

Oil & Gas Practice

# Recharging economies: The EV-battery manufac- turing outlook for Europe

As uptake of electric vehicles (EVs) increases, the EV-battery market represents an opportunity for European players. We assess the potential and look at factors guiding the location of production capacity.

*by James Eddy, Alexander Pfeiffer, and Jasper van de Staaij*



**With the dawn of electromobility** and the resulting increase in EV production, the market for EV batteries has seen consistently high growth rates over the past few years. In 2017, for instance, global EV-battery manufacturers produced an estimated 30 gigawatt-hours of storage capacity, almost 60 percent more than in the previous year—a trend that is poised to continue.

This market represents a substantial—but so far untapped—potential opportunity for European battery makers and carmakers, as well as for the European economy in general. Currently, the EV-battery market is dominated by players from only three countries, all of them in Asia: China, Japan, and Korea. In 2018, less than 3 percent of the total global demand for EV batteries was supplied by companies outside these three countries, and only approximately 1 percent was supplied by European companies.

In this article, we assess the potential market for EV-battery production in Europe and look at the major benefits of having such an industry located there. Moreover, we analyze the key decision criteria for battery-cell manufacturers when deciding the location of new production capacity.

### **Current situation: Electric-vehicle-battery-production paradox in Europe**

Thus far, the EV-battery situation in Europe has been something of a paradox: while European carmakers have struggled to secure sufficient battery supply, investments in battery manufacturing have been concentrated in Asia. Of the 70 announced gigafactories globally, 46 are based in China. Unlike China, Europe does not have a coherent industrial strategy to attract large-scale battery manufacturing. The resulting challenges for this incumbent industry and problems with planned investment have even led some of Europe's homegrown battery manufacturers to set up shop elsewhere—namely, China. Netherlands-based

Lithium Werks, which already has two plants in China, announced plans in September for another. The company says it prefers to build plants in China because the infrastructure is better, and it is easier to get the permits needed to build a factory.

With limited local options for supplying batteries, European car manufacturers have largely secured supply so far by signing long-term deals with Asian producers. Certain European premium OEMs, for example, have so far ruled out further investments into cell production and focus only on R&D and packaging. Nissan currently has a plant in Sunderland, United Kingdom, but is seeking to divest. Volkswagen just announced it is investing €1 billion in a battery-cell factory that it is developing in partnership with SK Innovation in Germany, while it also has major supply deals with LG Chem, Samsung, and Chinese battery maker CATL.

With most car manufacturers opting not to produce batteries themselves and failing to secure supplies near their European plants, European car manufacturers run the risk of operating at a disadvantage to competing car manufacturers that are closer and better able to secure battery supply as the demand for EVs grows. Consequently, there may be lucrative opportunities for battery manufacturers that establish facilities in the right places at the right times.

### **Opportunity in transition: Additional battery-manufacturing capacity needed**

With rapidly improving economics of EVs and a regulatory push across different European countries, we anticipate that by 2040 about 70 percent of all vehicles sold in Europe across different segments (passenger cars, vans, trucks, and buses) will be electric. Falling battery costs make it likely that the total cost of ownership for a passenger EV will reach parity with internal-combustion-engine (ICE) cars by the mid-2020s. In the meantime, tightening efficiency targets will

push car manufacturers to electrify a larger share of their produced fleets, while the sharing economy, autonomous driving, and transport as a service provide further incentives for electrification by fleet operators. In addition, many European governments have announced they intend to ban the sales of ICE vehicles by 2030 or 2040 (Exhibit 1).

This dramatic increase in EV numbers means that the potential battery market is huge. We project that by 2040 battery demand from EVs produced in Europe will reach a total of 1,200 gigawatt-hours per year, which is enough for 80 gigafactories with an average capacity of 15 gigawatt-hours per year (Exhibit 2).

The projected battery demand from EVs produced in Europe is more than five times the volume of currently confirmed projects in Europe, which include, for instance, Northvolt in Sweden, LG

Chem in Wrocław, Samsung SDI in Göd, and CATL in Erfurt (Exhibit 3)—additional demand of about 1,000 gigawatt-hours per year by 2040 versus today's announcements. This gap will have to be met by either battery imports or additional battery-manufacturing capacity in Europe.

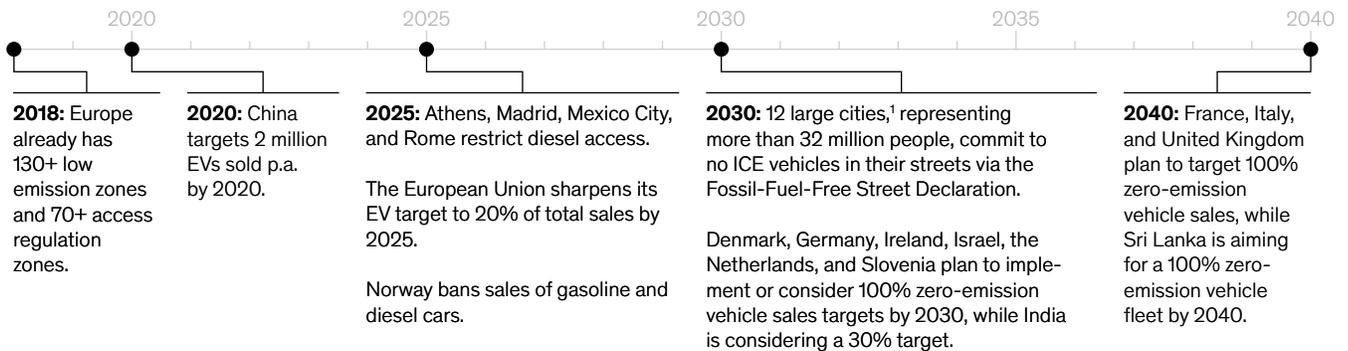
### Strategic considerations: Regional battery production

European car manufacturers, policy makers, and potential battery suppliers have strong economic and strategic incentives to ensure local battery production. The battery is the single most costly part of an EV, currently making up between 35 to 45 percent of total cost. It is also expected to be the tightest in supply as EV production and supply chains ramp up in the coming years. Not having this strategic part of the production process close by carries significant supply-chain risks for OEMs and

Exhibit 1

## Cities are increasingly introducing restrictions on internal-combustion-engine (ICE) vehicles, while many national governments are considering ending ICE vehicle sales.

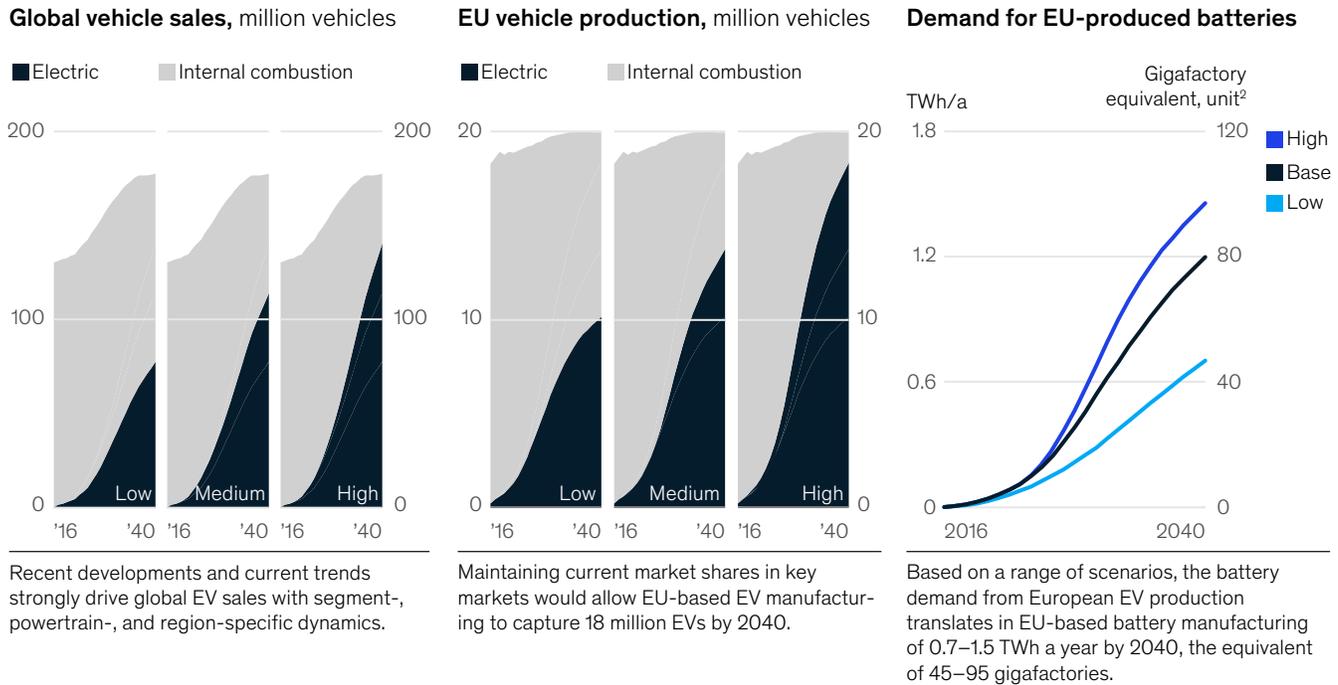
### Timeline



<sup>1</sup>The 12 cities that signed the Fossil-Fuel-Free Street Declaration are Auckland, Barcelona, Cape Town, Copenhagen, London, Los Angeles, Mexico City, Milan, Paris, Quito, Seattle, and Vancouver.

Source: C40; China Industry and Information Technology Ministry; *Daily Mail*; Electrek; *Guardian*; *Independent*; International Energy Agency; Harvey; *Il Sole 24 Ore*; London Government; Mairie de Paris; *Spiegel*; Sicilia; *Telegraph*; *Times of India*

**In 2040, EU electric-vehicle<sup>1</sup> production translates to EU-based battery manufacturing of 0.7–1.5 TWh a year, the equivalent of 45–95 gigafactories.**



<sup>1</sup>Includes battery electric vehicle, plug-in hybrid electric vehicle, hybrid electric vehicle, and fuel-cell electric vehicle across passenger cars and commercial vehicles.

<sup>2</sup>Assumes 15 gigawatt-hours/year equivalent to 1 gigafactory.

Source: IHS (data adjusted for short-term fluctuations); Energy Insights by McKinsey

represents a lost opportunity for policy makers to locate a significant share of value creation in Europe.

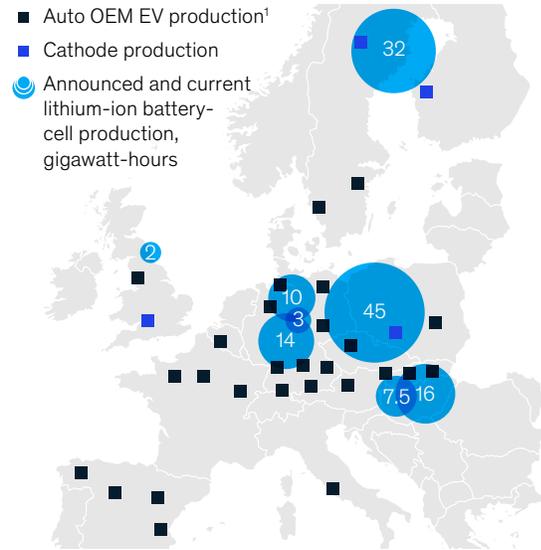
For European nations, the risk is that falling production of ICE vehicles and EV production without secure local battery capacity might make the European automotive industry less competitive. OEMs typically prefer to manufacture their products close to the markets. Yet, they could prioritize being close to the critical part of their supply chains and move their EV production closer to battery manufacturing, should battery manufacturers decide not to locate their gigafactories near anticipated EV production.

European car manufacturers, however, do not seem particularly eager to get involved in battery-cell manufacturing themselves. First, it is difficult to find the right chemistry, set up the production process, and get other components in place to produce battery cells. This kind of knowledge does not reflect the core competencies of a car OEM. Instead, car OEMs typically see value in the packaging of cells into modules and battery packs. Second, producing batteries in house or switching to a wider base of suppliers—perhaps even European suppliers—often presents risks: namely, that individual suppliers cannot secure enough raw materials at low-enough prices to support the required production. Growing battery demand

Exhibit 3

## In line with EV growth and new model launches from European OEMs, different players along the battery supply chain are ramping up capacities in Europe.

**Production locations,** not exhaustive



**Additional lithium-ion battery-cell production capacity:**

- BYD considering cell production outside of China, including in Europe
- Tesla to build another gigafactory in Europe (may be announced by the end of the year)

<sup>1</sup>Largest battery electric vehicle (BEV) and plug-in hybrid electric vehicle (PHEV) production locations as well as general leading truck/bus production locations in Europe in 2025; BMW, Daimler, and VW established competence centers for battery modules and packs located in Germany.

Source: IHS Automotive; McKinsey analysis

has already put pressure on a scarce materials supply, raising supply risks. The price of lithium has tripled since 2015, and global cobalt production in 2025 will likely need to be double that of 2016 production to satisfy global EV demand. To minimize this risk, EV manufacturers may be well advised to integrate more closely with cell manufacturers that have strong control over their own supply chains. Currently, a handful of Chinese, Japanese, and

Korean cell manufacturers dominate the market and much of the value chain, with control extending, in some cases, as far as the mines that extract lithium and other key metals.

Moreover, sourcing from nearby battery manufacturers allows OEMs to eliminate supply-chain risks, including transport concerns for dangerous goods and working-capital issues, while enabling co-development and troubleshooting of battery cells, packs, and EVs. We find that this can more than offset the potentially lower costs of a more distant plant, such as ones in countries that pay high up-front capital-expenditure subsidies, while allowing for greater flexibility and mitigating the risks associated with sourcing all batteries from one region.

### Coordination: The concerted effort of all stakeholders is required for successful ramp-up of battery production

To meet battery demand in the 2020s, automotive OEMs, their suppliers, and public stakeholders must start making the required arrangements now or find ways to accelerate the timeline. Recent experience shows it takes five to seven years from the start of planning a battery-manufacturing plant and setting up a pilot production line to reach full operational capacity of several gigawatt-hours per year.

The timing of establishing new battery production capacity, however, is critical. If EV production ramps up before cell manufacturers have announced local production, EV manufacturers might have already secured battery supply for their first cycle of new product platforms. On the other hand, if cell manufacturing ramps up before significant EV demand is in place, battery manufacturers face the choice between building smaller plants, which are less efficient because they don't benefit from the optimal size (typically around eight to 15 gigawatt-hours per year for optimal scale effects), or running large plants at (initial) low utilization due to lack of demand.

Regarding the scale of new plants, larger facilities with more than eight gigawatt-hours per year in capacity have been shown to be twice as productive per euro invested than smaller projects. Recent projects with more than eight gigawatt-hours per year have invested on average about \$120 million per gigawatt-hour per year in capacity. Extrapolating this to cover the 1,200 gigawatt-hours per year required by 2040 reveals a total investment of approximately \$150 billion across Europe to manufacture the cells. Further investment in R&D and the value chain (such as in electrolytes and electrodes) would add to that requirement.

### **Homegrown advantages: Other reasons why Europe benefits from battery manufacturing**

Should EV-battery-production capacity be installed in Europe, it would bring considerable advantages for Europe's economic, industrial, and sustainability efforts. With 1,200 gigawatt-hours per year of demand in 2040, the value of the cell market alone would be around €90 billion per year,<sup>1</sup> with the potential to create about a quarter of a million jobs in battery-cell manufacturing and R&D.<sup>2</sup>

Bringing gigafactories to Europe also has the potential to create jobs upstream in the supply chain and downstream in areas such as reverse logistics, recycling, and reuse. Furthermore, many components of European vehicles are manufactured elsewhere today; securing battery manufacturing in Europe could help locate much of the automotive industry's value-creation efforts in Europe.

Locating cell manufacturers close to OEMs in Europe allows for the creation of a research and innovation ecosystem, fostering codevelopment among players in EV production, cell manufacturing, and upstream materials development and

production (including cathodes, anodes, and electrolytes), along with recycling, research, and innovation networks. Battery-cell technology is also developing rapidly. Next-generation technologies, such as all-solid-state batteries, are already appearing on the horizon, and constant R&D is required to keep up. Asian manufacturers are currently more advanced, and European OEMs and cell manufacturers will have to decide whether to partner with them, try to catch up with them, or attempt to leapfrog to the next technological cycle. Battery-player reputation will also play a role, as European top-tier OEMs are unlikely to source from suppliers without proven track records. As the technology develops further, production of the next generation of batteries may even be best served by players not yet active in the current battery supply chain but with a proven record in high-tech manufacturing. There are European engineering and technology companies that may be well placed to step in as "second movers" and take a share of the next-generation-battery market.

With regard to sustainability, sourcing cells in European countries would allow manufacturers to benefit from Europe's rapidly decarbonizing power systems and reduce the overall carbon footprint of EVs in line with European targets for vehicle-life-cycle decarbonization.

### **Attractive location: Why make batteries in Europe?**

Battery producers have a wide range of locations to choose from, so understanding their needs can prove beneficial to countries that are making it a priority to attract this industry. At a high level, battery-cell manufacturers are typically looking for the best business case and lowest risk in supportive political environments, capitalizing where they can on financial incentives, smooth permitting and

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<sup>1</sup> Assuming average battery price of \$76 per kilowatt-hour in 2040.

<sup>2</sup> Assuming the same job requirements for gigawatt-hours-per-year capacity as the Tesla Gigafactory applied on 1,200 gigawatt-hours-per-year capacity in Europe in 2040.

licensing processes, clean energy, access to skilled labor, and proximity to customers and suppliers with good access to raw materials.

Many countries in Europe can offer these elements. The political systems in most European countries are predictable, and there is a strong commitment at most levels of government to transition to a lower-carbon system, of which EVs and their batteries are key components. Some have well-connected ports with good access to international raw-materials markets. Supporting infrastructure is widespread, as are supporting services.

Europe has some of the best technical-research facilities and universities in the world, which is especially important as battery technology develops. In Central Europe in particular, proximity to research institutions, as well as to suppliers of raw materials and manufacturers, allows battery manufacturers, sometimes together with manufacturers, to capture innovation spill-over and codevelop state-of-the-art components, batteries, and EV platforms.

While state-aid rules limit European states from offering direct financial incentives, the European Union and individual member states offer financing through a range of institutions and programs. In Eastern Europe, some manufacturers are offered tax breaks in special economic zones, and costs for energy, labor, and land use are still relatively low.

Additionally, some of Europe's competitive edges will grow in importance over time. These include its robust educational and knowledge bases, which

will become more significant as low-cost labor is gradually automated and technical expertise becomes increasingly critical.

Europe's strong background in recycling will become more important for manufacturers as the norms for extended producer responsibility rise and as upward pressure is put on the price of raw materials, such as cobalt and lithium. Having supply chains for reverse logistics and recycling in place also enhances security of supply of rare materials, which are often produced in volatile regions. Establishing a closed recycling loop could be a major competitive advantage for European countries in implementing a sustainable battery life cycle.

## Conclusion

It is important that Europe realizes the significance of the potential for local battery manufacturing and its importance for the transition to EV production. If this industry cannot be established in Europe, future EV manufacturing might happen elsewhere, with value creation and jobs following—potentially including current EV and legacy ICE-vehicle production, over time. Establishing battery manufacturing in Europe, however, could not only secure EV-production and other manufacturing jobs but also create new jobs in areas such as cell manufacturing, battery supply chain, and beyond. If this enormous opportunity is to be captured, stakeholders must act now, before EV manufacturers close decades-long supplier agreements—and leave latecomers to the EV-battery industry in the dust.

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