HOW FAST-MOVING TECHNOLOGY GENERATES FAST-CHANGING RISK

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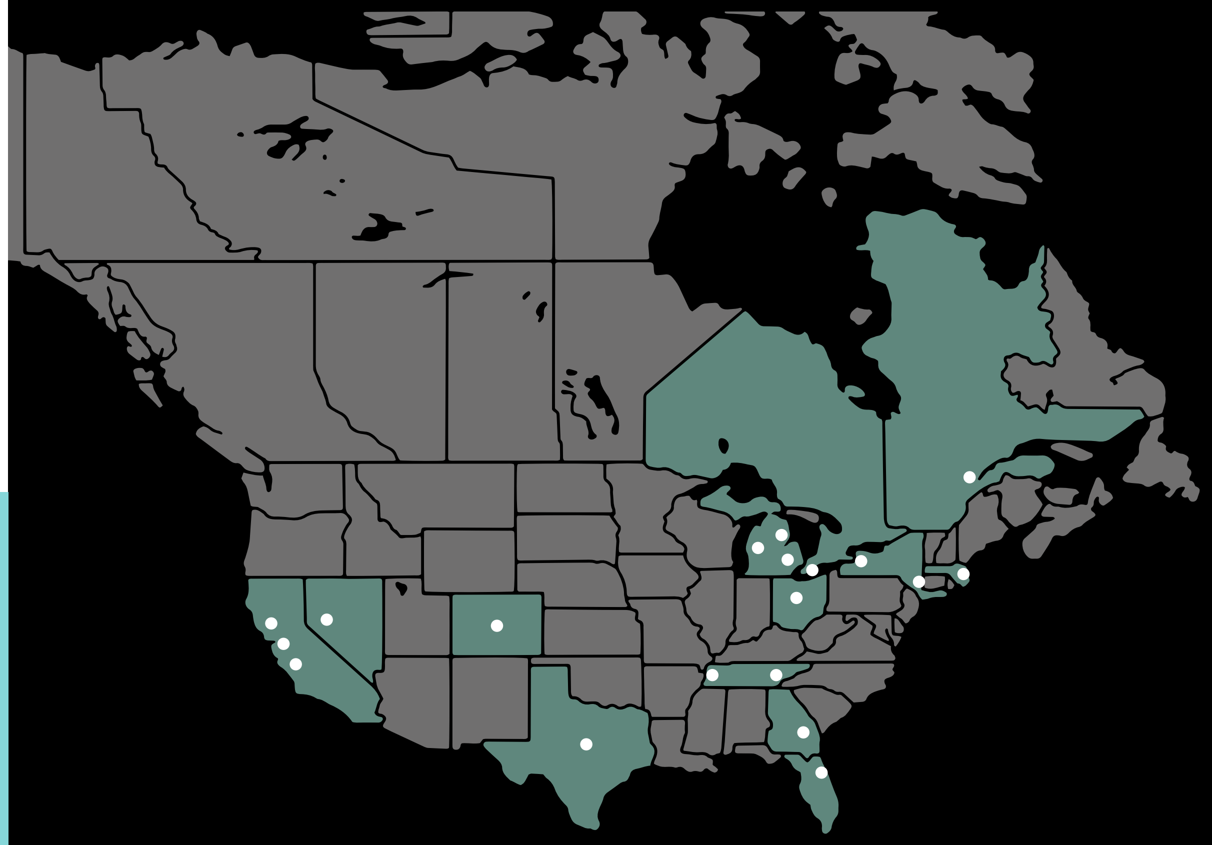
As the world pivots from fossil-fuelled internal combustion engines (ICEs) to electrically powered vehicles (EVs), global capacity for battery production is set to grow exponentially in the next few years. This article examines where and how EV batteries are made, and why this fast-evolving production process could have profound implications for insurers.

WHAT IS POWERING EV GROWTH?

In 2020, electric vehicles accounted for just 5%** of all global car sales. This rose to 9% in 2021 and 14% in 2022 when over 10 million EVs were sold worldwide. Rapid YOY growth is fuelled by government incentives, expanding charging networks, lower entry costs and improved vehicle range and performance. Car brands are responding to rising demand and aligning with regulation to de-carbonise the motor sector. In the USA, 71%* of drivers express an interest in their next vehicle being electric, and UK legislation dictates that by 2030 80%^ of new cars sold must be EVs, rising to 100% by 2035.

NORTH AMERICAN GIGAFACTORIES



EUROPEAN GIGAFACTORIES

FAST-GROWTH BATTERY PRODUCTION

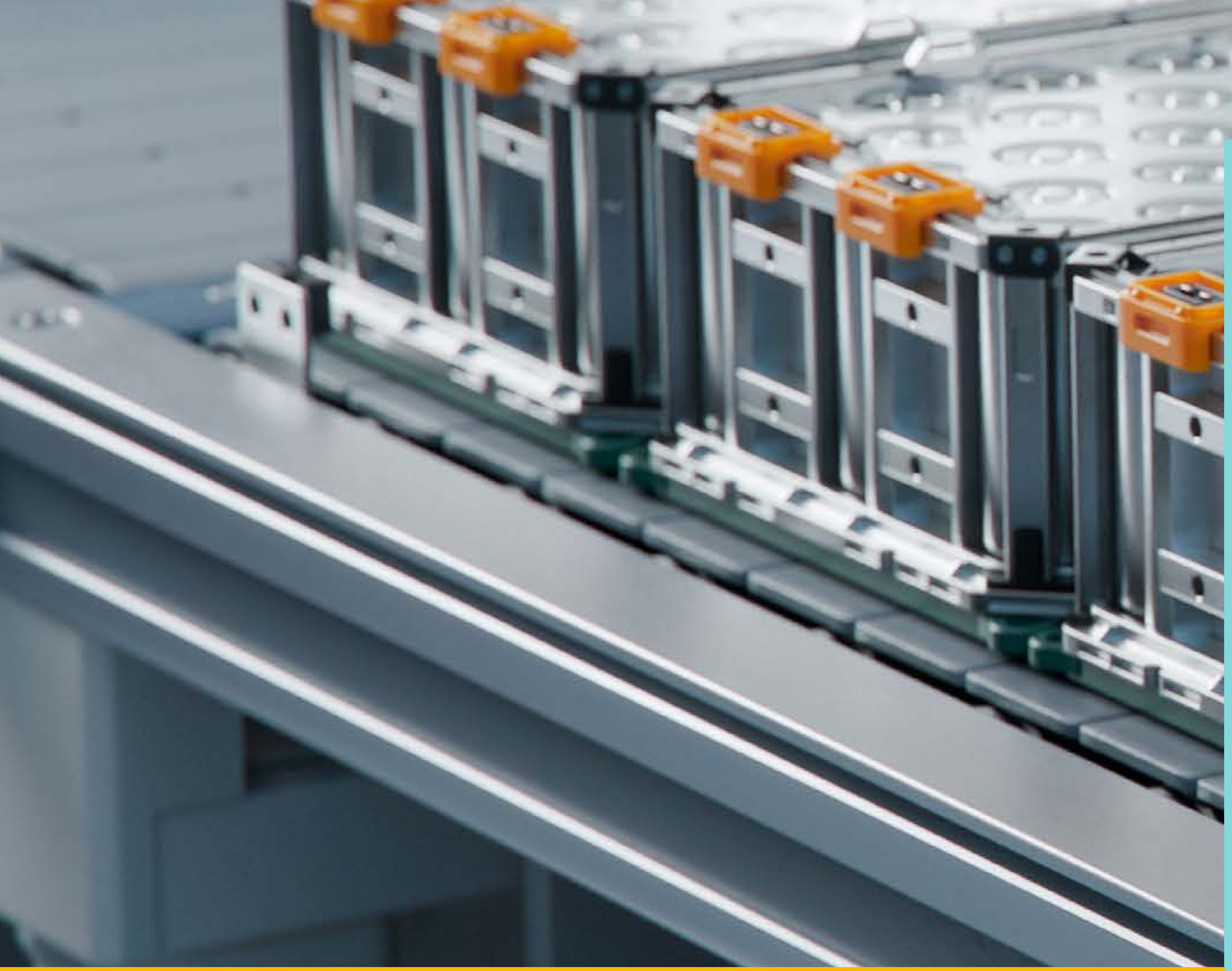
Manufacturers are ramping up battery production to support spikes in EV sales. In 2019 there were only two working battery manufacturing plants in North America. Today there are almost 30 planned, under construction or operational. In the UK and mainland Europe, more than 50 battery plants will be coming on-stream by 2027. Meanwhile China's dominance is predicted to continue, owning over 77% of the world's manufacturing capacity (893 GWh) *** in 2022 and set to retain 69% of the global market (6,197 GWh) by 2027.

ANATOMY OF AN EV BATTERY

EV batteries are mostly based on lithium-ion technology with cell voltages of 3.6 to 3.8 volts. Groups of cells are linked together in series to form a battery module. Multiple modules are connected in parallel to achieve the required capacity. Typically, EVs operate at a range of between 400 and 800 volts, which requires each module to comprise 100 to 250 cells. The number of modules dictates the power and range of each vehicle.

Each cell consists of an anode, cathode, separator and electrolyte, arranged in layers (like a Swiss roll), arranged in a prismatic or cylindrical configuration and housed in a metal casing. Anode active materials are generally carbon-based, while cathodes are typically composed of oxides of lithium cobalt, lithium manganese and lithium nickel manganese cobalt. Separators are often made of polyolefin plastic, and most electrolytes are non-aqueous solutions in which lithium hexafluorophosphate salt is dissolved in an organic carbonate. Ongoing research is exploring alternative electrode materials to boost efficiency, increase output and reduce cost.

* 2022 Consumer Reports
^ 2023 Statista
** 2023 Virta Global
*** Visual Capitalist 2023



BATTERY MANUFACTURING PROCESS

The first stage of manufacture, preparation of the active electrode materials, involves grinding, milling and drying of raw materials into a fine powder and mixing with solvents and binders to form a paste. Next, the paste is applied to thin metal foils which are dried, compacted and cut to size. During cell assembly, the foil electrodes are wound together with separators, electrical tabs are added, and the unit is inserted into a casing, filled with electrolyte and capped. Finally, the cells are charged and discharged to form a solid electrolyte interface. Once tested and quality-checked, the batteries are packed for storage or shipment.

While some facilities handle the end-to-end manufacturing process, others outsource the electrode material preparation to external plants. Preparation processes require solvent extraction systems on site for solvent recovery and environmental control. Typically, the solvent for cathode materials is N Methyl Pyrrolidone (NMP), a flammable liquid. Cell assembly takes place in a clean, dry environment to prevent contamination, which could lead to product failure. Often a facility will produce batteries for a range of vehicle manufacturers and completed cells may be shipped to other locations to be combined into modules and packaged into battery packs.

CONSTRUCTION RISKS

EV battery factories are typically large, steel-panel-on-steel-frame buildings with a relatively large number of smaller manufacturing equipment and centralised utilities. While under construction, they may present the following risks:

- **Ground Conditions:** None of the equipment (apart from milling machinery) is particularly large or heavy so ground loads rarely require significant piling.
- **Equipment Lifting:** Generally, loads are not large so lifting hazards are reduced. However, extended reach is required to lift lighter loads over pre-installed facilities. The electrical power intake yard is an exception as processing and battery charging demand large supplies of electricity.
- **Weather/Natural Hazards:** Exposures are generally location-specific and easily identifiable from the outset.
- **Fire Loads:** Risk from construction materials is likely to be low, but high volumes of equipment packaging waste are expected.
- **Water Ingress:** Failed weather protection or leakage of fluids is a significant exposure, especially towards the end of construction.
- **Equipment Failure:** Risk of installed equipment failing before the facility is operational.

TESTING/OPERATIONAL RISKS

Biggest exposures are during plant testing and commissioning:

- **Dust Explosion:** Requires installation of explosion relief, inerting and static control systems during electrode material preparation.
- **Low Flash Point Solvents:** NMP has a flashpoint of 90C, and all organic carbonate electrolyte solvents have low flash points. Fire risk increases when solvents are vapourised in drying ovens at over 100C.
- **Fire from Battery Charging:** Defective batteries may catch fire or explode due to overheating or internal short-circuits.
- **Poor Assembly Conditions:** Failure to maintain clean, very low-humidity conditions during battery assembly could interrupt production.
- **Construction Material Failure:** Sealants, lubricants etc must operate reliably in ultra-low humidity environments.
- **Skills Shortage:** Plants must recruit, train and retain highly skilled teams to keep operations running effectively.

UNDERWRITING CONSIDERATIONS

Every case is unique and driven by a different blend of risk factors. Variables range from the experience of contractors and operators to susceptibility to natural hazards, plant design, extent of fire precautions, and operating conditions, scale and flexibility. Policy coverage for each battery manufacturing facility should be tailored against these variables.

CHARGING INTO THE FUTURE

EV battery technologies are evolving quickly to meet the competing demands of car brands. Innovations such as silica anodes and lithium air batteries are already in-market, and the next generation of devices promises to be more powerful, compact and longer lasting. Manufacturing technology is fast developing too, with China's pre-eminent role set to ease as the West matures its production capacity and builds its own manufacturing solutions.

The exponential demand for EV batteries is sure to create a proportional growth in manufacturing plants. New products, manufacturing techniques and technologies will bring a new raft of challenges for the insurance community. To provide equitable terms and conditions for all parties, underwriters will rely on a strong understanding of the fast-changing EV battery landscape and its associated risks.