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The EV Legislation & Incentives Guide provides in-depth analysis of how and where legislation is impacting electrification in the automotive industry. It aims to help OEMs and lawmakers understand the regulations and incentives surrounding EVs today, as well as the legislation being worked towards by governments in different regions. The guide is released quarterly to provide the latest updates and offers an accompanying Excel version featuring deep, data-driven, analysis.



Electric Vehicle

#219

# EV Battery Technologies & Ecosystem

As EVs continue to proliferate in markets across the globe, automakers are racing to improve the efficiency, range, and bottom-line of their solutions. The common denominator behind these improvements is the vehicle battery – which already encompasses a wide, rapidly growing ecosystem of technologies, key players, infrastructure, and more.

With the battery itself employing cutting-edge technologies, and being the most expensive EV component, it has become the focal point of innovation and investment for the broader automotive industry. This innovation has in turn driven the ecosystem's growth – with an increasing number of companies dedicated to battery manufacturing and operations, and more frequent announcements of new technologies, systems, and partnerships. As a result, keeping track of its changes and new additions is becoming an increasingly difficult task.

This report profiles the key players and technologies involved in the EV battery ecosystem, while highlighting the factors encouraging innovation across the battery lifecycle. Offering accessible explanations of today's critical battery technologies, the report provides insight into the potential battery industry conditions of the future. It also addresses the recent trend of battery recycling and reuse – understanding its key initiatives and supporting technologies.

COVERAGE



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# Key questions answered

- > Which battery technologies are the most promising and how do they work?
- > Who is investing in major battery initiatives and which players are positioned to lead the market?
- > What might the automotive and battery industries look like in the future and why?

# This research supports



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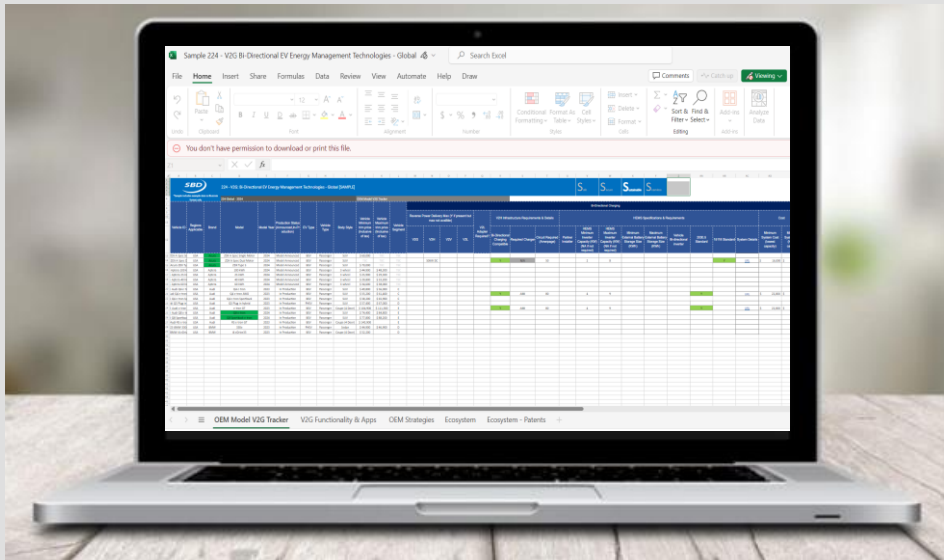
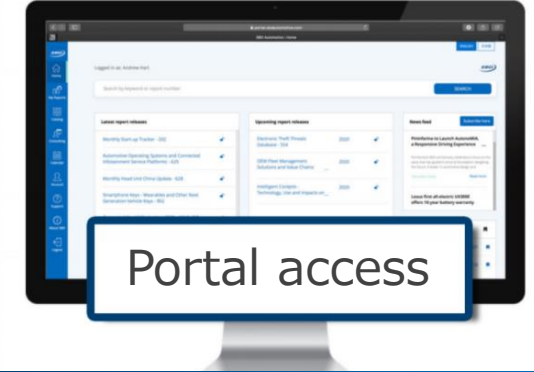
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## EV Battery Technologies & Ecosystem

For a comprehensive model-level data including tech/chemistry/packaging/special features

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## EV Battery Technologies & Ecosystem

Technologies and profiles of key players in the EV battery industry

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## 219 – EV Battery Technologies & Ecosystem

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## Introduction

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# Introduction

This report analyses the EV battery industry to draw a complete picture of its current development, the forces shaping it, its trends, and technologies already available as well as those coming soon to the market.

Batteries are still among the most expensive components in EVs, and the race is ongoing to improve production efficiency and lower costs. To achieve this, large investments are being dedicated to improvements across the value chain, and to R&D to find new and better alternative chemistries, creating an extremely varied and fast-evolving sector.

Sustainability is the other big challenge of the modern battery industry, driven by policies and regulations that become increasingly complex as governments are committing to achieving carbon neutrality.

The report looks at **FIVE key benefits of BEVs for automakers**:



## What are the key questions answered in this chapter?

- What new battery technologies have been launched and how do they differ from existing technologies on the market?
- Which battery chemistry and form factor are OEM groups using?
- How are suppliers and OEMS working together to meet battery demand?

Section	Content
<b>Bird's Eye View</b>	An overview of the key findings from SBD's view of what's important in battery industry
<b>Executive Summary</b>	Definition of all the EV-related terms covered throughout this report.
<b>The Basics</b>	A high-level overview of the battery industry across the regions (USA, Europe and China)
<b>What's New?</b>	Section focusing on new models launched, notable announcements, partnerships and acquisitions, and trends in the EV industry.
<b>Analysis</b>	What are the most important components of EV batteries, what is the chemistry behind, and what are all the chemistries being applied or researched today.
<b>Summary Tables</b>	The Market Summary section provides EV market share and sales volume data. The Vehicle Summary section various models with their technical specifications.
<b>Ecosystem</b>	Understanding other players (than automakers) and their contribution towards the battery industry and battery recyclers
<b>Future Outlook</b>	Four OEM personas are considered against drivers and barriers into the future to understand when Electric Vehicle benefits will be truly realized
<b>Next Steps</b>	Can SBD help you with any unanswered questions?

# We Listened and Invested In Our V2G Report to Align to Your Goals



## You Said...

"I sometimes struggle to relate conclusions from research reports to the Outcomes and KPIs that we are working towards..."

"I would like to see what has recently changed within a forecast or domain to help decide if any changes to strategy need to be made..."

"I want to know where we stand 'head-to-head' against the competition on major industry trends..."

"I can find it difficult to take actionable next steps on Guides without assessing the future direction of the industry..."

"It would be helpful to identify disruptive companies and start-ups to keep an eye for partnerships in the future..."

"I would like the topics to be more 'forward looking' to help with future planning and take advantage of enabling technologies..."



## We Did...

Added an **EV BIRDS-EYE VIEW** chapter with a high-level overview of all our EV reports.

Enhanced **CROSS-REFERENCING** with EV model data from our EV Guide and battery insights from our Battery Technology and Ecosystem Report.

Introduced a **FUTURE OUTLOOK** chapter with motivations such as Increased EV Range, and its drivers and barriers over time.

More **DATA-DRIVEN ANALYSIS** through our Summary Table analysis, our dedicated Analysis chapter, and Executive Summary.

Created a **V2G OEM RANKING** and an **ECOSYSTEM** chapter with offering, acquisition and patent insights for key non-OEM stakeholders.

Pushed boundaries to add the disruptive **NEW TITLE V2G: Bi-Directional EV Energy Management Technologies**





# Example slides from the report



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Technologies and profiles of key players in the EV battery industry

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# EV Charging is just a part of delivering the motivations of Electrification

**This Bird's Eye View chapter gives SBD's view of the major electrification trends from our relevant reports ...**

**...in the journey to delivering the nine key OEM Electrification motivations**



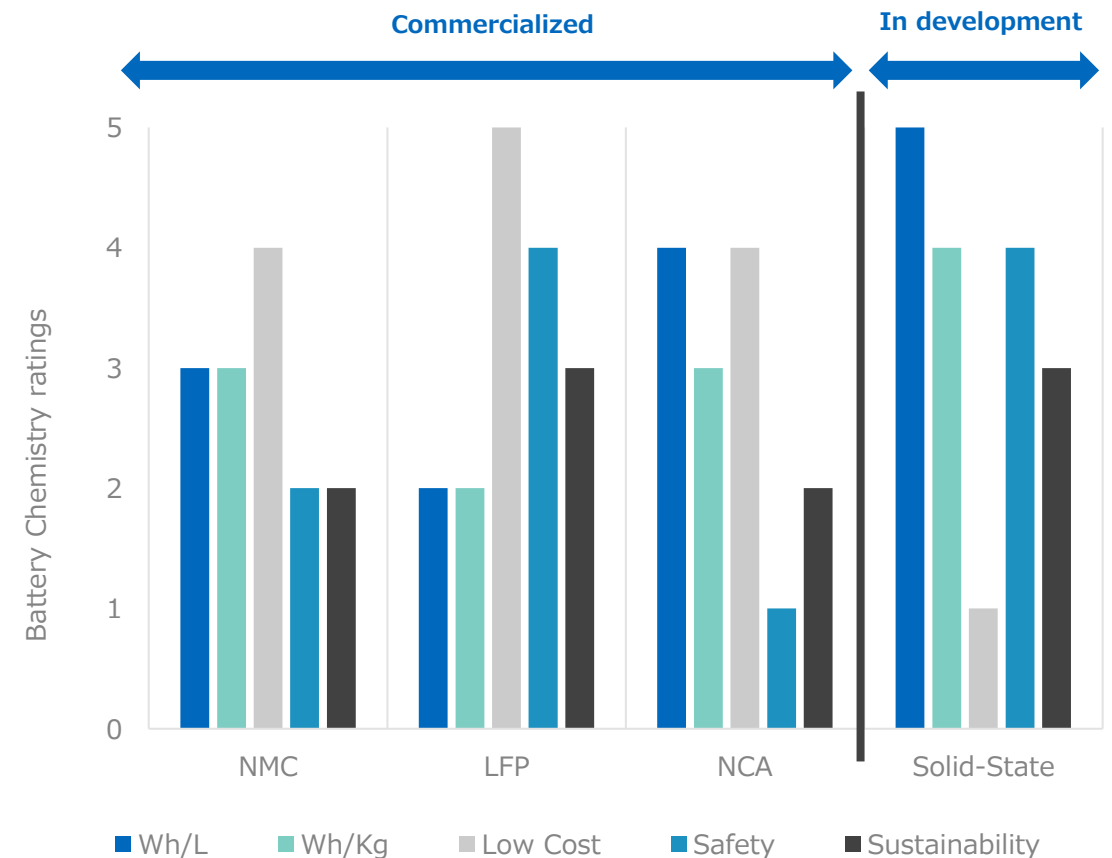
# Automakers are diversifying their approach to battery chemistry

**Top-performing new battery chemistries might not be the best option for all. Low-cost and established chemistries can be the answer for specific market segments.**

Several automakers and battery manufacturers have ongoing **investments** and are **jointly developing** new chemistries such as solid-state to share the **risks and costs**.

Currently the vast majority of **OEM Groups** are using **NMC, LFP and NCA** chemistries

**About 40%** of the OEM Groups **planning to introduce Solid-State battery**



## OEMs planning Solid State battery

### Advantages:

- Fast charging
- High energy density
- Safe and not flammable



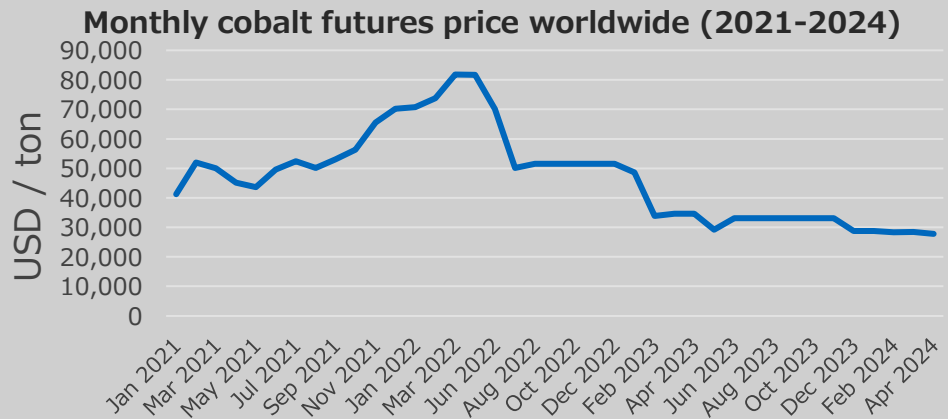








# Market Drivers: Geopolitics & Sustainability

## Overview

Regulations and recycling drive the market toward more localized, and sustainable solutions making it more appealing and resilient.

	Policies and Regulations	Sustainability
<b>Technology</b> 	 <p><b>R&amp;D, higher quality at lower cost</b> - May 2024 -</p> <p>China's Ministry of Industry and Information Technology revealed a soon-to-be-released draft guideline that will drive the lithium-ion battery manufacturers and overall market, toward more advanced, high-quality, and cheaper batteries, rather than just a market expansion. Details are still scarce, but at least 3% of revenues will have to be spent on R&amp;D and technological upgrades.</p>	<p>Two key aspects of battery sustainability are the reduction of rare materials, particularly those that are linked to ESG critical issues, and the development of a recycling industry.</p> <ul style="list-style-type: none"> <li>The first is pursued for environmental, human rights and geopolitical reasons, as 70-80% of the Democratic Republic of Congo's cobalt is owned and refined by Chinese companies. Cobalt content reduction in modern chemistries led to its price decline.</li> </ul> <p><b>Monthly cobalt futures price worldwide (2021-2024)</b></p>  <p>Source: investing.com</p> <ul style="list-style-type: none"> <li>For battery recycling, both the EU and USA are working to develop the industry for sustainability and to reduce dependence on China's exports. The USA IRA includes any material for batteries recycled in the USA as locally made and eligible for subsidies. In the EU, recycling targets 90% recovery of nickel and cobalt in 2027, rising to 95% in 2031, and 50% of lithium in 2027, rising to 80% in 2031.</li> </ul>
<b>Geopolitics &amp; Sustainability</b> 	 <p><b>Batteries Regulation</b> - Jul 2023 -</p> <p>The new regulation establishes targets for a full life-cycle, from sourcing, to manufacturing, and recycling. Batteries in the market will be allowed a low content of harmful substances. Recycling targets will be introduced gradually from 2025. Companies need to address and prevent ESG risks linked to raw materials such as lithium, cobalt, nickel and natural graphite.</p>	
<b>Demand</b> 	 <p><b>Market Protectionism</b> - May 2024 -</p> <p>In 2023, the USA limited imports from companies based in China, Russia, North Korea, or Iran by excluding them from IRA's tax credit eligibility. This also applied to companies that the governments of those countries hold a 25% share or more of the board. Batteries cannot contain parts manufactured or assembled in those countries, and 40%+ of minerals have to be extracted or processed in the USA. Later the tariffs of Chinese Imports have been increased up to 100%.</p>	

# NMC Battery

## Highlights

- NMC: Lithium Nickel Manganese Cobalt Oxide ( $\text{LiNi}_x\text{Mn}_y\text{Co}_z\text{O}_2$ )
- Nominal voltage of 3.6-3.8 V per cell
- NMC batteries generally have an energy density of 255-330 Wh/kg
- NMC chemistry allows the use of any battery cell format.
- Different types indicate the different elements ratios:

Naming	Nickel	Manganese	Cobalt
111	33	33	33
622	60	20	20
532	50	30	20
811	80	10	10

Ratios like 811 significantly reduce the need for Cobalt making the battery more sustainable, and higher nickel content can help drive higher energy density at a lower cost.

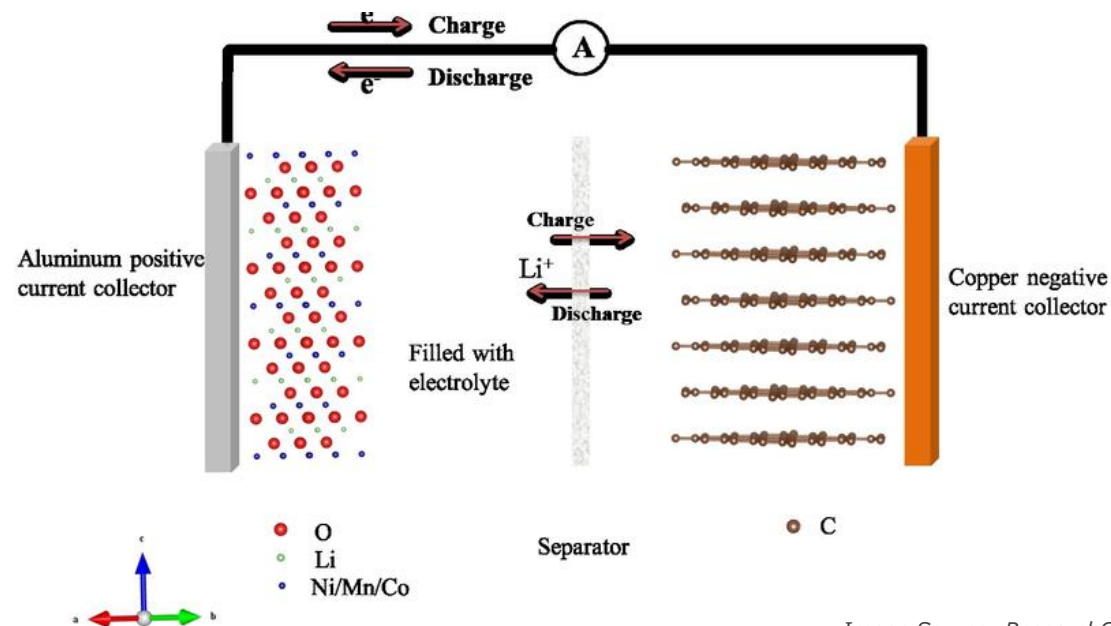
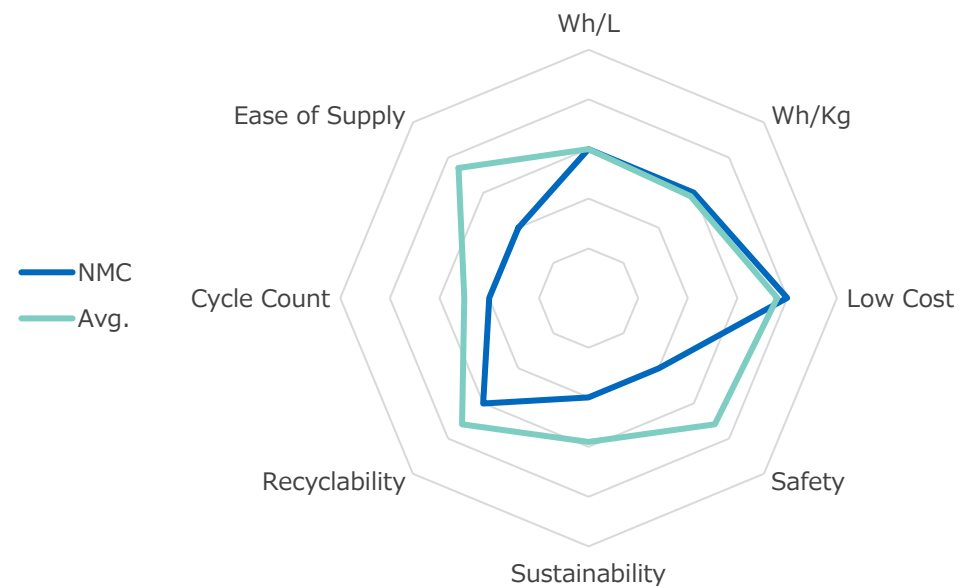


Image Source: ResearchGate

## Highlights

- NMC Chemistry is slightly above average in terms of volumetric and gravimetric energy density which has been the main reason for its success among the batteries already available on the market.
- A good level of recyclability is due to the strong development of the sector focusing on this specific chemistry.
- Cost, despite being potentially higher than other options due to the presence of rare materials, has also decreased getting closer to the \$100/kWh mark thanks to the continued focus on this chemistry and the strong competition between manufacturers.
- Cycle count remains below average as several new and upcoming technologies promise to offer significantly longer lifespan.
- Safety and ease of supply also remain below average due to the use of rare metals, and the inherent risk of thermal runaway with fire in case of mechanical damage and overheating.





# Ford Group

## Overview

Ford Group had approximately 186,000 EV sales in 2023, that primarily comprised of BEVs, which are double the sales of their PHEVs. The group with extensive regional coverage and highest cooling system score, ranks second overall among other OEMs. Its upcoming models will use prismatic cells versus the pouch cells used in current models and they will be also larger. Ford also have announced an additional equity investment in Solid Power for further development of solid-state vehicle battery technology, aiming to deliver longer range, lower cost and safer electric vehicles for customers.

## Suppliers



## Announcements

- Ford and Allego partnered to electrify European Dealership network with ultra-fast charging. (Link)
- Ford announced is investing \$3.5 billion in EV battery plant with Chinese company in Michigan (Link)
- Ford with LG Energy Solution and KOÇ Holding established a JV to build one of the largest commercial EV battery cell production facilities in the wider European region (Link)

Chemistry	Form Factor	Battery Packaging
NMC811	Pouch	Cell - to - Pack
LFP	Prismatic	Cell - to - Pack
Aluminum Air (Planned)	TBC	TBC
Solid State (planned)	TBC	TBC

## Highlights

- Ford Group uses different types of battery chemistry, including LFP and NMC. The group continue to expand its offering on battery chemistry types and is planning to introduce Aluminum Air and Solid State.
- For the NMC and LFP batteries, the cathode material used is Lithium iron phosphate

Chemistry	Form Factor			
	Cyl	Prism	Pouch	Other
LFP				
NMC				
NCA				
Other				

Greyed-out logos indicate planned batteries and form factors.

Energy Storage System	Battery Testing	Vehicle Charging Infrastructure	Battery Management Systems	Renewable Energy Production	Battery Diagnostics Software	Power Conversion System	Battery Recycling	Battery Swapping	Battery Leasing	Other Services (if any)
✓	✓	✓	✓	✓	✓	✓	✓			





# Volkswagen Group

## Overview

Volkswagen Group is planning to introduce a EUR 20,000 electric vehicle in 2027. In the 2024 Q1 results report, Volkswagen reported that orders for BEVs almost doubled compared to Q1.

Volkswagen have a strategy for a 'unified cell' which can contain differing chemistries and is to be used in up to 80% of models by 2030.

Volkswagen is planning to build battery gigafactories (though this could change depending on demand) in Valencia, Spain and St. Thomas, Canada.

## Suppliers



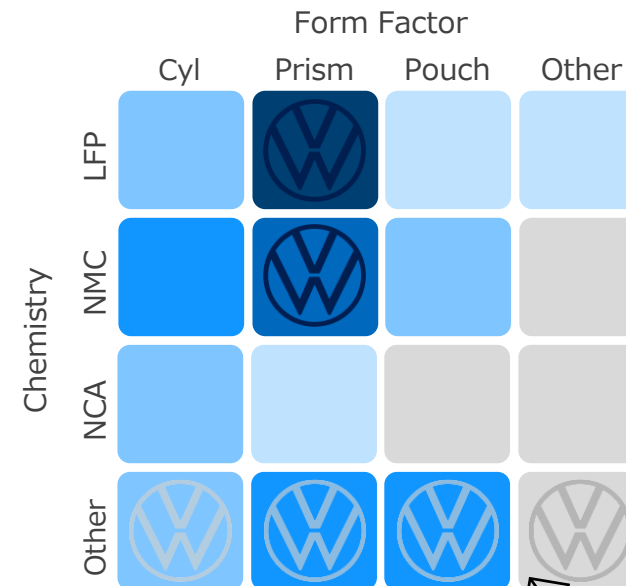
## Announcements

- Volkswagen and Mahindra sign supply agreement. ([Link](#))
- Volkswagen-backed PowerCo SE reaches significant milestone in St. Thomas gigafactory project. ([Link](#))
- Volkswagen considers sourcing solid-state batteries from Blue Solutions. ([Link](#))

Chemistry	Form Factor	Battery Packaging
Sodium Ion(Planned)	TBC	Cell - Module - Pack
LMFP	Prismatic	Cell - Module - Pack
LFP(Planned)	Prismatic	Cell - Module - Pack
NMC811	Prismatic	Cell - Module - Pack
Semi-Solid State(Planned)	TBC	Cell - Module - Pack

## Highlights

- LMFP and NMC811 are the only batteries currently being used by Volkswagen Group. However, the group is planning many other different battery chemistry for its EVs which includes LFP and Solid-State batteries.
- The group favor prismatic cells for its form factor.
- Volkswagen with its NMC uses Nickel based Cathode for Li-ion



Greyed-out logos indicate planned batteries and form factors.

Energy Storage System	Battery Testing	Vehicle Charging Infrastructure	Battery Management Systems	Renewable Energy Production	Battery Diagnostics Software	Power Conversion System	Battery Recycling	Battery Swapping	Battery Leasing	Other Services (if any)
✓	✓	✓	✓	✓	✓	✓	✓		✓	



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# Contact SBD Automotive

## Do you have any questions?

If you have any questions or feedback about this research report or SBD Automotive’s consulting services, you can email us at [info@sbdautomotive.com](mailto:info@sbdautomotive.com) or discuss with your local account manager below.



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