

rho
motion

Rho Motion: What to watch in 2024

EV Market

A snapshot of 2023

700%

Highest growth rate in Turkey following domestic **Togg** production and entry from **Tesla**

31%

EV sales grew **31% y-o-y**, BEV sales by 27% and PHEV sales by 43%

VW

Most BEV sales in Europe, followed by Tesla then Stellantis

59%

US & Canada was the fastest growing major region in 2023 with 59% growth compared to 2022

593

Unique **EV models** were sold across the globe in 2023

1.5m

Record month for EV sales set in December 2023 with over **1.5 million** sales

Tesla

retains **top spot** for BEVs, selling over 1.6 million units in 2023

BYD

Sold the most EVs, at **over 2.7 million**, and overtook Tesla in Q4 2023 for most BEV sales

What to look for in 2024

Our headline figure for 2024 will see PC & LDV EV sales rise to over 17 million units, up from 13.6 million in 2023.

In 2024, China is set to further extend its lead in the EV (BEV & PHEV) market. Both in terms of additional unit sales, and penetration rate growth.

In 2023, more than half of the additional EVs sold compared to 2022 were sold in China. The same is expected to be true again in 2024 as Chinese OEMs continue expansion plans at a rapid pace and only minor changes are made to the legislative landscape in the region.

Conversely, in Europe, cash incentives faced a tough time towards the end of 2023. In December 2023, Germany, Europe's largest EV market by volume, ended its EV subsidy abruptly, and early. Similarly, France has limited the vehicles available for the bonus-écologique, removing support for Chinese-made vehicles.

Support being reduced in large markets like this adds caution to expansion in Europe in 2024, however looking back on the UK's performance since June 2022 when EV subsidies were removed, we have seen consistent progress since then despite the lack of incentive. After the near-term shocks, France and Germany should be able to show a similar recovery. European OEMs will also face pressure from upcoming average fleet emission targets in 2025, where they must reduce emissions by 15% compared to 2021 levels.

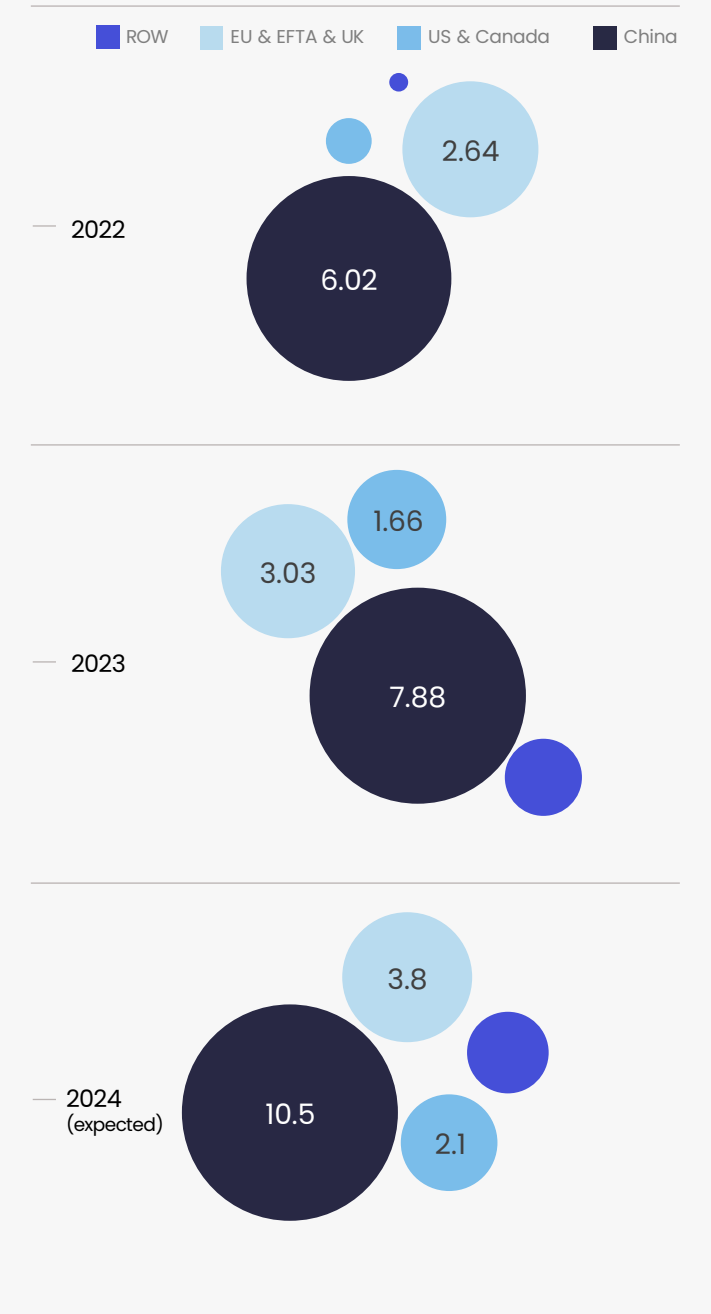
In North America, negative sentiment particular from legacy OEMs has fuelled fears of a slowdown in the region. GM is at a turning point of its EV journey as the Bolt & Bolt EUV reach the end of production whilst at their strongest ever point. New model lines such as the Blazer, Equinox and Silverado look to take over, however, to increase volume while ramping up three new models may prove difficult.

New, more stringent rules for IRA tax credit eligibility mean only a handful of BEVs *currently* qualify for the USD7,500 credit and with this only becoming tighter next year, plus US elections, 2024 could be the last moment for consumers to maximise this benefit.

Manufacturing of EVs in Asia Pacific is starting to pick up traction with many more expected to complete facilities this year such as BYD, Chery, MG, Neta and SAIC all in Thailand, and plans such as that of the government in Indonesia to manufacture 600,000 EVs per year by 2030.

Furthermore, as Chinese brands look overseas sights are of course set on Europe and growth there will certainly kick on in 2024, however, Asia Pacific is experiencing the force of these exports first as under-served EV markets with easier access logistically and geopolitically.

2022 – 2024 Passenger car and light duty vehicle unit sales by region (mln)



Battery Demand

A snapshot of 2023

1 TWh will have to wait for 2024, LFP gains six percentage points in market share.

0.99TWh

2023 battery demand reached **990 GWh**, just shy of 1 TWh for the year but 44% higher than in 2022

70%

EV Battery demand accounted for over **70%** of total battery demand

40%

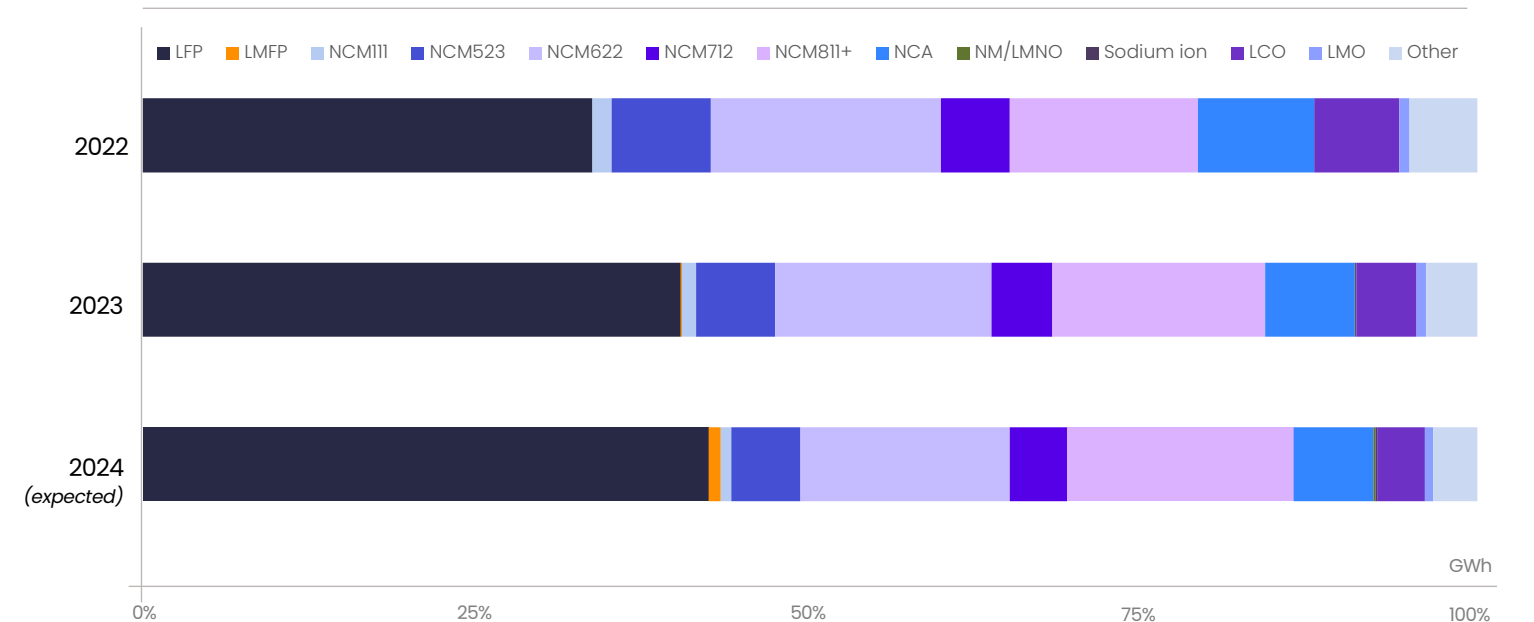
LFP accounted for **40%** of battery deployment, up from 34% in 2023

In this document one year ago, we mentioned the unavoidable buzz that sodium-ion had garnered in recent months. 12 months later and the first electric vehicles containing the technology have only just rolled off the production line. This just shows how long some timelines can become when vehicle qualification and untested technology are involved. LFP, a very much tested technology by now, continued its expansion of market share in 2023, though this has slowed slightly. It gained seven percentage points in 2021 and a further 13 in 2022. In 2023, it gained six percentage points, taking it to 42% of battery demand.

Throughout 2023 there was a range of battery technology advancements and announcements. Several cell producers announced their LMFP cells, such as CATL, EVE, Sunwoda, and Gotion, with the latter claiming up to 240 Wh/kg at the cell level. All solid-state battery announcements continued with some commercialisation expectations still aimed at 2027-28, though timelines have continuously been pushed back. NIO with WeLion, however, launched semi-solid batteries in China.

Following the Inflation Reduction Act, signed in August 2022, there was a plethora of production announcements in North America across the EV battery supply chain, particularly in Gigafactories. Major cell producers made huge investments, such as LG Energy Solution's \$5.5bn investment to build two facilities in Arizona and General Motors & Samsung SDI's \$3bn JV in Indiana. Chinese manufacturers even got in on the act with Ford-CATL's \$3.5bn facility in Michigan and Gotion's \$2bn announcement in September 2023. This prompted backlash and proposed bills such as the 'NO GOTION Act' to prevent companies based in China, Iran, North Korea, and Russia from getting the tax credit were introduced, though not passed.

Battery deployment by cathode chemistry, all markets



What to look for in 2024

We expect to see LFP market share growth to continue into 2024, with production expansion and market share of Chinese EVs still set to grow. However, this could be the peak year for LFP market share as other low-energy density chemistries start to enter the frame. Na-ion, and high-manganese chemistries such as LMFP, NM and LMNO are starting to either progress in development or are now being installed in vehicles. Together, these lower energy density options are still set to grow, pushing past 40% of global EV PC & LDV battery demand.

The sodium ion market will begin to materialise in China in 2024, announced gigafactory capacity has exceeded 100GWh, and GWh-scale sodium ion batteries will be produced in 2024. On the demand side movement will be slower, whilst lithium prices remain low. For the EV market models with sodium ion will be sold, but likely in limited volumes, deployment elsewhere such as two and three-wheelers is also already underway.

Looking to anodes, while the promise of Li-Metal and Solid State has had a reality check in 2023 from some, advancements in silicon have steadily progressed. 2024 could see a major milestone for one of the industries' startups as Sila Nano's Titan Silicon material will be used in the Mercedes EQG, coming this year.

Fast charging is also coming to the lower energy-density technology, manufacturers are looking to increase LFP's attractiveness by launching fast charging versions, CATL's Shenxing battery leads the way on this and ZEEKR expects to sell the ZEEKR 007 in 2024 with its in-house 800V LFP battery, capable of adding 500km of range in 15 minutes.

Dry electrode processes are also set to start making a mark in 2024 with Tesla's 4680s now employing this at a commercial scale and cells going on to power the Cybertruck. Other producers such as VW (PowerCo) are targeting using the process further down the line.

EV Charging Market

A snapshot of 2023

2023 growth remained strong in the face of economic headwinds, though grid constraints remain.

45%

In 2023, the total number of public chargers increased by **45%** across the globe, with a **55%** global in public fast chargers

The EV charging market exhibited healthy growth in 2023 to reach 3.8 million global charge points, a 45% increase on 2022. China remains the dominant market for public infrastructure, reaching 2.5 million points.

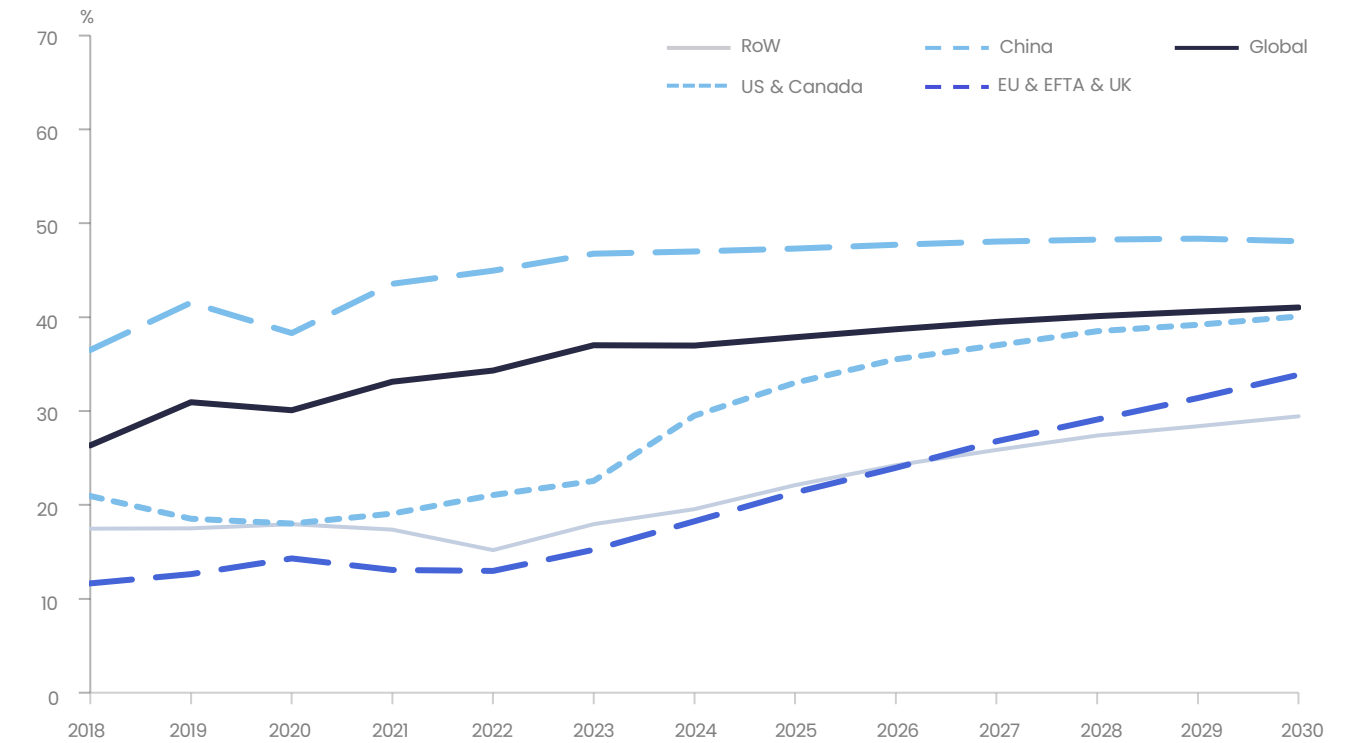
This growth has not come without challenges, however. One of the most significant in the charging market is that of grid connection queues, which have plagued charge point operators (CPOs) across Europe. Rapid expansion plans and a complex landscape of DNO approval processes have been primary drivers in lengthening wait times. Despite this, the growth of fast DC charging has been significant. This is particularly true in the EU, EFTA & UK, which saw fast charging grow 67% y-o-y, versus 39% growth in slow charging points.

22 → 26

In the US & Canada, the ratio of EVs to public chargers increased from 22 to 26 in 2023, indicating a slower pace of infrastructural rollout.

In the US, NEVI Formula Program funding has been slow to materialise into real demand. This is in part due to the long legislative processes that have been undertaken to allocate funding from the federal level to the state level, and from the state level to the operator level. Only a small number of states had allocated funding by the end of 2023, with just one station installed as of December 2023.

Share of fast charging (>22kW) in EV charging split by region, 2018-2030



What to look for in 2024

In 2024, grid connection queues will force CPOs to be more selective in their location choices.

In 2024, we expect a continued shift in strategy from CPOs, from rapid expansion to a more selective and targeted approach. Grid connection queues are unlikely to ease to any great degree in 2024 and low cash balances among many CPOs are highlighting the need to target locations with high potential utilisation rates. Though on the whole, utilisation rates remain low across European countries, high-traffic locations can exhibit rates as high as 70%. Sites in which nearby expansion is difficult, such as on highways, are particularly attractive to companies looking to maximise returns.

2024 will also see the continued momentum shown towards charger reliability and uptime, which has been an ongoing criticism of existing networks. New legislation across countries in Europe and the US is placing stringent requirements on charger uptime. As with any new technologies, teething issues are expected. In charging, a focus on the rapid development of networks and technology has led to a multitude of reliability issues across countries. Reputational damage is at the forefront of CPOs minds and will likely lead to a greater offering of software and monitoring solutions from charger manufacturers.

Battery Recycling

A snapshot of 2023

In 2023, global battery recycling capacity continued to surpass the available scrap for recycling, exceeding the overcapacity in 2022.

2.1mIn

Tonnes of global recycling pre-treatment capacity at the end of 2023

Global battery recycling pre-treatment capacity reached over 2 million tonnes in December 2023, up by over 40% y-o-y, with China contributing 70% of the increase. Regional capacity share remained similar y-o-y, with China accounting for 78% of the global share.

Outside China, annual capacity rose over 60% y-o-y in 2023, mainly led by the US and Europe. In Europe, capacity has developed around black mass production while there is an undercapacity in black mass refining. Some of the black mass produced in Europe was exported to other regions such as East Asia. Cross-border expansion continued, mainly with recyclers from South Korea, China or the US entering the European market.

78%

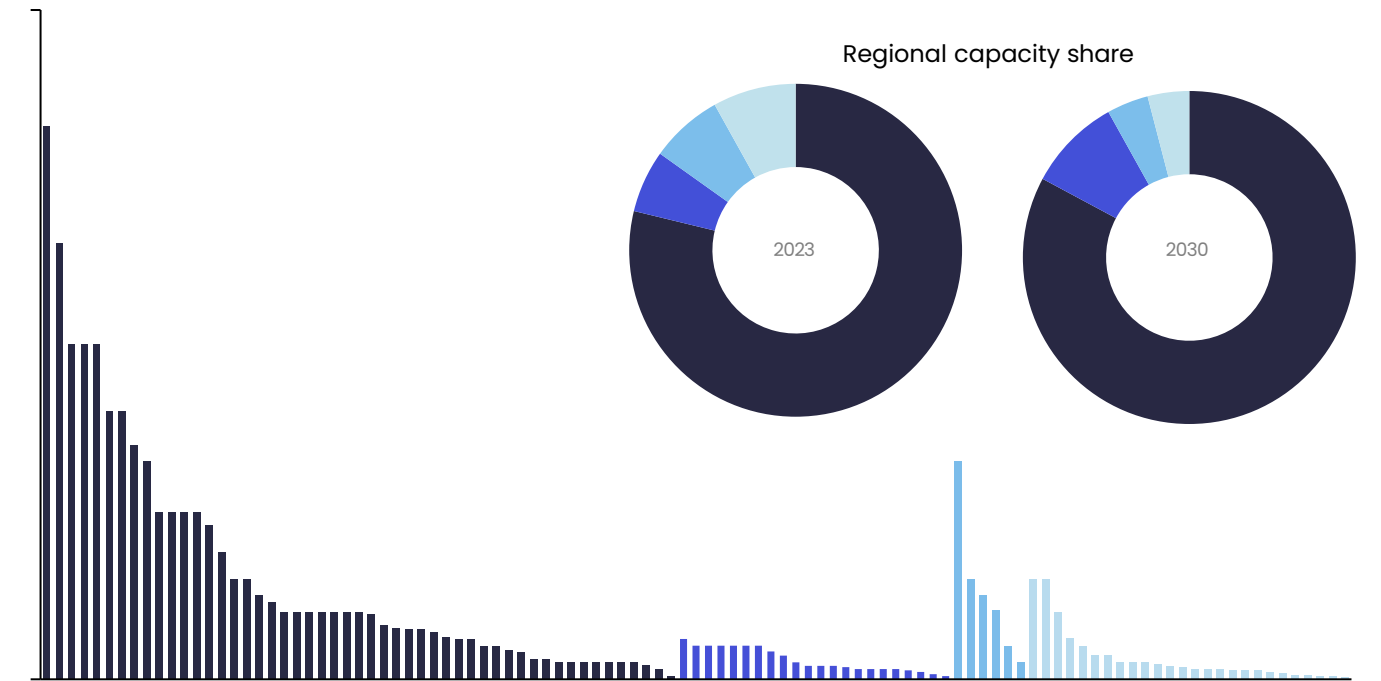
China accounted for 78% of battery recycling capacity in 2023

Global recycling input increased by over 30% y-o-y in 2023, largely sourced from production scrap across regions. Portables EoL accounted for over a quarter of the scrap in North America and Europe, which is much higher compared to China where production scrap dominates.

Regional battery recycling pre-treatment capacity by company, YTD December 2023

'000 tonnes per year of recycling inputs by company

China EU, EFTA & UK North America ROW



What to look for in 2024

In 2024, we expect overcapacity to persist on a greater scale than in 2023, driven by strong growth in major markets including Asia such as South Korea.

Looking ahead to 2024, global capacity will continue exceeding the available scrap with a strong expansion once again in major regions, China, Europe and the US. Notably, black mass refining capacity in Europe, currently undersupplied, is expected to increase sufficiently to absorb the regional scrap available. Additionally, cross-border expansion to Europe, mainly by recyclers with black mass refining capability, is anticipated to continue in 2024. In Asia (excl. China), we will begin to see capacity emerging in Southeast Asia, particularly in Indonesia. South Korea leads the regional expansion, followed by India.

Considering the persistence of overcapacity through 2024, the market is expected to face challenges.

Competition for securing feedstock is likely to intensify and financial pressure on margins, associated with potentially lower plant utilisation, could increase, among other factors.

While LFP battery recycling plants have concentrated in China, driven by EoL LFP batteries and production scrap domestically available, progress in LFP recycling outside China has been considerably slower. This is due to the predominance of NCM batteries and relatively lower recycling values for LFP than EoL NCM batteries. The trend in 2024 is expected to largely resemble that of 2023 with China dominating. However, there is an increasing interest in LFP recycling beyond Chinese players such as in South Korea, indicating a geographical diversification in LFP recycling development going forward.

Battery Storage

A snapshot of 2023

BESS was the fastest growing battery market in 2023, increasing 80% y-o-y.

Over **130GWh** of BESS installed globally in 2023 across the grid and behind-the-meter market

The stationary storage market in 2023 continued its upward trajectory, with 130GWh of new operational capacity, increasing 80% y-o-y.

The grid storage market accounted for close to 100GWh of this, more than double that entering operation in 2022. China dominated this space, accounting over 70% of new capacity, the US & Canada came in second with over 20GWh of new grid capacity, additionally, large-scale projects entered operation in Latin America and Africa for the first time. Larger projects are becoming commonplace, with 35+ projects over 500MWh entering operation this year, compared to less than 10 in 2022. In terms of project announcements, we tracked 74 projects over 1GWh enter our BESS project pipeline in 2023.

74 Projects over 1GWh entered the project pipeline in 2023

On the behind-the-meter side, growth has been more moderate, localised to specific regions based on market needs and support. Within Europe, namely Germany and Italy, residential storage installations close to doubled driven by the paired rooftop solar model and generous subsidies. In China, an increase in C&I storage was noted in 2023, with uptake at factories and shopping centres.

Despite the impressive growth, there were significant headwinds resulting in a slower than expected year. As of January 2023, close to 140GWh of projects had a planned completion date for the year, over 40GWh of this was delayed and, in some cases, cancelled. High interest rates, uncertainty over local regulation, grid connection queues and supply chain issues have all been to blame. In terms of the supply chain, 2023 saw improvements in cell and system supply as production capacity grew globally, however lead time for other components such as transformers continue to cause issues for developers.

86% of storage installed in 2023 was LFP

In terms of battery chemistry, LFP continued its growing dominance of the space, accounting for 86% of installed capacity, increasing from 77% in 2022. Part of this shift has been driven by dedicated LFP storage cells manufacturing, which has ramped up significantly over the last 18 months. Large format 280Ah dedicated storage cells are now the norm.

What to look for in 2024

2024 will see a diversification of chemistry, larger projects, and Europe become a bigger player in the grid storage market.

Strong growth is anticipated once again in 2024. New operational capacity is set to increase by close to 200GWh, with most of the growth coming from the grid market. At a regional level, Europe is set to see the strongest growth, with over 20GWh of planned grid capacity, compared to the less than 4GWh that entered operation in 2023.

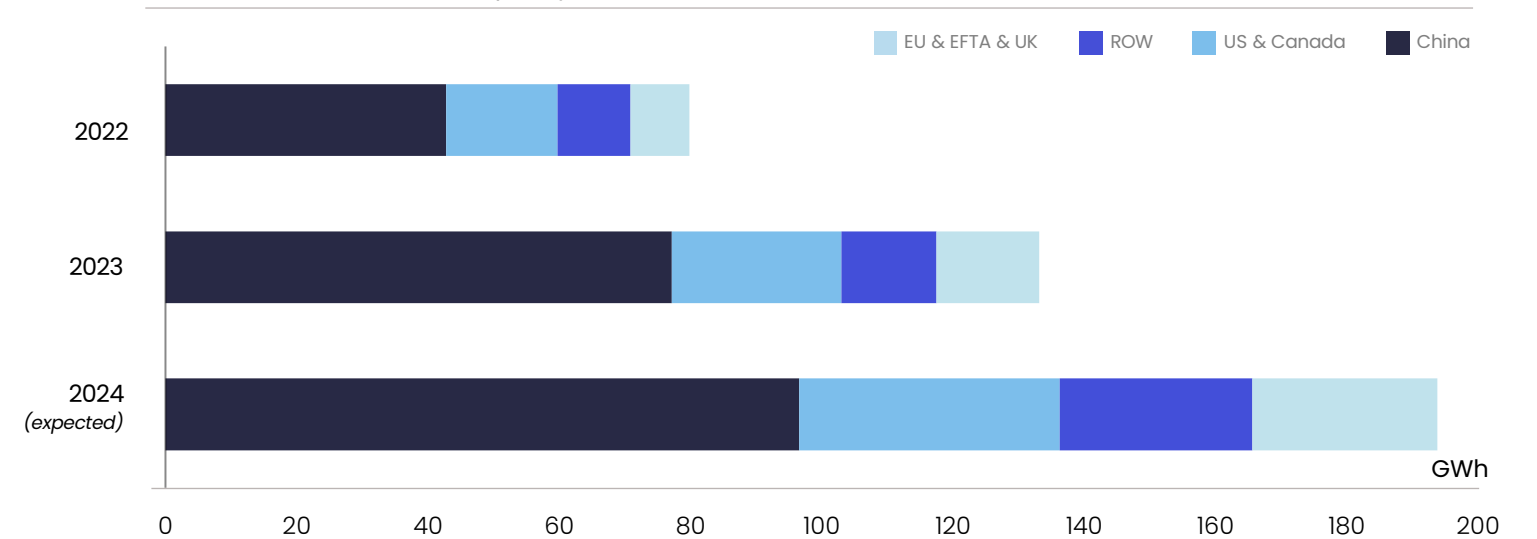
Having made up less than 1% of grid storage battery demand in 2023, non-lithium ion batteries will become more important in 2024. Based purely on announced projects, flow batteries are leading the alternative chemistry for storage space, with close to 5GWh of capacity due to enter operation in 2024.

LFP will continue to take centre stage, with Chinese players dominating the supply, however LFP is no longer just LFP, but specialised for its storage application. Large format 300Ah battery cells will take up more market share in 2024 and replace the current 280Ah products. EVE Battery and several other battery makers plan to launch 500+Ah prismatic cells in 2024. Meanwhile, the research focus has now shifted to long-duration cells. Hithium and SVOLT have announced the development of BESS cell dedicated to 4-8 hour duration BESS projects. Outside of China, 20+ projects with a duration over four hours are due to enter operation in 2024.

For sodium ion, many cell manufacturers and integrators are now pursuing the technology, however cheap LFP cells have slowed the pace. Despite this, two projects with a combined capacity of 104MWh are due to enter operation in 2024 using sodium ion. Throughout the year we can expect more announcements for sodium ion projects.

Finally on policy, more attention will continue to be given to the role of storage, with many issues such as the lack of profitability in standalone storage in China and long grid interconnection queues to be ironed out.

2022 – 2024 Installed BESS capacity (Grid & Behind the Meter)



EV Motors & Systems

A snapshot of 2023

2023 saw the end of ever rising average vehicle power as the market balanced itself

17.5mIn

electric motors deployed in EVs in 2023

85%

of EV motors were PMSM type, the highest ever proportion

6%

of BEVs sold use 800V or higher architecture, only a slight increase

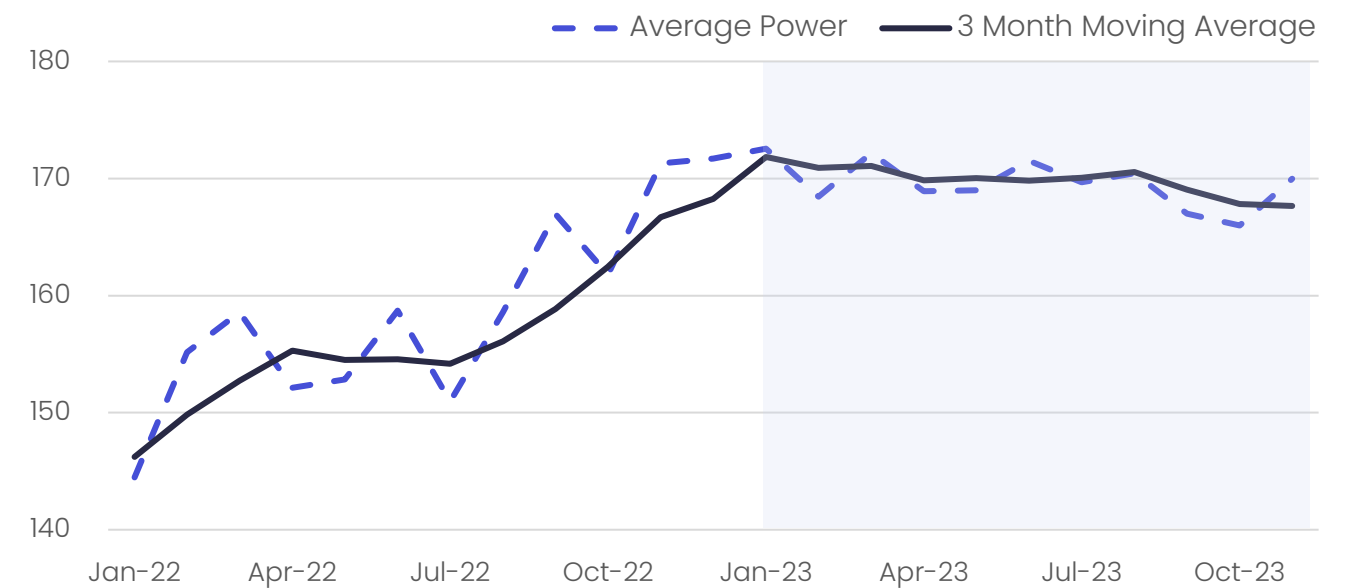
Beyond batteries, development continues across the EV, in 2023 we saw the introduction of the first 48V low-voltage systems in EVs as well as significant progression elsewhere, from steer-by-wire and brake-by-wire to magnet free motors and modular drives. Driver experience is also at the forefront pushing forward progress with new chipsets for cockpit control.

Permanent Magnet Synchronous Motors (PMSM) actually increased market share in 2023, up from 84% to 85%. A continued result of the increasing market share of China in the EV market, the region particularly favours PMSM technology with its domination of the rare earth supply chain locally.

Elsewhere, development continued to look for alternative options than rare earth permanent magnet motors. Tesla teased at its technology day that it would move to zero rare earth content in its future PMSM design, leading to speculation a ferrite magnet alternative is on the way. Meanwhile Proterial demonstrated the possibility of this technology, first in simulation then in prototype with an increased rpm making up for the loss in magnetic strength

ZF released its I²SM, a new separately/electrically excited synchronous motor with an inductive ring to pass power to the rotor. Then, DeepDrive released its CSD 450, a dual rotor configuration using 50% less magnetic material.

Rho Motion EV Power Tracker, 2022-2023



What to look for in 2024

In 2024 the stabilisation of average vehicle power is expected to continue. With a greater balance between small and large vehicles being achieved, more reflective of a mature market, we do not expect the significant changes seen in vehicle power in 2022 to return. On the technology side, alongside continued movement towards low-rare earth and rare earth free technology through product releases and future roadmaps, higher torque and the integration of components into Integrated Drive Modules (IDMs) is expected to feature.

Development of ex-China rare earth supply chains will continue in 2024. MP Materials has begun shipping NdPr Oxide, the raw material key for rare earth magnets, with production ramping significantly this year and customer deliveries commencing.

In semiconductors, heightening trade tensions continue between the US and China, however development of advanced designs will continue, led




predominantly by Nio, Geely and BYD, often in collaboration with ex-China players. AI chips have also seen a boom in 2023 on the back of large-language models, however autonomous driving technology continues to be a top priority for most OEMs, significant progress towards higher SAE levels will come in 2024 with testing licenses granted in China and more approvals in Europe.

Rho Motion: What to watch in 2024

Click on a product icon below for more details.




EV & BATTERY

-

-  EV & Battery Quarterly Outlook
-  EV Battery Chemistry Monthly Assessment
-  EV & Battery Monthly Database



EV PRODUCTION & SALES

-

-  EV Production Quarterly Outlook
-  EV Sales Quarterly Outlook
-  EV Sales Monthly Assessment



BATTERY RECYCLING

-

-  Battery Recycling Quarterly Outlook
-  Battery Recycling Capacity Database


EV MOTORS & SYSTEMS

-

-  EV Motors & Systems Quarterly Outlook
-  EV Motors Monthly Assessment




CHARGING & INFRASTRUCTURE

-

-  EV Charging Quarterly Outlook
-  EV Charging Monthly Assessment
-  EV Charging Monthly Database





ENERGY STATIONARY STORAGE

-

-  BESS Quarterly Outlook
-  BESS Monthly Assessment
-  BESS Monthly Database

FOCUS REPORTS

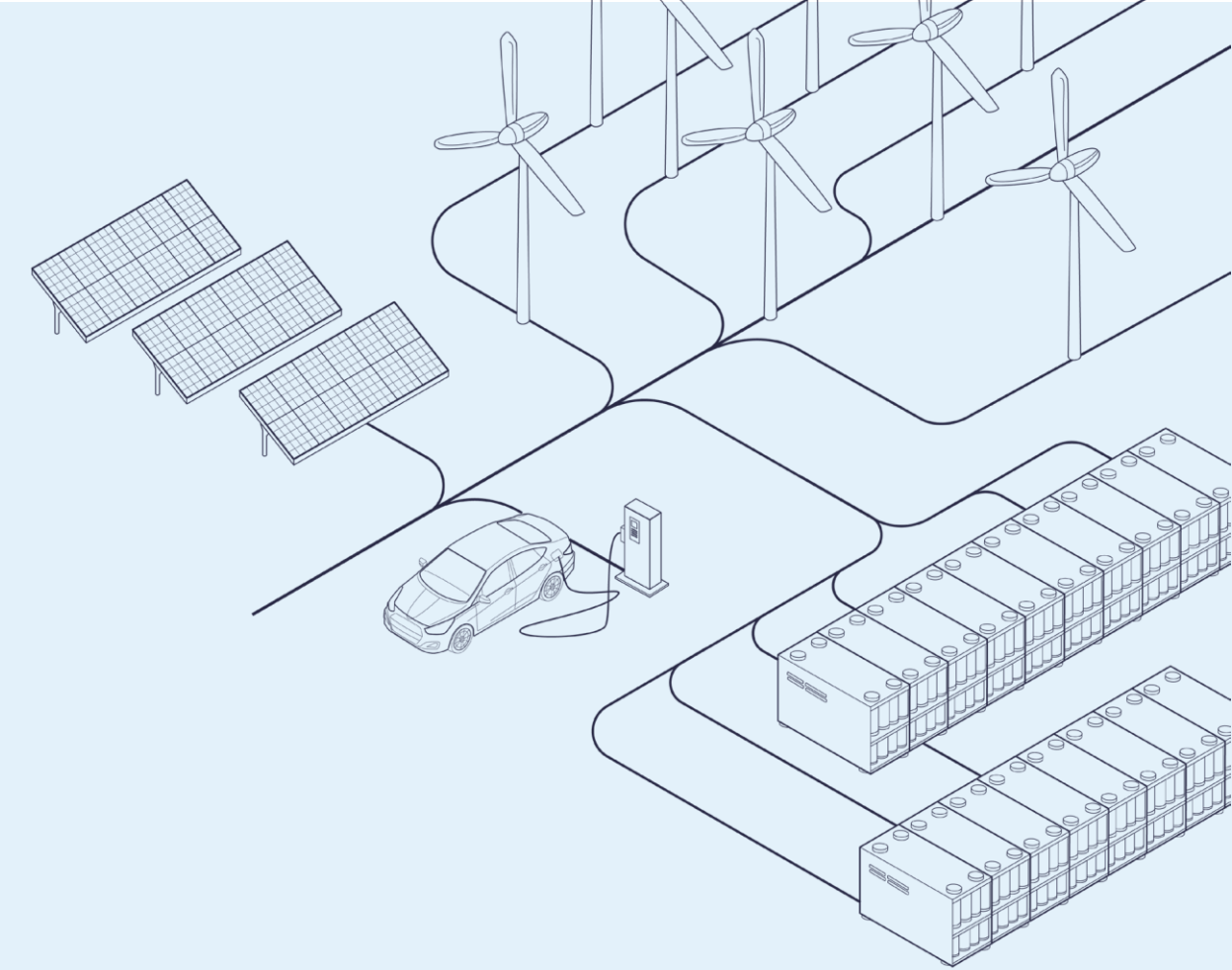
-

-  eMicromobility and 2&3-Wheeler Outlook
-  Portables Battery Outlook
-  Battery Cell Cost Model
-  NRMM Battery Outlook

BATTERY DEMAND SERVICE

-

-  Battery Demand Outlook Service
-  Monthly Battery Demand Service



rho
motion

Our products

Rho Motion is an industry leader, delivering forecasts and analysis on the EV & battery, EV charging and energy stationary storage markets. Our analysis is delivered in flexible, dynamic formats that can be customised for the user.

[SEE ALL PRODUCTS](#)

rho
motion

Get in touch:

Email: info@rhomotion.com

Telephone: +44 (0) 203 960 9986

www.rhomotion.com