outages caused by extreme weather and natural disasters such as wildfires, blizzards and floods, with the average of power duration reaching record high.

Rising electricity prices

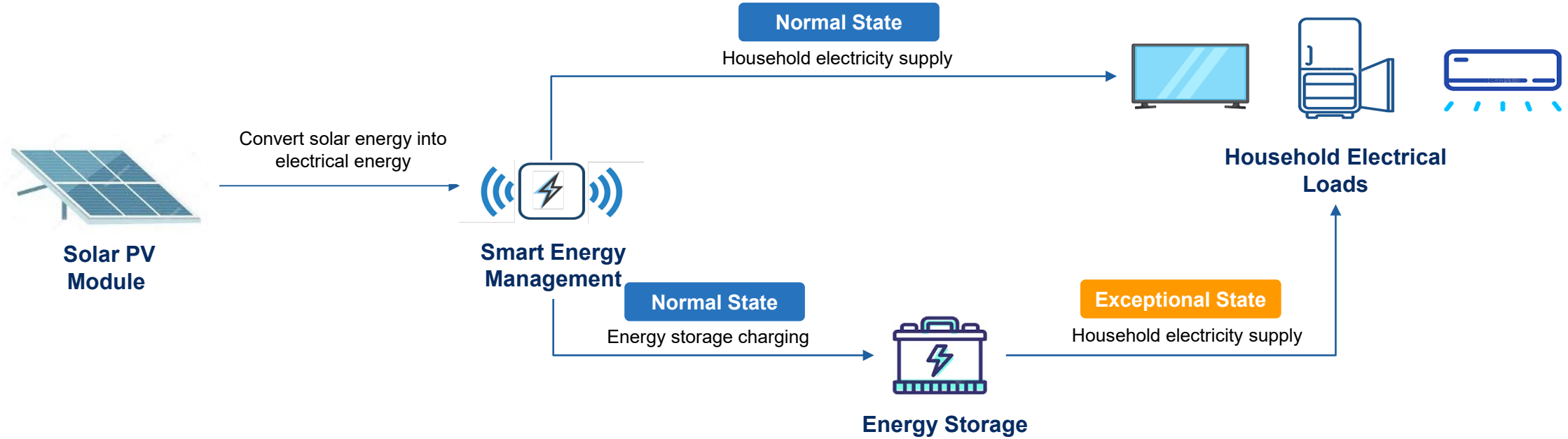
Driven by fluctuations in natural gas and other energy prices, electricity expenses across the U.S. have shown an overall upward trend, significantly impacting family living costs.

EHB, an integrated family energy solution with reliability and cost-effectiveness, is becoming a key choice for consumers to cope with the dilemma of electricity stability and optimize electricity costs.

Source: expert interviews, public information, Frost & Sullivan

EHB：Integrated family energy solution of solar PV module, energy storage and smart energy management

EHB is an integrated family energy solution of solar photovoltaics(PV) module, energy storage and smart energy management, combining of electricity generation, energy storage and electricity utilization. EHB covers the needs of emergency power outage, daily electricity optimization and green energy management and provides backup power for families, guaranteeing emergency demands of electricity and achieving energy independence in daily life.



Green electricity generation	Intelligent storage strategy	Safe electricity supply
Solar PV module can provide a green and stable power source and maintain steady operation in extreme environments.	Energy storage with large capacity can adjust the energy strategy under various conditions, providing backup power and guaranteeing emergency demands of electricity.	Smart energy management can carry out the intelligent distribution of electricity and optimize energy utilization efficiency.

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Source: expert interviews, public information, Frost & Sullivan

EHB provides diverse and stable home backup power solutions for different loads in various scenarios

Category	Core Functions	Examples
EHB for Critical Loads	■ **Flexible and diverse power input** according to specific needs through the utility power and solar energy ■ **Stable and reliable electricity supply** for the core loads under power outage and other emergency conditions ■ **Adaption to critical loads** including refrigerators, heating appliances and pumps to maintain steady operation in off-grid conditions	
EHB for Individual Appliances	■ **Timely and stable electricity supply** for outdoor activities, emergency backup and daily household electricity ■ **Reliable and Continuous electricity supply** for critical household power loads in the situations of sudden cut-off	
EHB for Outdoor Adventures and Entertainments	■ **Flexible applications** with small volume and weight, easy to carry, providing emergency electricity supply in various outdoor and home scenarios.	
Whole-Home Backup	■ **Green power infrastructure for family** providing reliable and stable electricity supply for the whole-home electrical loads	

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Source: expert interviews, public information, Frost & Sullivan

EHB can provide uninterrupted and stable power supply during outages caused by extreme weather and natural disasters, significantly enhancing household power reliability

Scenario	Core value	Actual scenario
Extreme weather	■ Energy storage has been optimized for continuous power delivery in high-temperature conditions, ensuring stable electricity output under elevated ambient environment.	■ In 2025, Arizona experienced large-scale power outages due to heatwave.
	■ Solar PV module employs functional enhancement in low-temperature conditions, and energy storage with active thermal control and predictive insulation ensures stable operation and continuous power supply.	■ In 2021, Texas suffered a collapse of utility power caused by extreme cold, resulting in 2.4 million power outages and affecting millions of residents.
Natural disasters	■ Energy storage with enhanced structural protection can maintain reliable operation in submerged conditions and provide uninterrupted power supply during floods.	■ In April 2025, severe thunderstorms and floods across the central and eastern United States led to numerous power outages.
	■ Energy storage employs high-rigidity enclosure for seismic vibrations, along with modular battery fixation to minimize displacement and reduce the risk of detachment.	■ In December 2022, a magnitude 6.4 earthquake struck northern California, leading to power outages of over ten thousands households.

Source: expert interviews, public information, Frost & Sullivan

EHB can promote household energy self-sufficiency, and cost-effectiveness, while continuously shorten payback period will further elevate the economic value of EHB

Dimension	Core value	Practical case
Reduced electricity costs	■ EHB builds an electricity system of self-generation and self-consumption with the combination of solar PV module and energy storage，significantly enhancing energy self-sufficiency, reducing reliance on the utility power and lowering overall electricity costs.	■ EHB with solar PV module and energy storage can raise household self-sufficiency rate in power to 70% , substantially reducing dependence on the utility power.
	■ EHB adopts flexible energy management strategy by taking advantages of peak-valley electricity price differences to reduce the average cost of household electricity usage.	■ In California，the peak energy charge for residential customers can be 2 to 3 times higher than the off-peak energy charge according to PG&E's standard. Significant cost savings can be achieved through the buy-low, sell-high strategy.
Shortened payback period	■ With the decline in costs of solar PV and energy storage and the support from government incentives, the cost per unit of electricity generation by EHB is decreasing and the payback period is shortening. EHB is shifting from an optional equipment to critical infrastructure for modern home energy management.。	■ The stable decline in the cost of energy storage batteries has driven the cost optimization of the entire energy storage system, reducing the initial investment cost.
		■ The *Inflation Reduction Act introduced by* the U.S. federal government in 2022, increased the tax credit rate for residential energy storage from 26% to 30%, and allowed separate energy storage to qualify for subsidies.

Source: expert interviews, public information, Frost & Sullivan

EHB offers a solution of green energy and an environmental-friendly lifestyle with added advantages such as property appreciation and financial incentives

Dimension	Core value	Practical case
Environmental-friendly	■ EHB deploys solar power resources instead of high-carbon resources such as diesel to reduce household carbon emissions.	■ In 2023, New York state launched an incentive program, offering financial support for the installation of solar PV and energy storage.
	■ Aligning with subsidies for residential energy storage and carbon neutrality policies, EHB offers families an option to keep in line with energy policies.	■ The U.S. Environmental Protection Agency (EPA) initiated *Clean Energy Homes* to encourage households to adopt clean energy solutions such as solar PV and energy storage.
	■ EHB reflects the conception of energy-saving and low-carbon lifestyle, satisfying the family's expectations for a green and environmental-friendly living environment.	
Added advantages	■ Residentials with solar PV and energy storage are more competitive in the market, proven to have greater potential for appreciation in real estate transactions.	■ According to the research data from Solar Reviews in 2025, households equipped with solar PV and energy storage have an average selling price advantages of 6.9%.
	■ Residentials with solar PV and energy storage will enjoy benefits from financial incentives including green loans and insurance discounts, after satisfying the requirements for green ratings and obtaining green building certifications.	

Source: expert interviews, public information, Frost & Sullivan

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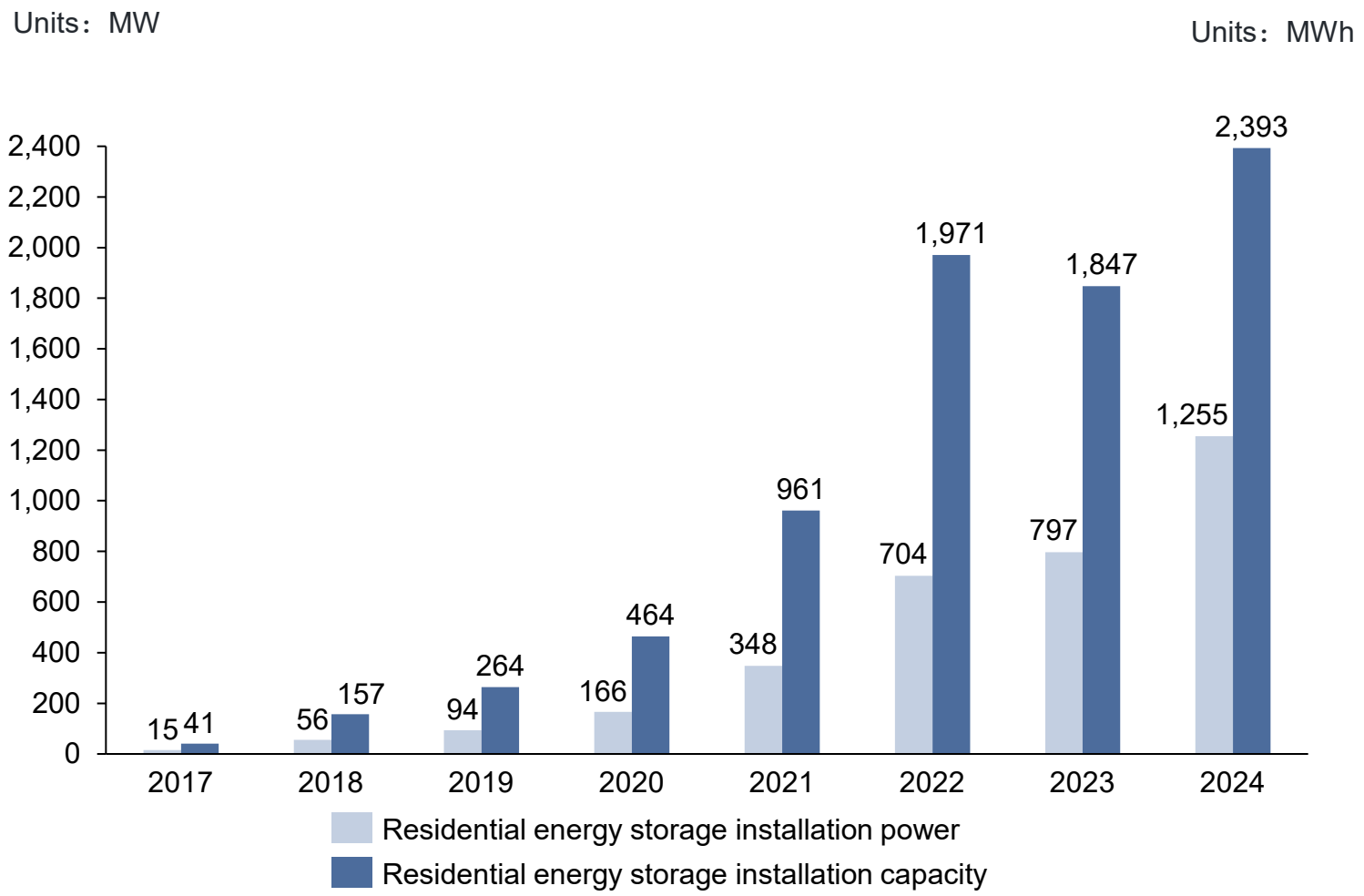
Under the steady growth of the North American residential energy storage market, EHB is gradually becoming the critical infrastructure for modern home energy management

The U.S. residential energy storage market installations，2017 - 2024



Market Insight

- **The United States is one of largest residential energy storage market in the world.** Driven by the reduction in installation costs, policy incentives and power stability concerns, **the scale of the U.S. residential energy storage market installation maintains the trend of steady growth**, while the CAGRs from 2017 to 2024 of the installation power and the installation capacity are 88.2% and 78.8%.
- **Technical efficiency, cost-effectiveness and system compatibility** are the focus point of the market. The instability of the utility power brought by the frequent natural disasters fosters the growth of demand for residential energy storage solutions. Enterprises are devoting to the exploration of diversified products and services to satisfy demands for different scenarios of residential energy storage.
- **With comprehensive advantages in power stability, cost-effectiveness and smart energy management,** EHB is gradually becoming the critical infrastructure for modern home energy management by promoting household energy self-sufficiency.

Source: expert interviews, public information, Frost & Sullivan

California has the largest PV deployment and the most mature residential energy storage market in the U.S., exploring advanced market mechanisms and business models

Market Status

- **California has the highest PV penetration rate** in the U.S.. In 2024, the cumulative installed PV capacity in California reached 50.6GW, and the proportion of PV power generation in the total power generation in the state reached 32.4%, maintaining the leadership in North America.
- **California residential energy storage market is with high maturity and activeness** in market mechanisms. In 2024 Q3, the deployment of residential energy storage in California accounted for 62% of the total deployment in the U.S..
- The following factors have driven the growth of the residential energy storage market in California:
  - **Rich solar energy sources** with an average of 300 days of sunshine per year, suitable for the PV deployment
  - **Implementation of NEM3.0** which elevates the profit margin of integrated solutions of PV and residential energy storage
  - **The aggregation mechanism** driving small energy storages to form virtual power plants(VPP), expanding the profit path and increasing the willingness of residential energy storage deployment

Market Case

- Sunrun is one of the largest solar PV and energy storage service provider in the U.S., offering families a suite of residential solar PV and energy storage products, including solar panels, batteries, and smart monitoring platforms with a variety of service modes.
- The core business mode of Sunrun is providing diversified residential solar PV and energy storage services through different charging methods, lowering the investment threshold. With innovative mechanisms such as virtual power plants, it fully releases the grid synergy value of distributed energy, driving the market expansion of residential solar and energy storage.

Product Portfolio


PV Module


Energy Storage


Smart energy Management


Charging Pile

Pricing model

- Full payment
- Installment loan
- Equipment loan
- PPA

Market Players

- There are three types of market players: equipment suppliers, integrators, and aggregators. Equipment suppliers provide PV and residential energy storage equipment. Integrators provide integrated solutions including installation, operation and maintenance. Aggregators provide profit solutions by integrating residential energy storage of clients through VPP and other market mechanisms.

Equipment supplier: TESLA, swell, solaredge

Integrator: SUNRUN, sonnen, vivint.Solar

Aggregator: PENINSULA CLEAN ENERGY, CPA CLEAN POWER ALLIANCE

Source: expert interviews, public information, Frost & Sullivan

Texas is experiencing the powerful growth of residential energy storage deployment, equipment suppliers as Tesla is exploring the strategy of eco-energy communities.

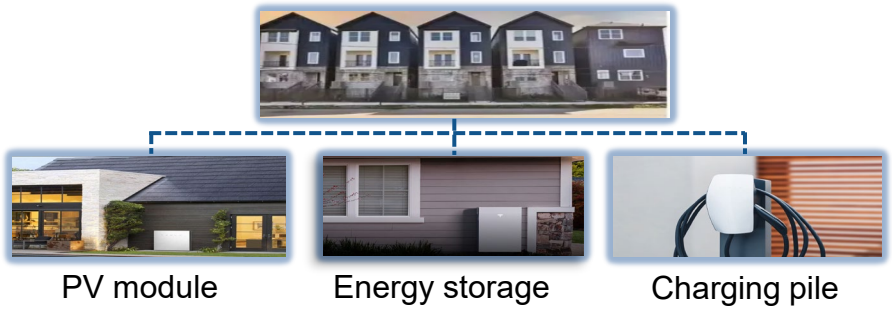
Market status

- **Texas is one of the largest regions** in the U.S. solar energy storage market. From 2022 to 2024, the proportion of Texas's utility-scale energy storage installation capacity to the total utility-scale energy storage installation capacity in the U.S. was 31%, 24%, and 33%, respectively, ranking first in the U.S. for three consecutive years.
- Currently, the penetration rate of residential energy storage in Texas is relatively lower compared to utility-scale energy storage. However, **Texas has become one of the states with the fastest growth in residential energy storage** in the U.S..
- The following factors have driven the growth of the residential energy storage market in Texas:
  - The high proportion of detached houses and sufficient roof area provide abundant space for the installation of PV
  - The vast rural areas with weak coverage of utility power, and household storage can satisfy the upgrading demands of traditional electrical facilities
  - The Electric Reliability Council of Texas (ERCOT) has achieved electricity marketization. Residential energy storage can generate profit by utilizing peak-to-valley price differences.

Market case

- Tesla launched a development plan for eco-energy community named *Tesla-powered Community* in Houston, 2022. It started official sales in 2025. The community was constructed with the conception of circular renewable energy cycle, equipped with Tesla's products including Solar Roof V3, Powerwall 3 energy storage systems and charging piles, achieving energy independence.

Tesla-powered Community



PV module | Energy storage | Charging pile

Market player

- There are two main types of market players: equipment suppliers and integrators. Equipment suppliers provide PV and residential energy storage equipment. Integrators provide integrated solutions including installation, operation and maintenance.

Equipment supplier	Integrator
TESLA, GENERAC	FREEDOM SOLAR POWER

Source: expert interviews, public information, Frost & Sullivan

EHB device industry chain includes upstream raw materials, midstream power generation and energy storage equipment manufacturers, downstream distributors and application scenarios

EHB device industry chain can be divided into three segments:

- **Upstream:** Component manufacturers, mainly including raw materials such as battery cells, inverters, electronic components, packaging materials, solar PV modules, etc.
- **Midstream:** Product manufacturers, such as those designing and producing home power generation and energy storage systems. Some leading manufacturers have achieved independent technology, while many small companies in the industry mainly contract manufacturing for export products.
- **Downstream:** Distributor and application scenarios, with online presence in cross-border e-commerce and social media platforms, and offline presence in large supermarkets and retail stores.

Analysis of EHB device industry chain

Upstream: Raw materials

- Battery Cells, Battery Packs
- Lithium Battery
- Electronic Components
- Inverter
- Sensor
- Solar Panels
- Parts Suppliers
- …

Midstream: Power generation and energy storage equipment manufacturers

Jackery Solar Generator, ECOFLOW, HUAWEI, TESLA, ANKER, PowerOak, RENOGY, Baseus, Yoobao, ZENDURE SuperCharged, GOALZERO

Downstream: Distributor

Online

amazon, ebay, yahoo!, TikTok

Offline

Costco Wholesale, OBI, The Home Depot, Best Buy, Walmart, Lowe's, Canadian Tire, target, Harbor Freight (Quality Tools at Ridiculously Low Prices)

Downstream applications

- Family Emergency
- Emergency Power Supply
- Medical Emergency
- Power Grid Evacuation
- Security Continuity
- Camping
- Emergency Assistance
- …

Source: expert interviews, public information, Frost & Sullivan

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Electricity stability concerns and rising electricity prices are the main pain points in the North American market, providing EHB with broad space of market penetration

Aging Power Infrastructure

- Aging infrastructure across the U.S. power system has led to higher failure rates and longer average annual outages.

- Power outages may cause property losses and induce health risks by disabling critical household electrical loads like ventilators and refrigerators.

Extreme weather and natural disasters

- Frequent extreme weather events and natural disasters have triggered widespread and prolonged power outages.

- Power outages caused by extreme weather and natural disasters may cause the disfunction of critical loads including heating appliances and refrigerators, leading to property losses and health risks.

Rising electricity prices

- Fluctuations in electricity prices have caused an increase in household living expenses.

- The increase in electricity prices, which leads to a rise in the cost of living, forces families to cut their budgets on other necessities such as food and medicine, resulting in a decline in the life quality.

Core value

- EHB can provide a stable electricity supply. In the event of a power outage, it can respond quickly within a short period of time to supply power to critical household electrical loads, ensuring their uninterrupted operation and eliminating potential property losses and health risks.

Core value

- EHB can provide a green and cost-effective power resources and implement flexible energy management strategy by taking advantages of peak-valley electricity price differences to reduce the average cost of household electricity usage.

EHB

Source: expert interviews, public information, Frost & Sullivan

In recent years, the U.S. federal and state governments have introduced a series of incentive policies promoting EHB through reducing investment costs and providing rebates or tax credits.

Related Policies in the U.S.

Policy	Institute	Effective Date	Key Provision
New Jersey Energy Storage Incentive Program	The New Jersey Board of Public Utilities	2025	The state targets 2,000 MW of energy storage by 2030 with incentives for front-the-meter and behind-the-meter energy storage projects。
Self-Generation Incentive Program	California Public Utilities Commission	2024	Customers installing energy storage are eligible for rebates, with amounts ranging from $150 to $1,000 per KWh.
Net Energy Metering 3.0	California Public Utilities Commission	2023	The implementation of a dynamic net billing mechanism significantly lowers the compensation rate for exported electricity, encouraging households to adopt energy storage to increase energy self-sufficiency.
Residential Clean Energy Credit	Internal Revenue Service	2023	Households installing solar PV, energy storage, and other clean energy equipment are eligible for a 30% federal tax credit, which is available from 2022 to 2032.
Inflation Reduction Act	Congress of the United States	2022	Up to $14,000 in tax credits or direct rebates is available for residential electrification and efficiency.

Source: expert interviews, public information, Frost & Sullivan

With the technological advancement, EHB embraces gradual development in performance, cost-effectiveness and system compatibility, better satisfying the diversified demands.

Solar PV

- **Performance improvement：** With the advancement of design, packaging and other processes, the power generation efficiency of solar PV under non-ideal conditions such as low light, shading, and low temperatures has significantly improved.
- **Compatibility enhancement：** With mobile and modular designs, the compatibility of solar PV modules has been enhanced, increasing suitable for a variety of non-fixed scenarios and expanding the coverage of EHB.

Energy storage

- **Performance improvement：** With the rapid development of the global new energy industry, lithium-ion battery technology has continued to advance, and its cost-effectiveness has continued to increase. It has gradually replaced other secondary batteries such as lead-acid batteries and become the first choice for EHB.
- **Cost reduction：** Driven by the new energy vehicle and battery industries, battery companies have accelerated their production capacity, and the expansion of scale advantages has further reduced the price of lithium-ion batteries.
- **Improved safety:** The development of new high-performance, low-cost battery materials and corresponding electrochemical systems, the exploration of efficient processing and production technologies, the promotion of overall technological progress in the industrial chain, and the improvement of the safety of lithium-ion batteries.
- **Increased energy density：** The energy density of lithium batteries continues to increase, which enables energy storage to store more energy without increasing their size.
- **Increase in power：** The increase in energy density has also driven the development of EHB towards larger power. EHB can use lithium batteries with higher energy density to store more electricity to meet the needs of households during peak power hours or provide backup power when the utility power is unstable.

Smart energy management

- **Efficiency improvement：** With the advancement of edge computing technology, smart energy management are capable of real-time analysis of power fluctuations and battery status, dynamically adjusting working modes to reduce energy losses and improve energy efficiency.
- **Intelligentization：** With the integration of AI algorithms and big data analytics, smart energy management can achieve more accurate power predictions and optimize the energy allocation of electrical loads, enhancing the stability of EHB.

Source: expert interviews, public information, Frost & Sullivan

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Household energy independence: EHB emerges as a critical solution for North American households to address energy crises

Critical Load Backup

- **Reliable Electricity Supply**：EHB enhances grid independence by providing uninterrupted power during outages, supporting critical loads such as refrigerators, lighting, WiFi routers, and water pumps.
- **Life-Safety Protection**：For households with medical devices (e.g., ventilators, oxygen concentrators), EHB prevents life-threatening disruptions by ensuring continuous operation during outages.

Environmental Responsibilities

- **Carbon Reduction**：EHB eliminates emissions versus diesel generators. Each EHB-equipped home can reduce about 1.59 metric tons of CO_2 annually, accelerating decarbonization.
- **Clean Emergency Power**：Unlike polluting fossil-fuel generators used during weather-induced outages, EHB delivers zero-emission power backup, mitigating air quality degradation.

Economic Advantages

- **Cost Savings**：Energy self-sufficiency reduces electricity bills while increasing property values through “resilience premiums”.
- **Community Resilience**：During hurricanes/wildfires, solar-powered EHB systems maintain off-grid operation, strengthening neighborhood disaster preparedness.

Source: expert interviews, public information, Frost & Sullivan

Intelligent system integration：AI technology is redefining North American EHB solutions with dynamic optimization and predictive maintenance

AI-Driven Energy Coordination

- **Real-Time Optimization:** AI-powered energy platforms integrate solar PV, storage, and consumption data to dynamically allocate power, improving household energy efficiency by 20-30%.
- **Sustainability-Meets-Savings:** Smart management reduces carbon footprints while delivering quantifiable cost savings through precision load optimization—creating dual environmental and economic value.

Predictive Maintenance

- **Proactive System Protection:** Machine learning models analyze equipment health and weather patterns to preempt failures, automatically activating backup power to minimize outage durations.
- **Cost-Safety Synergy:** Predictive maintenance cuts equipment failure rates by 40%, reducing repair costs and downtime. Adaptive charge/discharge strategies simultaneously ensure reliability and lower electricity bills.

Balanced Energy Security & Economics

- **Grid-Resilient Operation:** Self-adjusting algorithms modify power parameters in real-time based on grid conditions, while priority load management maintains redundancy during extreme weather.
- **Smart Consumption Profiling:** Behavioral analytics predict usage patterns to establish optimized energy schedules—maximizing the value of every kilowatt-hour.

Source: expert interviews, public information, Frost & Sullivan

Renewable energy convergence： EHB combines solar PV, storage and EV chargers to create a complete, self-balancing power solution for modern North American houses

Unified Energy Matrix

- **The Energy Trinity Imperative：** Volatile electricity prices and EV adoption are driving demand for integrated solar-storage-charging solutions. This combination now delivers the most cost-effective residential power architecture.
- **24/7 Renewable Utilization：** Grid modernization needs and decarbonization goals jointly propel this synergy, enabling round-the-clock self-consumption of solar energy while reducing grid dependence by 40-60%.

Intelligent Coordination

- **Adaptive Optimization：** Through real-time monitoring of EHB system operational and external environmental factors (e.g., weather and electricity prices), intelligent algorithms can automatically optimize the power generation strategies, battery charge/discharge cycles, and EV charging power allocation, to ensure peak operational efficiency across varying temporal and load conditions.

Next-Gen Energy Management

- **Smart Energy Management Revolution:** Through mobile apps or smart interfaces, homeowners gain real-time visibility into system performance metrics, including solar generation output, battery storage levels, electricity consumption patterns, and EV charging status. This unprecedented transparency enables precise, data-driven control over household energy flows.

Source: expert interviews, public information, Frost & Sullivan

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Jackery has set a new benchmark for EHB solutions, with a product matrix that covers all-scenario home emergency power needs

EHB Major Players Comparison

Major Players	Founding Date	Product Type	Company Introduction	EHB Products
Jackery	2011	Esential Home Backup Home Energy Storage Portable Energy Storage Solar PV Modules	As the **global leader in portable energy storage and the pioneer of EHB**, Jackery is a leading global provider of innovative solar power generation and sustainable energy solutions, with over 5 million devices sold worldwide. Its product range covers **EHB for critical loads, EHB for individual appliances, outdoor adventures and entertainment, whole-home backup,** covering all-scenario emergency power needs for households.	
Tesla-Powerwall	2003	Home Energy Storage Solar PV Modules	The company's home battery product line is diverse, focusing on innovation and sales in the home energy storage sector. **Its products include the Powerwall series of home energy storage batteries and solar panels and solar charging solutions.** In 2023, the Powerwall brand extended its product line from portable energy storage batteries to large-scale home energy storage systems.	
Huawei	1987	Home Energy Storage Solar PV Modules	Huawei’s EHB provides integrated clean energy solutions for villas**. Its products cover smart string inverters and energy storage systems**, widely applied in family energy management and emergency backup power scenarios.	
GoalZero	2009	Portable Energy Storage Home Energy Storage Solar PV Modules	The company is an American off-grid and portable solar equipment manufacturer. **Its product line ranges from 200Wh portable power stations to 8000Wh home energy storage devices**, covering a wide range of application scenarios. It collaborates with multiple Chinese enterprises, with its main products manufactured by factories in China.	

Note: The order of companies does not imply ranking. The analysis focuses on major market players.

Source: company official websites, expert interviews, public information, Frost & Sullivan

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