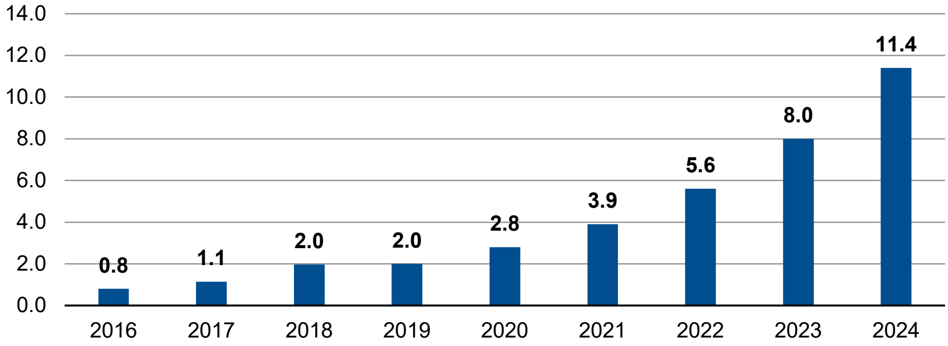
# Electric car sales: Europe takes pole position
# Government subsidies still determine demand

**Europe has become the world's hottest electric-car market this year despite the slump in overall auto sales, underscoring how government subsidies continue to drive global demand for light vehicles with alternative powertrains.**

**We forecast a 33% rise in global electric vehicle (EV) sales to around 2.8 million units in 2020 from 2.1 million units in 2019, when growth was a relatively weak 6%, based in part on estimates from the International Energy Agency. First-half EV sales rose 14% in contrast with the 28% slide in sales of all light vehicles. Plug-in hybrid vehicles (PHEVs) rather than battery-electric vehicles (BEVs) continue to make up the majority of EV sales worldwide.**

**In Europe, we expect that EV sales will rise by more than 50% this year, having jumped by around 57% in the first half compared with the same period in 2019. Generous government subsidies in many markets explained the surge in demand. For the first time since 2015, more EVs were sold in Europe in H1 than in China.**

**Figure 1: Outlook for electrified vehicle sales by units (million)**




Source: International Energy Agency, Scope Ratings

We expect the trend to continue for the rest of 2020 and next year. In Europe, new customer subsidies have come into force in June and July, notably in France and Germany, ensuring bumper summer EV sales compared with 2019. EV sales should approach 1m units this year, not far from recent peak sales in China. Sales of that magnitude in Europe – equivalent to around 7% of all light vehicles sold (7.5% in H1) – would allow European original equipment manufacturers (OEMs) to meet emissions targets set by the European Union, thereby avoiding environmental penalties.

Subsidies will also determine growth in the US, where the government has toyed with the idea of phasing out a volume-linked tax credit for BEVs, despite a steep decline in demand of the broader market. In China, sales of new energy vehicles (NEV) – comprising BEVs, PHEVs, and fuel-cell cars - will likely remain subdued following the 70-80% reduction in purchase subsidies in July 2019. The new regime favours longer-range BEVs which should spur demand for new models in the future. For now, the aggregate subsidies are significantly lower than previous incentives for customers to buy cars with alternative powertrains.

The crucial role subsidies play was evident in how EV sales developed in 2019, the first year in the past 10 when demand grew by less than 50%. Demand fell in China, with the reduction in incentives, and in the US, where sales volumes of Tesla Inc. and General Motors Co. EVs crossed thresholds that led to cuts in generous consumer tax credits. Strong deliveries of Tesla's Model-3 sedan in 2018 also distorted comparisons.

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The enduring importance of subsidies shows that BEVs have not yet become a compelling alternative to vehicles with internal combustion engines. In Europe, the roll-out of a wide variety of new EVs through 2020 will give customers a much broader choice. If technological improvements reduce battery costs, helping to bring down sticker prices for new cars, and generous incentives remain in place, we expect EVs will become an increasingly competitive alternative to petrol- and diesel-fuelled light vehicles – repeating the experience of the initially heavily subsidised wind and solar energy sectors which are now an established part of the Europe's electricity networks.

One caveat: from the research we have reviewed, we conclude that scale effects in battery-cell production are limited given the high proportion of costs made up by raw materials such as cobalt. Recent technical developments of battery-cell chemistry with lower shares of cobalt have helped lower unit costs for battery cells but only the next generation of lithium-ion batteries expected in 2025 will likely lead to a significant drop.

## Subsidies drive the market: the lessons from China, US in 2019

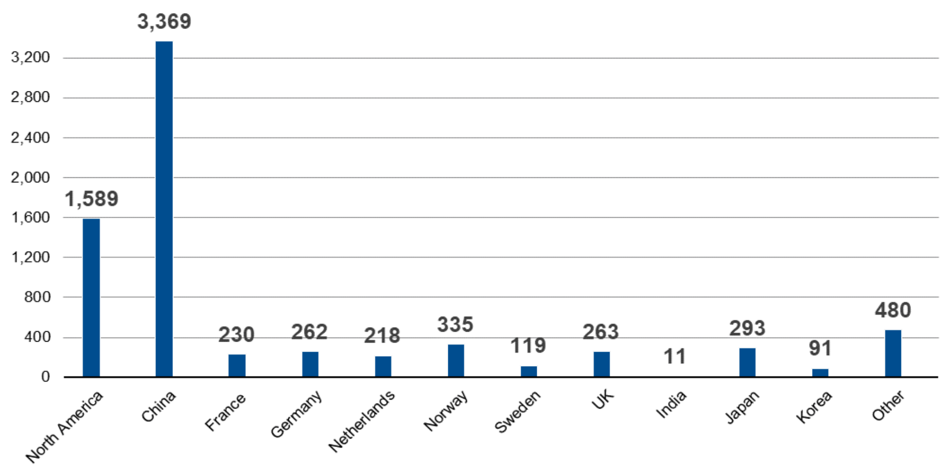
**Global sales of EVs above 2% of all vehicles sold in 2019**

The global stock of electrified passenger cars, BEVs and PHEVs, rose to 7.2m units in 2019. BEVs accounted for 67% of the world's electric car fleet and 33% were PHEVs. As in previous years, China accounted most of the world's electric-car fleet, representing 47% of all EVs sold so far, Europe for 25% while the US represented 20%. EVs accounted for 2.3% of all vehicles sold worldwide, up from 2.2% in 2018. Sales remained limited to a few countries: just 10 accounted for more than 95% of all EVs sold.

**First year in a decade with only single-digit % growth**

However, in other ways, 2019 was an unusual year. With a total of 2.1m EVs sold in 2019, up from 1.98m units sold in 2018, the yearly increase of only 6% marked the first year in the past decade when was less than 50%. There was a 10% decline of EV sales in the US and a steeper decline in China. Electric car sales in the US fell mainly because of high delivery numbers of Tesla's Model 3 in 2018 which were not repeated in 2019. Sales of BEVs, PHEVs, and fuel-cell cars in China were severely affected by a 70-80% cut in purchase subsidies in July. Under the new subsidy regime with lower absolute subsidies, the government is offering more financial support for EVs with extended driving range. More favourable subsidies for long-range BEVs (range > 300km) should lead to a higher demand for more expensive models with better performance set to be launched in the coming years. Subsidies for NEVs are well below the EV incentives of a decade ago that Beijing used to spur development of and demand for alternative powertrains.

**Figure 2: New electric car sales (BEV and PHEV), cumulative data by country**




Source: International Energy Agency, numbers in thsd; cumulative for the period 2010-2019

**BEV stimulation similar to subsidies for wind and solar**

The experience of 2019 showed that government stimulus remains a prerequisite for developing the market for EVs and providing support for OEMs in meeting stricter environmental targets.  For many consumers, BEVs are not yet a true alternative to vehicles with internal combustions engines – incentives are still required to change perceptions. The same was true with other “green” products in the past such as wind energy or solar energy – for example, through favourable feed-in tariffs – where subsidies facilitated the sustainable development of alternative energy sources. BEVs have zero tailpipe emissions but will not be “green” products through the entire value chain until renewable energy sources rather than coal become more important in the electricity-generation mix in countries with the biggest car markets.

## First-half trends in 2020: Europe finds itself in driving seat

**EV sales buck H1 market slump**

Sales of electrified vehicles bucked the slump in the overall market in the first half of 2020 as the Covid-19 pandemic disrupted production, supply-chains and triggered a collapse in demand. The global light vehicle market shrank 28% compared with the same period last year while unit sales of electrified vehicles increased 14%.

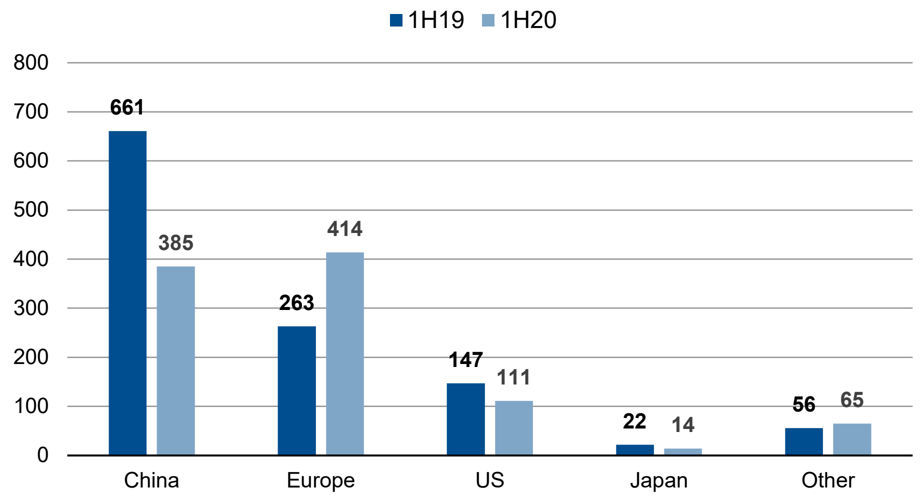
**China EV sales rebound**

In China, the subsidy cuts of 2019 have continued to leave their mark on the unit sales. Sales of EVs in China were down 42% in the first half, keeping in mind that the subsidy regime was more favourable in H1 2019. Data for July suggest a recovery of NEV sales with an increase of 44% compared with July 2019. While the generous cash incentives on a country-wide and regional level were scaled back in June 2019, we still see growth momentum in the Chinese market supported by policy on new-energy vehicles set out by China’s Ministry of Industry and Information Technology. The policy announced in Sept. 2017 sets out specific targets of new-energy vehicles to reach 12% in 2020. Failure to achieve these targets could result in fines for auto makers but players in the industry can buy credit from those competitors that exceed their NEV sales targets. The regulatory target for NEVs in China looks ambitious but achievable for auto OEMs. For instance, VW has targeted EV sales of 400k units in 2020 compared with total Volkswagen AG sales of 4.1m vehicles in China in 2019.

**Tesla’s shutdown holds back US sales**

US EV sales were partly held back by the shut-down of Tesla’s final assembly in April/May.

**Figure 3: EV unit sales (BEV/PHEV, ‘000) in H1 20200 vs H1 2019**




Source: EV Volumes, in thousand units

In Europe, a growing line-up of EV models - more than 30 new and improved BEV/PHEV models were launched in the second half of 2019 – have attracted more customers.

European car OEMs must comply with more stringent carbon emission targets in 2020 and, consequently, launched the vehicles supporting this goal (there was no regulatory benefit in 2019 to the sale of low-carbon vehicles). First-half European EV sales increased by 57%, representing about 7.5% of all vehicles sold in the region. For the first time since 2015, more EVs were sold in Europe than in China.

## Outlook for BEV/PHEV market in 2020/2021

**New models and additional incentives support demand**

The growth of EV sales across Europe should continue in 2020/2021. Additional environmental incentive schemes have become effective in various European countries in June/July 2020, notably France and Germany, and have led to a an almost 200% rise of EV sales in July 2020 compared with July 2019. For the remainder of this year, purchase incentives for EV should continue to support a further uptick of unit sales and the European market should reach EV unit sales levels that we used to observe in China before the changes in incentive schemes in that region (i.e. 1m units). This would translate into a EV market share of new vehicles sold of about 7% suggesting that the auto industry as a whole could achieve a sufficiently high number of low-carbon vehicle sales in 2020 to comply with the EU's regulatory goals.

**Tax credits in US for Tesla vehicles phased out**

An interesting market to watch will be the US, where reductions and then eliminations of tax credits for some EV manufacturers have clearly had an impact on demand. The substantial rise of BEV vehicles sold in 2018 and early 2019 underpinned by a generous USD 7,500 tax credit. The measures work by offering any buyer of a BEV a USD 7,500 tax credit if the BEV is one of the first 200,000 made by an individual OEM. Beyond that threshold, the tax credit falls by half. Tesla and GM have both surpassed the cumulative sale of 200,000 EVs, triggering first a reduction in the credit and then its elimination in January this year for Tesla and in April for GM. It remains to be seen whether the tax credit remains in place for other OEMs in the US. The Trump administration has entertained the idea of scrapping the BEV-subsidy completely.

**Demand for BEVs in the US market-driven or policy-driven?**

Until that happens, we believe Tesla and GM's EVs are now at clear pricing disadvantage to competitors, given that an OEM that has not reached the 200,000 aggregate sales ceiling has a price advantage of USD 7,500 per vehicle. The year 2020 will be a "proof of concept" whether the strong demand for Tesla vehicles in the US was market-driven (i.e. appealing product in the eyes of the customer with willingness to pay) or simply a policy-driven effect (appealing product in the eyes of the customers and bought because of governmental subsidies on top).

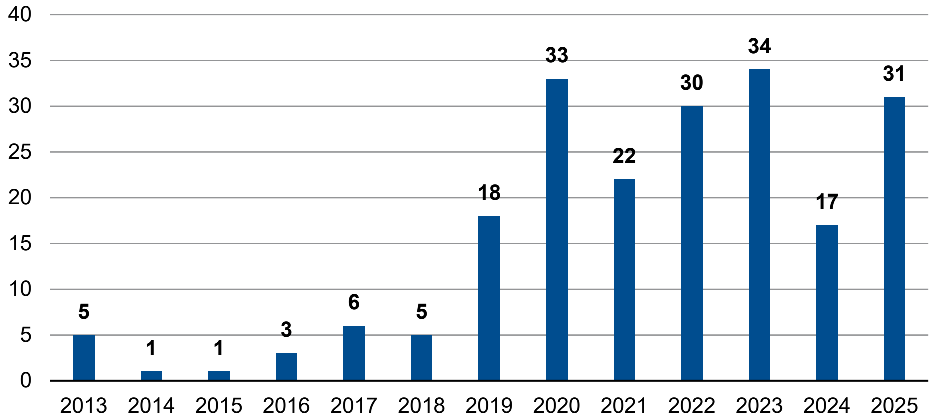
**OEMs target 25% share of BEVs by 2025**

OEMs have laid out different product and model strategies for the coming years. Projections and plans by different OEMs point towards a share of about 25% of battery-powered vehicles by 2025. The largest share of vehicles along the way towards achieving those targets will very likely be plug-in hybrids and a gradually rising share of BEVs.

**Expanding EV line-ups should underpin segement growth**

The wider range of BEV/PHEV models coming to market should encourage demand assuming that public policy measures (eg, direct purchase subsidies, reduced VAT on BEVs, exemptions from vehicle taxes, free access to toll roads) remain in place.

Figure 4: Number of new EV model launches in Europe




Source: International Energy Agency, Scope Ratings

**PHEVs continue to dominate segment**

Our estimates, based in part on data and forecast from the International Energy Agency, put the total number of EVs sold in 2020 at around 2.8m, the majority of the vehicles being PHEVs.

## Battery costs: technology is improving; economies of scale modest

**Key cost item for BEV is battery pack**

The key component of a BEV is the battery pack providing the energy for the electric-drive module (electric motor) and DC/DC converter. Battery types consisting mainly of nickel, manganese and cobalt (NMC) and NCA (nickel, cobalt, aluminium) – as used by Tesla for its BEVs – are the backbone of today's industry, installed in about 75% of all EVs. They should remain the prevailing chemistry for EVs for the next few years. Despite the "Lithium-ion (Li-ion)" naming convention for the battery technologies mentioned (NMC, NCA), lithium is not the primary component of those batteries. Prices for Li-ion batteries have fallen markedly since the introduction of the technology in the 1990s.

**Battery chemistry improved and cell capacity increases**

Four drivers have helped to reduce cost of Li-ion battery cells while simultaneously improving performance: battery chemistry, battery capacity (energy density), manufacturing capacity, and charging speeds. Despite the achieved, energy density of battery cells and recharging time still compare poorly against gasoline. The electric drivetrain has a better energy efficiency than internal combustion engines (90% versus 26% for internal combustion engines due to loss of most of the energy though wasted heat). There is still a long way to go in terms of battery technology for BEVs to become the norm on the streets.

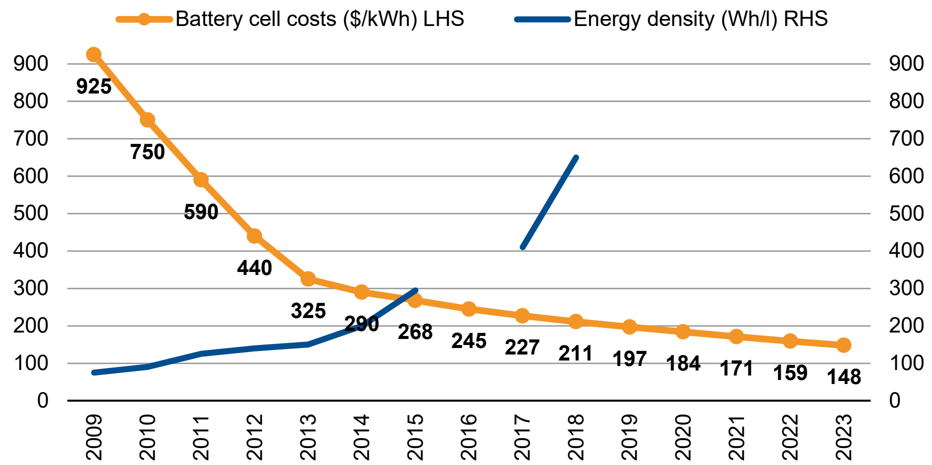
**Cells costs remain key barrier for further BEV demand**

Production costs and performance of batteries remain one of the key barriers for a further take-up of demand for BEVs (if one disregards the fact that customer choice for BEVs has so far been limited). With current prices for battery cells of about USD200/kWh, it remains difficult for car OEMs to offer BEVs at an economically attractive price point.

**Economes of scale limited in battery production**

From the research that we have reviewed, we conclude that further production cost reductions of battery cells look feasible. Cost improvements should result from improved battery chemistry and larger production numbers (scale effects/learning curve effects). According to calculations of the U.S. Department of Energy (DoE BatPaC model), the cost effects from scaling up battery cell production facilities is not as significant as one would think when thinking about the scale effects in production. According to DoE calculations, the production cost for battery cells decreases by 9% when production is increased from 10,000 battery cell packs (of 60 kWh each) to 50,000 units while an increase from 100,000 units to 500,000 suggests a cost decrease of 12%. Currently, most of the battery cell manufacturers have capacities of 3 GWh to 8 GWh suggesting production of 50,000 to 130,000 cell packs (assuming 60 kWh cell packs). Battery cell factories announced for completion in various countries worldwide including Hungary, China, India, Germany are all planned to have "gigafactory" size with annual capacity of 25 GWh – 35 GWh. Hence, whenever these factories are fully loaded, a unit-cost effect of USD20/kWh-US25/kWh should become effective (assuming unchanged input prices).

**Figure 5: Cost of battery cells in $/kWh and battery energy density**




Source: U.S. Department of Energy (DOE), Bloomberg New Energy Finance, Volkswagen

**What are the key components of a battery pack?**

**Cost of battery pack:** Cost of li-ion battery cells + pack costs

**Cost of li-ion battery cells:** Key cost items are raw material prices for anode and cathode material. Main cathode materials are lithium, nickel, cobalt, manganese in different in different combinations (cell chemistry). Cost of battery cells currently is about 60% raw materials and 40% overhead and production

**Pack costs:** battery management systems including thermal management plus other pack content such as wiring, cooling plates, plastics/pack cover

**Battery chemistry advancements improve performance and cost**

Improvements in battery chemistry promise both further cost reductions and increased battery performance. Battery cells consist of a cathode (positive pole) and anode (negative pole) and the battery performance (energy density) is influenced by the chosen chemistry mix. Typical cathode materials currently used are nickel, manganese, cobalt (also known "NMC") and most current battery designs use graphite as an anode material.

**Specific energy of batteries**

**Specific energy:** Capacity to store energy per kg of weight. Energy density of battery cells is only about 2% specific energy of gasoline. Battery cells currently have energy densities of about 300 Wh/kg versus 13,000 Wh/kg for gasoline. The specific energy of battery packs with those cells is about 30%-40% lower.

Energy density of batteries improved over the decades with every new generation of anode/cathode chemistry. Nickel cadmium batteries (banned since early 2000s) had energy density of 40 Wh/kg while the subsequent chemistry (NMH, nickel metal hybrid) already doubled the energy density to 80 Wh/kg. A breakthrough in energy density was achieved in the early 2000s with lithium-ion, again doubling the energy relative to preceding technology (NMH). One of the key reasons why BEVs developed in the early 90-ies were not successful was the lack of battery technology available at that time (NMH technology insufficient to develop BEVs with long ranges).

**Reducing cobalt input to lower unit costs for battery cells**

Current Li-ion NMC battery cells have a uniform content of cathode material, i.e. the share of cathode materials nickel, manganese, and cobalt are equally weighted (known as NMC111). Current technology advances aim to reduce the cobalt content in battery chemistries leading to a higher energy density (i.e. more energy stored for a given quantity of cathode material). The next battery technology is the NMC 622 chemistry where nickel atoms account for 60% of the cathode (with the remainder equally spread between manganese and cobalt). The change in cathode composition from NMC111 to NMC622 promises a 7% cost decrease for battery cells according to IEA calculations.

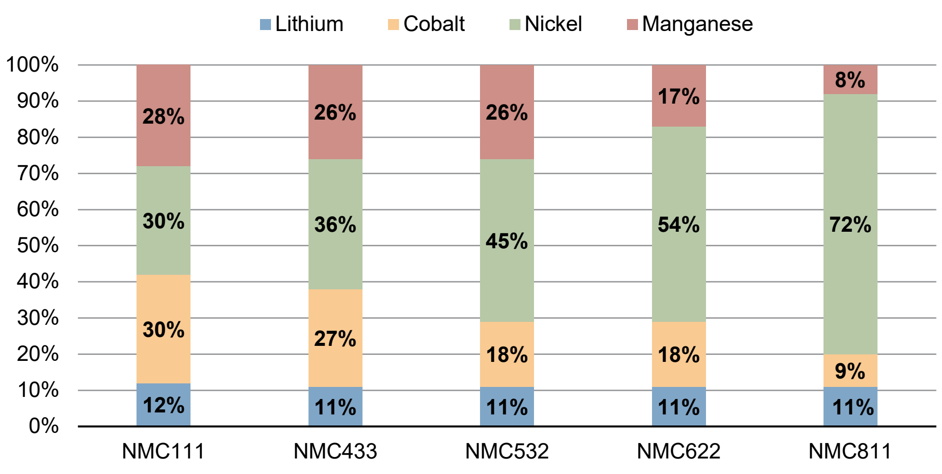
**Next generation cell structure to reduce cell costs further**

The next generation of Li-ion batteries, known as NMC811, is likely to enter mass production around 2025 is expected to have an even lower cobalt content with the benefit of a further increase in energy density: i.e. 80% of the cathode atoms are nickel with the remainder equally spread between manganese and cobalt. According to calculations of the U.S. DoE (BatPac model), the NMC811 chemistry (using graphite as anode material) could result in cell costs in a range of USD 100/kWh-USD 122/kWh assuming a cell production capacity of 7.5GW/year - 35GW/year and cell pack size of 70–80 kWh.

**Battery cell maker LG Chem also working on reduced cobalt**

Calculations of the IEA are in line with announcements by cell-maker LG Chem. LG expects to improve the energy density of battery cells by 30%-40% in 2020 (relative to 2017) leading to cost reduction of USD 20/kWh-USD 30/kWh suggesting a unit-cost improvement slightly better than then calculations that the IEA has done for the move from NMC111 to NMC622. LG Chem also expects to improve unit-costs of battery cells by a further USD 25/kWh through the reduction of the share of cobalt in the cathode mix (i.e. the move to NMC811).

**Figure 6: Metal content of Li-ion battery by cathode chemistry**




Source: International Energy Agency

**Lower cobalt share reduces raw material risks**

The technology transition from today's NMC111 to NMC622 and eventually to NMC811 cathode chemistry will reduce the dependence on volatile pricing and expense of cobalt. Battery pack costs increase by 9% if the cobalt price rises by 50% while the cost increase would be only 2.5% with NMC811, according to IEA calculations.

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