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Future Developments for Global Energy Storage

Key Trends for the Decade Ahead



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OUR INDUSTRY EXPERTISE: OVER 40 PROGRAM AREAS SERVING A WIDER RANGE OF SECTORS

F&S has a long track record (avg. 15Y+) in having industry analysts and consultants tracking value-chains of each of these markets and sub-markets.



Digital Media

TOP TRENDS DRIVING GROWTH IN THE POWER & ENERGY SECTOR



Source: Frost & Sullivan

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WHERE IS THE INVESTMENT GOING?

In 2030, 85% of power investment will be renewable and 93% will be low carbon



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DECADE OF DECENTRALISATION



Annual investment in decentralised energy will approximately double over the course of the decade - accounting for approximately 25% of total power generation investment





STORAGE USE CASES WILL CONTINUE TO INCREASE AS THE TECHNOLOGY DEVELOPS



Universe of opportunity for storage will continue to expand through continued technology innovation, supportive regulation and cost reductions



Key Drivers

- Avoiding peak charges
- Opportunity for revenue stacking
- Lower incentives for sale back to grid
- Regulatory mandates

Key Restraints

- Lack of subsidies
- Regulatory barriers
- Uncertain ROI

Source: Frost & Sullivan

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KEY TOPICS FOR DISCUSSION



Storage in the Home



Reserves & Production



Just Lithium? The Contenders



Beyond Batteries



Source: Frost & Sullivan

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RAPID ESCALATION IN GRID STORAGE INVESTMENT



Global deployment will reach 11.2 GW annually in 2025 and 19.3 GW in 2030, while the \$2.0 billion annual investment in 2020 is poised to increase to \$15.9 billion by 2030

Total Grid Battery Energy Storage Market: Investment and Annual Capacity Additions Forecast, Global, 2019–2030





"Grid-scale battery energy storage will be a major challenge to traditional peaking plants and will fundamentally underpin the next wave of renewable investment".

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ASIA FORECAST TO ACCELERATE INTO FIRST PLACE IN 2027



Asia and North America are anticipated to be the leading regions, accounting for 46.2% and 32.4%, respectively, of the total grid battery storage power capacity by 2030

Total Grid Battery Energy Storage Market: Capacity Deployment Forecast by Region, Global, 2019–2030



Source: Frost & Sullivan

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REGIONAL GRID STORAGE TRENDS



North America currently the hottest growth market, but Asia coming to prominence. European market evolving fast

North America

- Largest global market in 2021
- Hybridization of RE with storage
- ITC and utility procurement, key drivers

Europe

EU Clean Energy legislation
Limited frequency regulation

- opportunities
- TSO projects



• Greater growth after 2023

Asia

- China, with 35% of global additions by 2030
- RE Integration, transmission deferrals and ancillary services

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Latin America

- Regulatory barriers
- Chile as a hot spot
- Renewables firming and transmission deferrals

Africa and Middle East RE-plus-storage to replace diesel generation in Africa

 Batteries to support surge in solar PV in the Middle East

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ARSENAL FOOTBALL CLUB BET'S ON BATTERY STORAGE



Universe of opportunity for storage will continue to expand through continued technology innovation, supportive regulation and cost reductions

Key Features Of This Installation

Features:

 A 3MW/3.7MWh battery storage – Pivot Power EDF on 15 year contract.

Avoiding peak demand:

- Peak demand sell energy back to the grid.
- Avoid peak time consumption prices can be double.

Shared revenue model:

Revenues shared between Pivot
 Power, Arsenal FC + investor Downing
 LLP.



EUROPE THE LEADING REGIONAL MARKET FOR RESIDENTIAL BESS



Japan and Australia the key markets in Asia

Residential Battery Energy Storage: System Installations Forecast by Region, Global, 2020–2030



Source: Frost & Sullivan

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GERMANY WILL CONTINUE TO DOMINATE THE EUROPEAN MARKET



Further upside potential in 2022 as higher energy costs encourage more households to consider residential solar PV + storage

Residential Battery Energy Storage Market: System Installations Forecast by Country, Europe, 2020–2030



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REGIONAL RESIDENTIAL STORAGE TRENDS



US and China catching up on early movers Germany, Japan and Australia



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KEY PLAYERS IN THE RESIDENTIAL SOLAR+STORAGE VALUE CHAIN

Consolidation within the value chain likely to drive further efficiency savings and lower price points for customers



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LITHIUM RESERVES & PRODUCTION



A small number of countries account for a huge percentage of overall reserves raising dependency concerns



Lithium Reserves, KT



Lithium Production, KT

CONTINUED INNOVATION THROUGH THE 2020S SEE A NUMBER OF TECHNOLOGIES VYING FOR FUTURE MARKET ADOPTION



Lithium-ion currently dominates the market, but by 2030 the picture could be very different



SOLID STATE BATTERIES KNOCK OUT LITHIUM?



Solid state batteries offer the potential to increase charging lifetime, decrease weight and faster charge times



2 – 10 times the density of lithium

80% more energy stored than lithium-ion

800km range for EVs





THERMAL STORAGE GAINS TRACTION

Significant growth forecast in the second half of the decade, as solid state materials or molten salts are deployed across a larger number of applications. Over 608 MW of Thermal Storage is under development or has been announced, with projects predominantly in Chile, South Africa, and United States



Thermal Storage Installed Capacity (Europe)	Technology	Efficiency	Cost	Life	Suitable Applications
PCMs STES 0.3% 1.5% Molten Salts 98.3%	Sensible TES	90% -92%	\$25-\$30/KWh	10,000 Cycles	< 500 ° C– 700 ° C
	Latent TES	90%-92%	\$25-\$90/KWh	3000-5000 Cycles	<600 ° C- 750 ° C
	Thermo-Chemical	40%-50%	\$80-\$160/KWh	<100-500 Cycles	500 ° C- 900° C
	Mechanical-Thermal	40%-60%	\$400-\$800/KWh	20-40 years	<200 ° C -> 400 ° C

Source: Frost & Sullivan

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COMPRESSED AIR ENERGY STORAGE

CAES / LAES systems are suitable for grid scale storage (up to 500 MW) and cost lesser compared to Pumped Hydro storage, and Flywheels while offering the same benefits to the grid



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FLYWHEELS

With response time in milliseconds, Flywheel Energy storage systems have a unique role to play in frequency /voltage regulation and in improving grid stability with storage requirements of up to 20 MW



Estimated Investments in Flywheels



Estimated Capacity Additions (2022-2030)



(Announced projects and F&S Estimate)



Source: Frost & Sullivan

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KEY CONCLUSIONS



Decade of strong growth forecast for grid battery storage



High energy costs driving residential market



Cost of lithium raising concerns over its dominance



Role for non-battery storage in the overall market – longer duration