WHAT COMES AFTER LITHIUM-ION?

THE NEXT BIG LEAP

IN BATTERY INNOVATION

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Lithium-Ion batteries have driven the energy transition for decades, but the industry is now approaching a critical turning point.

As the demand for safer, more efficient, and scalable energy storage accelerates, the spotlight is shifting toward emerging technologies that aim to address the limitations of lithium-ion.

The table below provides a high-level comparison of key next-generation battery contenders:

BATTERY TYPE	ENERGY DENSITY	COST	SAFETY	COMMERCIAL READINESS
Sodium-Ion	Low-Medium	Low	Safe	Early Stage
Solid-State	High	High	Safe	Developing
Lithium-Sulfur	Very High	Low	Moderate	Not Ready Yet
Graphene-Enhanced	High	High	Safe	Limited Use
Metal-Air	Very High	Low	Moderate	Experimental

Let's dive deeper on each of these battery types. →

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1 SODIUM-ION

Stage:

- Commercial pilots and limited market release

Best for:

Grid storage, low-to-mid range EVs, and forklifts seeking cost-effective, sustainable energy solutions.

PROS

Abundant and Cheap Materials
Sodium is far more abundant than lithium and doesn't require rare metals.

Lower Production Cost
Can often reuse existing lithium-ion battery production lines with slight modifications.

Good Performance in Cold Climates
Sodium performs better in lower temperatures than lithium.

CONS

Lower Energy Density
Can't store as much energy, making it less suitable for high-performance EVs.

Heavier
Not ideal for applications where weight is critical.

2 SOLID-STATE

Stage:

- Advanced R&D and early prototyping

Best for:

High-performance EVs, aerospace, next-gen consumer tech, and heavy-duty forklifts requiring enhanced safety and energy density.

PROS

Much Higher Density
Could double the range of EVs compared to lithium-ion.

Non-Flammable Solid Electrolyte
Makes them safer—less risk of fire or explosion.

Longer Lifespan
Fewer charge cycles needed for the same performance.

CONS

High Cost and Manufacturing Complexity
Materials and processes are expensive and hard to scale.

Durability Issues
Dendrite formation and interface instability are still being solved.

3 LITHIUM-SULFUR

Stage:

- Emerging R&D

Best for:

Lightweight electric vehicles, drones, aerospace, and potentially high-performance forklifts needing longer runtimes.

PROS

Very High Energy Density
Up to 5x that of lithium-ion, enabling longer runtimes or lighter battery packs.

Lightweight and Low-Cost Materials
Uses abundant sulfur, reducing battery weight and raw material expenses.

Environmentally Friendlier
Less reliance on toxic metals like cobalt or nickel.

CONS

Shorter Cycle Life
Capacity fades faster due to the shuttle effect requiring more frequent replacements.

Volume Expansion
Sulfur expands during charge/discharge, causing mechanical stress inside cells.

Low Conductivity
Sulfur's poor electrical conductivity limits performance and efficiency.

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4 GRAPHENE-ENHANCED

Stage:

- Limited commercial use and advanced R&D

Best for:

High-performance EVs, portable electronics, and forklifts needing faster charging and improved durability.

PROS

Improved Conductivity
Graphene boosts electrical and thermal conductivity, enhancing battery efficiency and lifespan.

Faster Charging
Enables quicker charge times compared to standard lithium-ion batteries.

Higher Power Output
Supports heavy-duty applications with better performance under load.

CONS

Higher Cost
Graphene production and integration add to battery manufacturing expenses.

Scalability Challenges
Large-scale, consistent graphene quality remains difficult to achieve.

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5 METAL-AIR

Stage:

- Early R&D and prototype development

Best for:

Long-range EVs, backup power systems, and potentially forklifts requiring ultra-high energy density.

PROS

Extremely High Energy Density
Significantly higher than lithium-ion, promising much longer runtimes.

Lightweight
Uses oxygen from the air as a reactant, reducing battery weight.

Low Material Cost
Uses abundant metals like zinc or aluminum.

CONS

Limited Rechargeability
Many metal-air batteries are primary (non-rechargeable) or have limited cycle life.

Technical Challenges
Issues with air cathode stability, electrolyte management, and efficiency remain.

Slow Power Output
Lower power density can limit performance in high-demand applications.

Driving the future of material handling takes more than keeping up — it takes showing up, improving, and doing the work.

Stay tuned for more insights into the future of forklift technology.

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