



Singapore Battery Consortium

2021 Q2 Newsletter

SINGAPORE BATTERY CONSORTIUM

Understanding curation of recent industry developments and technology news

Recent industry developments and technology news are specifically curated based on the relevance to the progression of the industry. Each news event is categorized based on importance and area of focus (see below for description for both).

15 January 2020
SK Innovation announces 10 GWh expansion of factory in U.S.
 SK Innovation will build its second U.S. factory in Georgia, from which it intends to ship another 9.8 GWh to VW in Tennessee. Its total production goal of 100 GWh by 2025 outpaces its publicly known manufacturing projects, so expansions near already-planned facilities will likely be a forthcoming trend. In the Southeast U.S., automotive manufacturers are nearby: VW is in Tennessee, Daimler has factories in South Carolina and Alabama, where Hyundai also is, and Volvo, BMW, and Kia are located in Georgia. Clients should expect SK Innovation to ramp up production near customers and keep chipping away at its 2025 goal.

Very **3** Important | Energy **4** Storage

- 1 Link:** Hyperlink to original news article. Note some news articles may be behind paywall.
- 2 Analysis:** Writeup of the news event as it relates to industry development and recommendations for action.
- 3 Importance:** Take on the potential importance of the event from "Truly Disruptive" to "Ignore"
- 4 Area of Focus:** Category of the news event based on the to the topic.

Importance	Description
Truly Disruptive	A game-changing, landmark development
Very Important	Significant news that will have strong implications
Average Importance	Worth noting, but not likely to be too important or disruptive
Low Importance	An over-hyped development, which is not worth monitoring closely
Ignore	Misleading or irrelevant development, worth being cautious about

Area of Focus	Description
Built environment energy use	Hardware and software technologies for commercial and residential energy consumption
Business models and regulations	Novel business models for energy production, consumption, and distribution, as well as policies with transformational impact on new energy technology development
Energy for mobility	Energy sources for powering road, rail, aviation, and marine – includes movement of goods and people
Energy storage	Various forms electrochemical energy storage, such as Li-ion and solid-state batteries
Stationary storage	Utility-scale and long-duration energy storage for grid services, renewables integration and backup, and microgrid support

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Battery stalwarts continue to battle in the market and courtroom for shares of the growing battery industry



11 April 2021

LG Energy Solution and SK Innovation reach settlement in battle over trade secret theft



Very Important

Energy storage

Following a ruling from the ICT that determined SK Innovation utilized trade secrets belonging to LG Energy Solution, the two companies have announced a settlement, under which SK will pay LG \$1.8 billion and royalties. The original ruling would have forced a limited 10-year ban on SK batteries in the U.S., crippling the company's plans for almost 20 GWh of capacity by 2025 in the U.S. and forcing customers Ford and Volkswagen to secure batteries elsewhere. The settlement amount is equivalent to the investment for a 15 GWh battery plant, and paid royalties would push SK's profit margin even slimmer in the U.S.

RioTinto

14 April 2021

Rio Tinto produces battery-grade lithium from borate waste in California

Average Importance

Energy storage

After a small-scale trial to recover lithium from waste rock in 2019, Rio Tinto is moving forward with a demonstration plant to scale up lithium recovery from borate waste. The site has an initial capacity of 10 tons per year of battery-grade lithium, moving up to 5,000 tons per year at a scale production plant. The gap between supply of battery-grade lithium and demand in cell production continues to widen, with conventional mines requiring up to 10 years to become operable. Rio Tinto is well-positioned to enter lithium production with its access to capital and lithium resources.

GROUP14

22 April 2021

Group14 Technologies launches commercial manufacturing factory to develop silicon anodes

Average Importance

Energy storage

Group14 Technologies, a silicon-carbon composite materials provider for Li-ion batteries, announced the launch of its commercial-scale manufacturing factory. The facility is reportedly capable of producing 120 tons per year of Group14's silicon-carbon material, SCC55, which it claims can deliver up to 50% higher volumetric density than Li-ion batteries available on the market. Although Lux predicts the production to cater to 200,000 BEVs, the company is presumably concentrating on consumer electronics, with its materials yet to be validated for automotive batteries. Interested clients are encouraged to monitor this development and should view this as progress in establishing a domestic battery ecosystem in Li-ion battery supply-demand.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Manufacturing capacity scale up is critical to meeting projected demand for both EVs and stationary storage



23 April 2021

[SES closes Series D funding round at US\\$139 million](#)

Very Important

Energy storage

GM led the investment round, with contributions from SK Inc., Temasek, Applied Ventures, SAIC Motor, and Vertex. SES recently announced a joint development agreement with GM to build a manufacturing prototyping line in the U.S. for its lithium metal cells for production by 2023. The company is one of few that are able to manufacture lithium metal anode foils. In the lithium anode space, the only other company attracting more funding is QuantumScape, but SES has already demonstrated its manufacturing ability at its Shanghai location with a production capacity of 10,000 cells per month.



23 April 2021

[Fluence to begin 1 MW energy storage pilot project](#)

Average Importance

Stationary storage

With cooperation from Siemens AG and Lithuanian TSO Litgrid, Fluence will begin a 1 MW energy storage pilot project. The project will use an energy storage system (ESS) to act as a transmission line by injecting or absorbing power. The ESS acting as a virtual transmission line will serve as a means to assist in grid stability as Lithuania ramps up renewable power generation and switches its grid from post-Soviet operation to a grid connected with others in Europe. Although this is an initially small deployment, ESS used to stabilize the grid will become increasingly important for TSOs, especially in areas with high renewables penetration or an aging infrastructure.



3 May 2021

[GM and LG Energy Solution to invest US\\$2.3 billion in second Ultium Cells manufacturing plant in U.S.](#)

Very Important

Energy for mobility

General Motors and LG Energy Solution announced a \$2.3 billion investment to build their second battery cell manufacturing plant in the U.S. The investment will help Ultium Cells, a joint venture of LG Energy Solution and General Motors, increase the production of large-format, pouch-style cells that can be stacked vertically or horizontally inside the battery pack. The technology on the BEV platform was previously highlighted during the LG investor day, with a focus on optimizing battery energy storage and layout for each vehicle design. Although the plant is expected to be functional in 2023, clients are encouraged to monitor the development and view this investment as further progress in the U.S. domestic supply chain system.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Growing synergies between electric vehicles and ride-hailing a key trend to monitor moving forward



6 May 2021

[Solid Power closes US\\$130 million Series B](#)

Very Important

Energy for mobility

BMW Group, Ford Motor Company, and Volta Energy Technologies led the round, and Solid Power will expand its joint development agreements with the automakers. Following the delivery of its 2 Ah cells to partners last fall and the successful roll-to-roll production of 20 Ah cells, Solid Power will deliver 100 Ah cells to BMW and Ford by 2022. In the race for solid-state batteries, Solid Power has focused on the manufacturability of its technology. Although it has achieved high energy densities, the cells currently require elevated operating temperatures and have shown limited cycle life for fast charging. Clients should expect this sizable investment to accelerate Solid Power's timeline for implementation.



6 May 2021

[Oxis Energy to supply semisolid-state lithium-sulfur batteries by 2022](#)

Average Importance

Energy storage

Following Oxis Energy's partnership with Sanyo Trading Company last fall, the battery company will deliver 10 Ah to 20 Ah semisolid Li-S cells by summer 2022 at the earliest. The cells will have a claimed specific energy of 450 Wh/kg and an energy density of 550 Wh/L. Oxis will mass-produce its electrolyte in Wales, U.K., while the cells will be manufactured at its Brazilian plant, due to be completed by Q4 2021 and commissioned in 2023. Oxis will demonstrate its technology in aviation, marine, defense, and heavy-duty EV applications, which require high energy density and safety but can accept a low cycle life.

UBER

12 May 2021

[Uber partners with Arrival to design BEVs for ride-hailing](#)

Average Importance

Energy for mobility

Arrival has partnered with Uber to optimize the design of the small passenger vehicle it's developing for ride-hailing services, though it should be noted that the vehicle is not exclusively available to Uber. While Uber has maintained relationships with major automakers in the past, most focused on its since-sold autonomous vehicle project. Uber faces a major challenge of electrifying its fleet, which it aims to do by 2030, and offering drivers affordable electric options is crucial. Clients should expect Uber to announce additional partnerships with other automakers, as well as partnerships with infrastructure providers.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Nio continues to lead the deployment of battery swapping with global expansion



17 May 2020

[Nio expands battery swapping network to Europe](#)

Very Important

Energy for mobility

The company's European battery swapping network expansion currently only includes plans for Norway, as it is aiming to complete four stations near Oslo in 2021 and expanding to other cities in 2022. With one of Europe's largest electric vehicle markets, Chinese companies Xpeng and Nio have both focused on Norway as their beachhead market in Europe. Clients should expect Nio to expand aggressively to other countries in Europe within the next year to capitalize on its first-mover advantage, as other OEMs – most recently Renault – have made favorable comments on battery swapping.



18 May 2021

[ESS Inc. to go public via SPAC](#)

Average Importance

Energy storage

ESS Inc., a developer of iron-flow batteries, will partner with ACON S2 Acquisition Corp. to become a publicly listed company. Battery companies, like QuantumScape and Li-Cycle, are joining the SPAC craze. This is one of the first startups in the long-duration stationary storage space to go public. ESS Inc.'s success depends on its ability to secure projects and scale up its manufacturing. The company plans to have a capacity of 2 GWh within the next 18 months and has identified North America and Australia as strong targets for its technology. Clients should observe ESS Inc. in the coming months for further project announcements and take note of estimated timelines for operation.



19 May 2021

[Harvard develops solid-state batteries with high current density that can prevent dendrite formation](#)

Very Important

Energy storage

Scientists at Harvard University have developed a design for a solid-state battery (SSB) that uses a hierarchy of interface stabilities to achieve an ultrahigh current density with no lithium dendrite penetration. The researchers claimed that the multilayer battery, where the less stable electrolyte is sandwiched between more stable solid electrolytes, prevents the penetration of lithium dendrites by controlling and containing them. The team also reported achieving 82% capacity retention after 10,000 cycles at a 20C rate and 81.3% capacity retention after 2,000 cycles at a 1.5C rate. Interested clients are encouraged to monitor this development and view the lithium dendrite prevention in the design as progress in the SSB space.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Ford's F-150 is a landmark moment for the electric vehicle market in the U.S.



20 May 2021

[Ford's F-150 Lightning marks a turning point in North America's electrification roadmap](#)

Truly Disruptive

Energy for mobility

Ford's F-150 pickup truck has been the best-selling car in the U.S. for an astonishing 40 years, and this week, the brand revived the "Lightning" moniker to launch an electric version of the vehicle. It includes some novel features, such as 11 electrical outlets, the ability to use the vehicle to provide backup power to a home and optional Blue Cruise hands-free highway driving. The most notable feature: a base price under \$40,000. The biggest markets for pickup trucks in the U.S. are California, which has aggressive electrification targets, and Texas, indicating a large potential demand for this vehicle.



BATTERY
RESOURCERS

31 May 2021

[Battery Resourcers raises US\\$20 million Series B](#)

Average Importance

Energy storage

Battery Resourcers closed its Series B with Orbia Ventures, with TDK Ventures and Jaguar leading and Land Rover's InMotion Ventures contributing. The battery recycling company differentiates itself by recovering battery materials and producing NMC cathode materials as an end product. Its process takes in a variety of cathode chemistries, including LFP. Battery Resourcers plans to ramp up processing to 10,000 tons of waste batteries, from which 28% of recovered materials by weight can go directly to new batteries, and 68% can be recycled into other products.



2 June 2021

[Oxis Energy enters administration and moves to sell its 43 patent families and R&D assets](#)

Very Important

Energy storage

Just last month, the company announced a solid-state LiS battery and was named as a potential supplier for Bye Aerospace's new jet, which is expected to continue for now. LiS batteries have had a tumultuous path toward commercialization, with many startups pivoting away from the technology to focus on other energy storage technologies. Oxis' struggles will severely impact the outlook of LiS batteries, pushing commercialization outlooks further into the future. Clients interested in adding IP to their R&D portfolio would benefit from acquiring Oxis' patents but withhold expectations that LiS is ready to compete in the energy storage market.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Southeast Asia remains an untapped market for vehicle electrification



FOXCONN

8 June 2021

PTT forms joint venture with Foxconn to manufacture electric vehicles

Very Important

Energy for mobility

Southeast Asia has been one of the slowest regions to adopt electrified transportation due to few available models of electric vehicles, limited infrastructure, and a more price-sensitive market compared to other regions. Activity in the region is now picking up, and the announcement that Thailand's largest corporate entity would partner with Foxconn to leverage its electric vehicle platform will no doubt accelerate electrification of the region. Clients should watch for further announcements from the two companies on charging infrastructure and timelines for operating in the region, as none were provided, but they are important for understanding the pace of adoption in the region.



9 June 2021

CATL to begin production of sodium-ion batteries

Very Important

Energy storage

In a move to diversify its battery product portfolio, CATL will begin manufacturing Na-ion batteries in July. This is the first time a major cell manufacturer has bet on the chemistry. Na-ion has a lower bill of materials than Li-ion; it can be transported safely at 0 V and meets many of the same performance requirements that Li-ion has for stationary storage. Clients should anticipate CATL tapping into a reliable market in China considering the country's massive demand for short-duration energy storage and industrywide concerns over material shortages for Li-ion batteries.



11 June 2021

JAC launches two swapping-enabled BEVs in China with a focus on taxis

Average Importance

Energy storage

Though the company is the manufacturing partner of Nio, an early pioneer in battery swapping networks supporting nonfleet vehicles, JAC's models will be sold into the taxi market. Unlike Nio's current vehicles, JAC's will be powered by smaller 44.5 kWh battery packs using LFP cathodes, but they will likely use stations similar to those of Nio and other swapping networks, as earlier this year, the Chinese government put standards in place regarding safety, inspection, and operation of battery swapping stations. Clients should take note of this announcement, as now Nio, BAIC BJEV, Geely, and SAIC/Roewe all make swapping-enabled vehicles, and expect more announcements to follow from other automakers.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Battery recycling continues to gain traction as industry on cusp of a significant supply of end-of-life EV batteries

 amPLe

17 June 2021

[Ample expands battery swapping to Japan through Eneos partnership](#)

 ENEOS

Very Important

Energy for mobility

Eneos and Ample will pilot a battery swapping network before the end of March 2022, marking the first expansion of Ample's solution outside the U.S. Clients should take note of two important parts of the announcement. First, Eneos is a key partner for Toyota's Woven City project, and Ample's solution is nearly identical to the solution proposed at Japan Smart Energy Week in 2018. Toyota could be one of the first automakers to adopt Ample's swapping solution. Second, the project will explore the idea of overbuilding battery capacity at its swapping stations in order to optimize energy consumption, which could improve economics of battery swapping.



18 June 2021

[Solid Power expands solid-state battery portfolio to include silicon anodes and conversion cathodes](#)

Very Important

Energy storage

Solid Power has historically focused mostly on lithium metal anodes and NMC cathodes, but it recently announced that it is working on alternatives to this combination. The company specifically called out silicon-dominant anodes, of which it has been producing 2 Ah cells but will move to the 20 Ah format this year, and conversion-type cathodes, which are likely sulfur-based. Interestingly, Solid Power noted its silicon product would beat its lithium metal product to market, targeting commercialization by 2026. Clients should view this move as a hedge against lithium metal, which the company still needs to improve the chemistry of, providing Solid Power several paths to market.

 POSCO

21 June 2021

[Posco enters battery recycling through China joint venture](#)

Average Importance

Energy storage

Posco recently announced its plans for battery recycling through its joint venture – Posco Hy Clean Metal – with China's Huayou Cobalt, a Li-ion battery and new cobalt materials producer. The JV will import "black mass" from Europe to be recycled at its first 10,000 ton per year hydrometallurgical plant in South Korea, producing nickel, cobalt, manganese, and lithium for reuse in Posco Chemical's battery cathode plant. Posco has been heavily investing across the battery value chain, including in battery materials, lithium extraction, and now recycling. Clients should expect similar JVs between chemical companies and cathode producers to invest in battery recycling as part of their long-term manufacturing strategy.

RECENT INDUSTRY DEVELOPMENTS AND TECHNOLOGY NEWS

Capital continues to pour into the industry as battery developers ramp up commercialization and production



23 June 2021

[NanoGraf Technologies announces 800 Wh/L Li-ion cell using silicon anodes](#)

Average Importance

Energy storage

Following funding of \$1.65 million from the U.S Department of Defense for the development of Li-ion batteries, NanoGraf Technologies claims to have achieved a high energy density Li-ion cell using silicon anodes. The company claims that the 18650 cells have achieved an energy density of 800 Wh/L and the material developed has increased the battery capacity in the form factor by an initial 12%. Although NanoGraf claims this is a success for the cylindrical cells, the metrics have yet to be validated for the other form factors.



23 June 2021

[Solid Power follows SPAC trend and will receive up to US\\$650 million](#)

Very Important

Energy storage

The solid-state battery company has steadily increased its manufacturing capabilities and will deliver full-size cells to its automotive partners by next year. Solid Power recently announced its electrolyte is compatible with silicon-dominant anodes, likely recognizing lithium anodes inhibit a timely path to commercialization. With the company's focus on scaling production, the extra capital will carry it through expansion; however, Solid Power still doesn't aim to be a cell supplier. Instead, it will depend on strategic partners for commercial production. Solid-state batteries continue to be huge capital sinks but are slowly inching toward commercialization.



29 June 2021

[Northvolt raises US\\$2.7 billion to step up battery production](#)

Very Important

Energy storage

The latest funding round was led by Swedish pension funds and Omers Capital. Northvolt will use the new investment, in the form of equity, to improve the factory production capacity from a planned 40 GWh to 60 GWh. The funding comes after Northvolt signed multiple contracts with automakers and also acquired Cuberg earlier this year to expand to the U.S. With a goal to transition quickly from producing cells at Northvolt labs to large-scale development, the company is staking a claim to become a leading battery cell manufacturer across Europe.

BATTERY SWAPPING

An alternative to fast charging stations

Instead of quickly charging the battery, battery swapping solutions aim to physically replace a depleted battery with a charged one. Battery swapping can address two main challenges with fast charging: It slowly charges depleted batteries to minimize grid impact, and it allows for faster addition of range in vehicles.

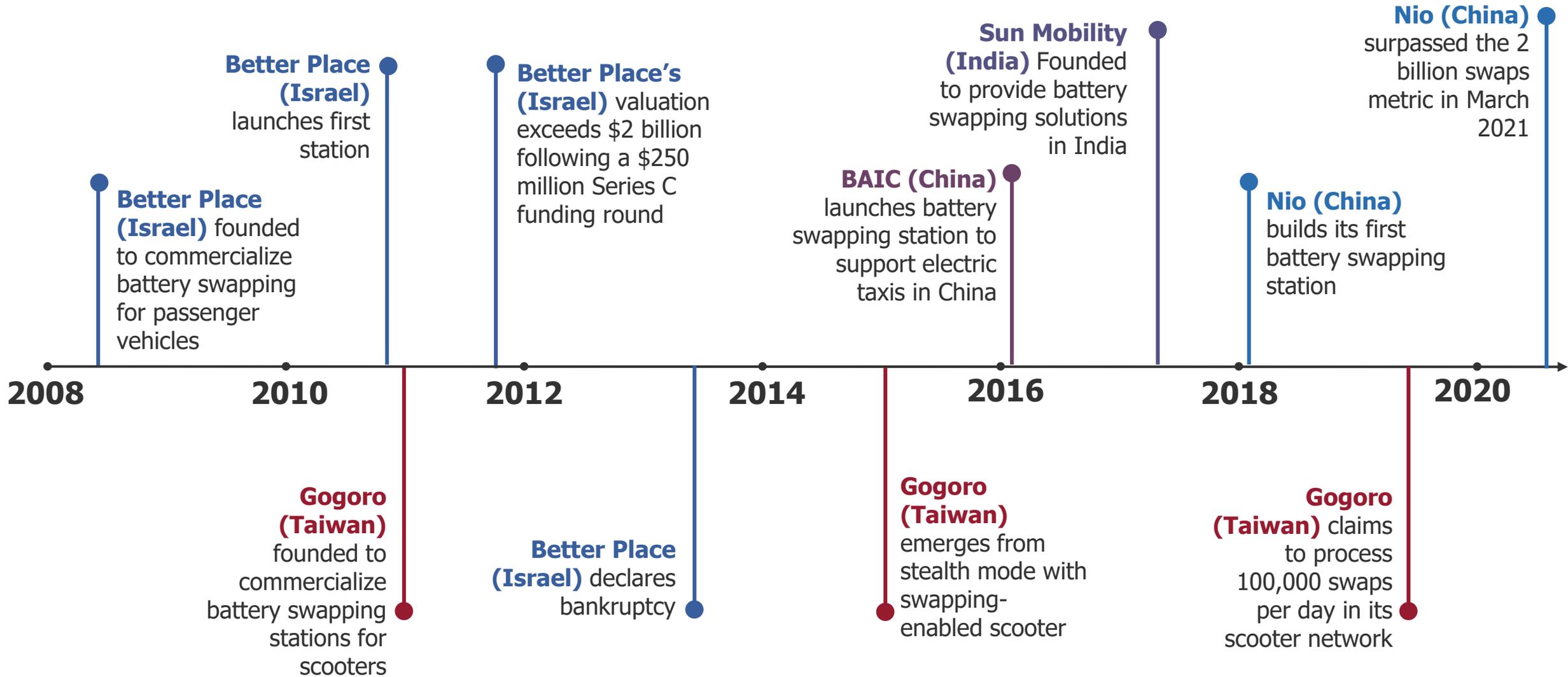
Most proposed solutions, such as Nio's solution shown to the right, use robotics to automatically swap the batteries, a process that can be completed in three minutes. Given that the battery pack can weigh up to 0.5 metric tons, robotic solutions are required for Nio and many others focused on light-duty vehicle swaps. As the battery is no longer part of the vehicle, Nio's customers purchase the vehicle and lease the battery pack. Similar to Tesla's early deployments of its supercharger network, the company has offered free swapping as an incentive for customers.



Source: Nio

BATTERY SWAPPING

Battery swapping has existed for more than a decade



BATTERY SWAPPING

Early battery swapping operations failed, but renewed interest is focused on a specific high-value application

Battery swapping, and its primary innovator Better Place, failed a decade ago for three key reasons:

- **Station costs ballooned:** Battery swapping stations, like fast charging, involve high capital costs; Better Place claimed the station costs were roughly \$500,000 – although it was later revealed that the real price tag was closer to \$2 million. With so few vehicles on the road, not enough swaps were occurring to earn back these high costs.
- **Battery packs were not standardized, and too few compatible vehicles were sold:** Early battery swapping models required automakers to agree on one standardized swappable pack design and use pricing models where customers leased the battery. The only compatible vehicle, the Renault Fluence Z.E., had sold fewer than 1,000 units at the time of Better Place's bankruptcy in May 2013.
- **Infrastructure needed to span a large geography:** In order to ensure that vehicle owners could freely travel using their vehicles, infrastructure needed to be deployed across entire regions. To make matters worse, the Renault Fluence Z.E.'s range was just 115 miles, meaning this swapping infrastructure needed to be densely deployed.

Today, the renewed focus on battery swapping is aimed mostly at supporting taxi fleets. This is a promising application fit, as it reduces those two of these three barriers: The large fleet usually consists of one vehicle manufacturer and is restricted to operation in a city or other small geography.

BATTERY SWAPPING

Assessing the costs of battery swapping

In order to assess and compare the costs associated with the deployment and regular operations of battery swapping, Lux developed a model that considers expected capital expenditure (CAPEX) and operational expenditure (OPEX) for battery swapping.

In this case, we use the model to perform a cost analysis of infrastructure supporting an electric fleet of taxis in two different countries – the U.K. and China. We selected the U.K. due to its focus on decarbonizing its taxi and ride-hailing fleets and China because it is the biggest EV market in the world. The model will showcase expected costs for battery swapping in each location.

Our analysis relies on a combination of publicly available information, academic publications, corporate studies, and primary research.



Source: Nio

BATTERY SWAPPING

Methodology

For both geographies, we considered the same fleet size and project lifetime; however, there are other variables that are specific to each geography that define the charging requirements for each fleet. For instance, the annual average distance driven by a taxi in London is half of that in China. The model considers these daily traveled differences, which translate into average daily charging requirements, in order to identify the necessary infrastructure configuration to satisfy the needs of each taxi fleet. Furthermore, the model considers vehicle specifications, charging hardware and installation cost, and electricity price differences in both regions. The table below summarizes some of these constant values as well as region-specific variables.

	U.K.	China
Fleet size (vehicles)	100	100
Project lifetime (years)	10	10
Vehicle range (miles)	230	160
Annual travel distance (miles)	30,000	61,950
Electricity rate (US\$/kWh)	0.23	0.10

BATTERY SWAPPING

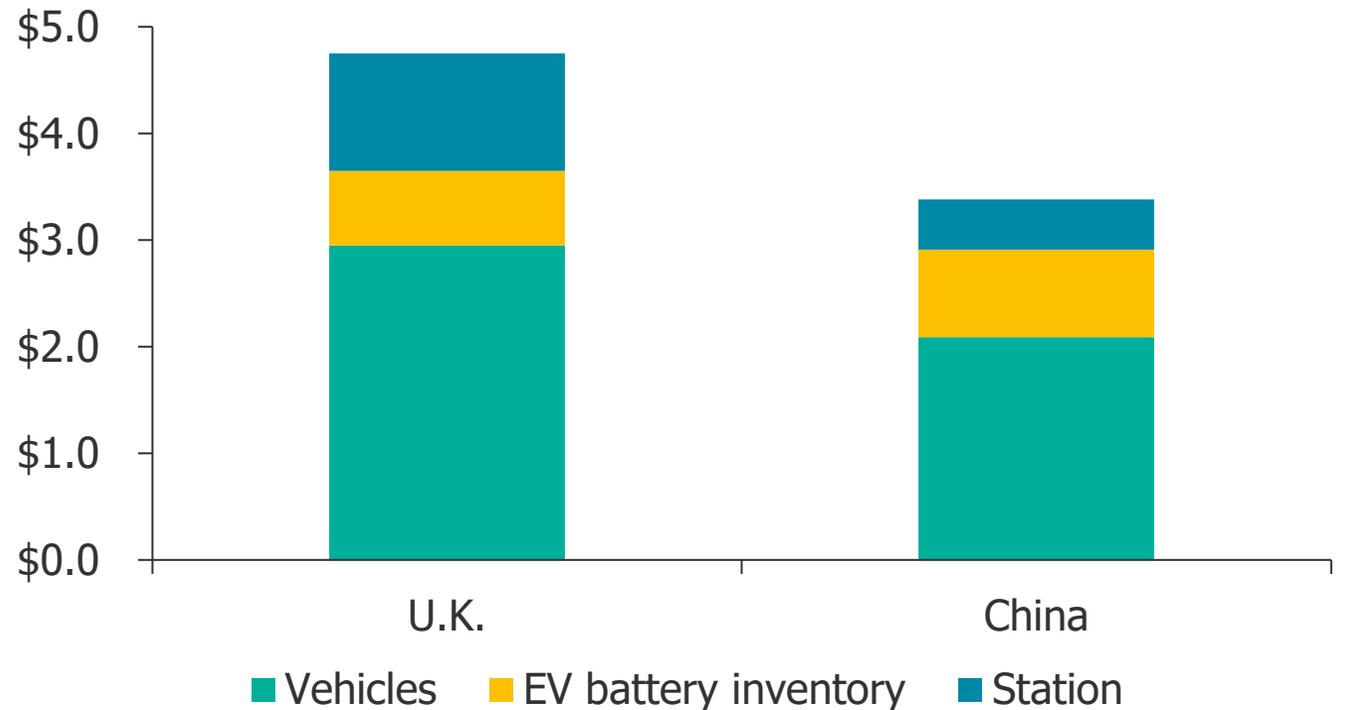
Capital costs range up to US\$4.75 million with vehicle costs making up more than 60% of total

With a fleet of 100 electric taxis, the results show that a battery swapping operation in the U.K. has a projected CAPEX of \$4.75 million and in China a projected CAPEX of \$3.38 million. Vehicle costs make up 62% of total CAPEX in both geographies and is largely driven by the need for extra batteries that are charged and available at the station. While EVs capable of battery swapping can be sold at a lower price with the battery purchased separately or even leased, we assume in our model they are purchased upfront.

On the station side, we found that U.K.-based battery swapping stations cost roughly US\$1.1 million, which is more than double that of the US\$470,000 price tag in China largely due to differences in engineering, permitting, and construction costs.

Battery Swapping Project CAPEX

\$US million



BATTERY SWAPPING

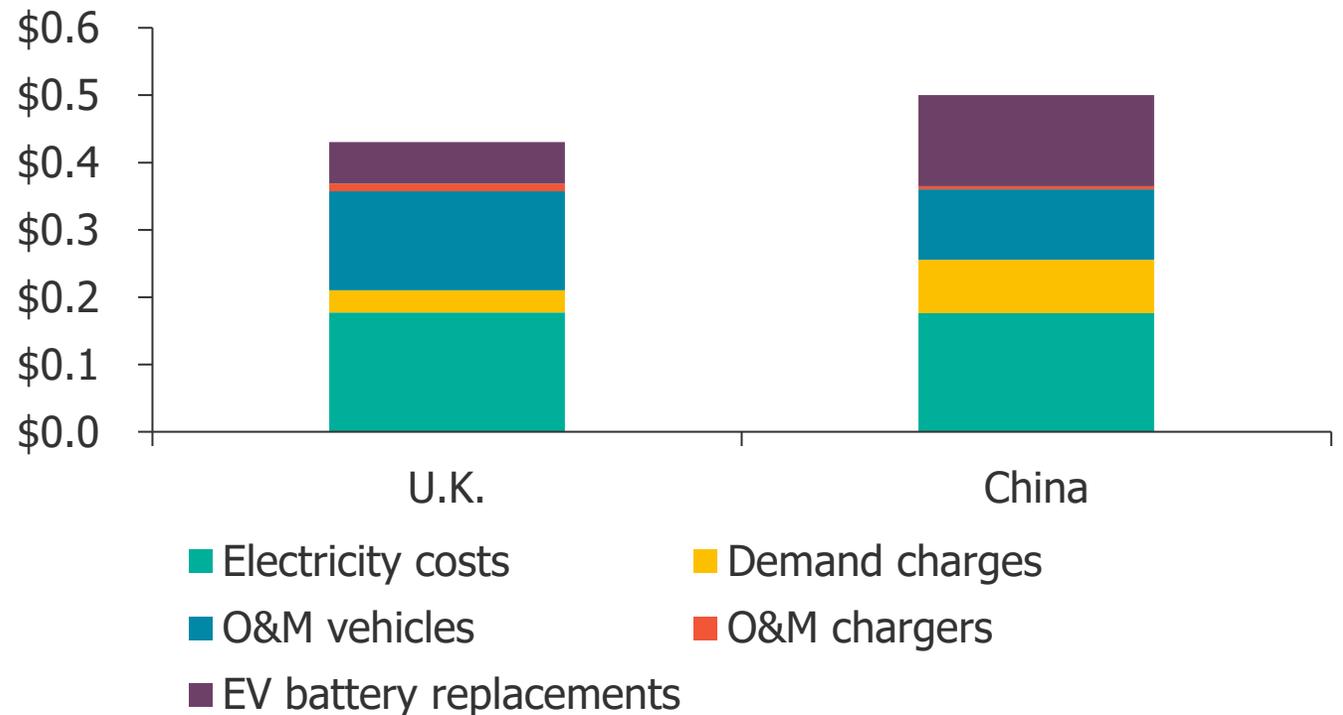
Capital costs range up to US\$4.75 million with vehicle costs making up more than 60% of total

In terms of annual operating costs, battery swapping operation in the U.K. has a projected OPEX of US\$430,660 and in China has project OPEX of US\$500,000. In both cases, the electricity costs are the main element contributing to OPEX making up 41% and 35% of total annual OPEX in the U.K. and China, respectively. The second major cost contributor in the U.K. is the O&M of vehicles at 34% of total annual OPEX.

However, in China, the second major cost contributor is EV battery replacements at 27% of total annual OPEX, largely due to stations performing close to double the number of daily swaps compared to the U.K., requiring more charged batteries in the station ready to be swapped to minimize taxi idle time. In the U.K. EV battery replacements only makes up 14% of total annual OPEX.

Battery Swapping Project OPEX

\$US million

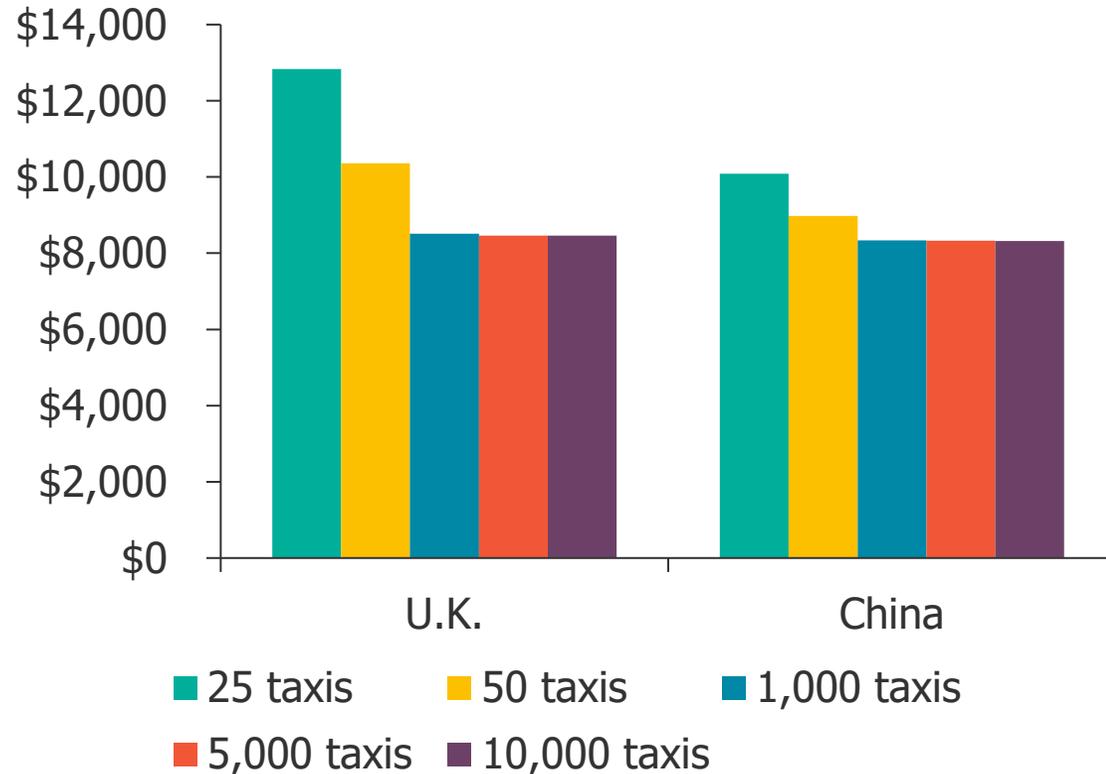


BATTERY SWAPPING

The impact of fleet size and EV range on annual costs

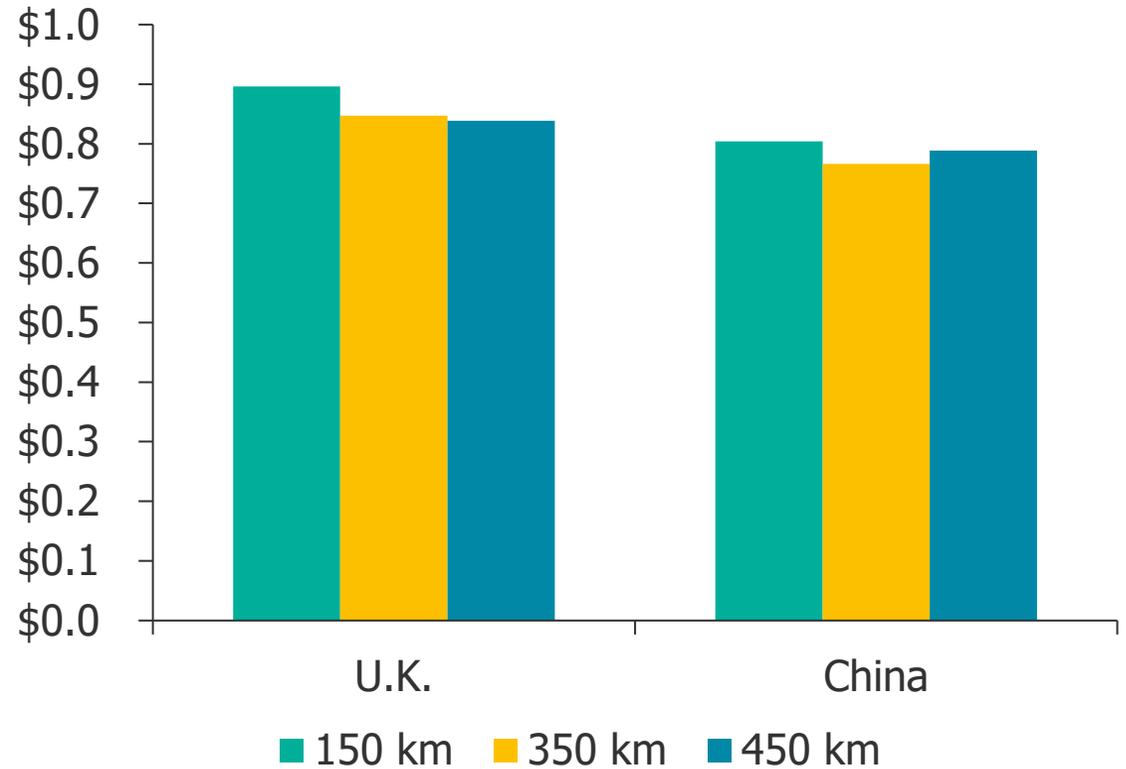
Impact of Fleet Size on Annual Costs

Annual cost per vehicle (\$US)



Impact of EV Range on Annual Costs

Total annual costs (\$US million)





BATTERY SWAPPING

China will be the first market where swapping wins

Battery swapping still has to catch up with incumbent EV charging solutions; innovations around battery swapping are further behind in the technology learning curve than those related to other alternatives, such as fast charging. Further technology development in combination with the push for a larger installed base of battery swapping stations will help drive costs down.

Current incentive schemes in China actually benefit battery swapping deployments, making them more cost-effective than fast charging alternatives. In addition, swapping infrastructure in the country is being deployed to support both electric taxi fleets and private EV drivers.

Instead of installing charging points all around major Chinese cities to support the growth of electric mobility in the country, China may opt to promote battery swapping stations, as they allow drivers without access to fixed parking to use stations to power their EV within minutes.



Source: FreeWire

BATTERY SWAPPING

Battery swapping faces stiff competition from fast charging

While fast charging addresses key consumer pain points, as with battery swapping, it also does so with high costs and significant strain on the grid. By 2035, just 13% of the vehicle fleet charging at 350 kW simultaneously would consume the world's entire power generation capacity. However, integrating stationary storage with fast charging provides ample benefits that positively impact both CAPEX and OPEX of fast charging, presenting competition for universal adoption of battery swapping.

First, stationary storage reduces installation costs by avoiding grid connection upgrades. Developers are already integrating Li-ion batteries into fast charging solutions. Second, the stationary storage component will become an additional source of income for charging infrastructure owners as well, through the participation in energy markets, further increasing the attractiveness of this type of configuration.

INNOVATE SMARTER & GROW FASTER

About Lux Research

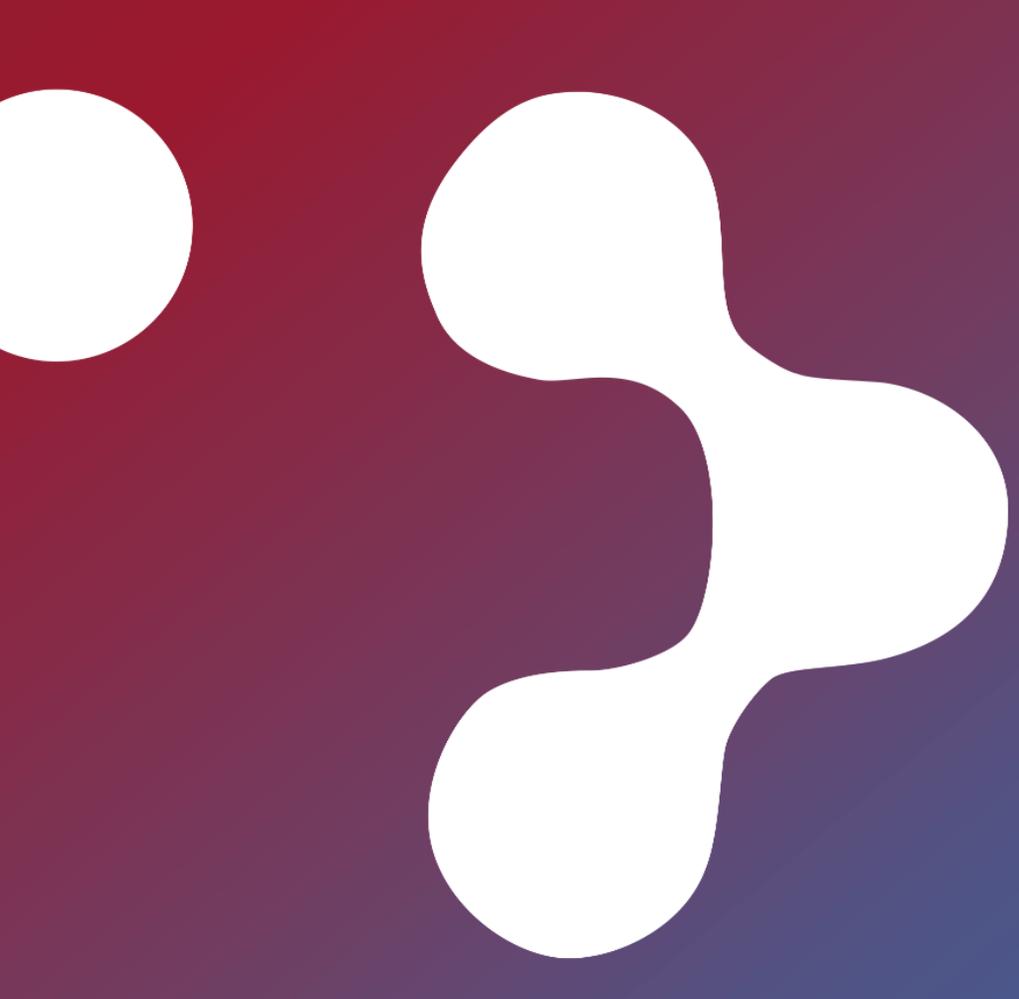
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TECHNICAL EXPERTISE

PRIMARY RESEARCH

ADVANCED ANALYTICS

BOSTON NEW YORK AMSTERDAM SINGAPORE TOKYO



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