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THE BIG STORY / DECEMBER 2018

EV Infrastructure Charges Up

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Audi e-Tron GT promises ultra-fast charging.

Dotting the floor at November's Los Angeles Auto Show was a bevy of new battery-electric vehicles, ranging from upstart Rivian's pickup truck to more futuristic concepts like the iNEXT drawing eyes to the BMW stand.

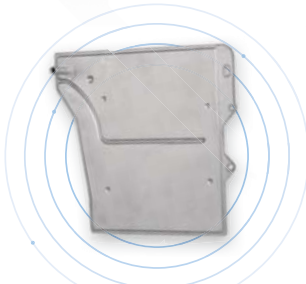
That's not unusual for this exhibition, held in a state that is driving the country's zero-emissions-vehicle movement and which always plays to a crowd that

leans decisively green.

This year it's different, however, because the shift to electrification is getting serious. Automakers are expected to spend some \$255 billion over the next few years developing and putting into production a next-generation range of BEVs, according to AlixPartners. Nearly 300 new or significantly redesigned BEVs will debut globally between now and 2025, Wards Intelligence data shows.

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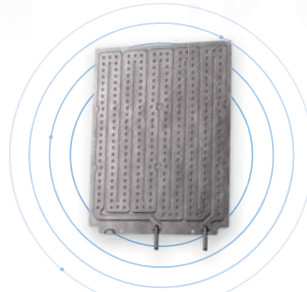
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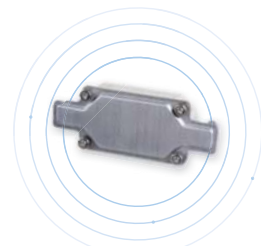
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But will they have a place to plug in?

LMC-Wards forecast data shows a cumulative 6.629 million battery electric vehicles, plug-in hybrids and extended-range electric vehicles will be sold in the U.S. in 2018-2025, which could put a strain on the country's inadequate public charging infrastructure.

As of Dec. 5, there were 54,638 Level 2 and 3 outlets or connectors nationwide, according to the U.S. Dept. of Energy. That equates to about 121 vehicles per connector if the 2018-2025 forecast holds. That means an extraordinary tenfold increase to 550,000 connectors will be required for each of those 6.629 million plug-ins to be able to access a public charger for at least 60 minutes during the hours of 8 a.m. to 8 p.m.

The good news is charging-network suppliers and service providers – comprising an industry valued at \$1.16 billion in 2016 – are moving quickly to keep pace. Forecasts now suggest public charging capacity will grow at a compounded annual rate of 25%-

30% over the next five years in both North America and Europe. Much of that new infrastructure is being backed by the automakers themselves, keen to ensure their new-generation, long-range BEVs don't fall flat because consumers remain wary of being marooned in a vehicle that has run out of juice.

“The infrastructure has to come first,” says Simon Lonsdale, chief strategy officer for ChargePoint, the U.S.'s largest public-charging network with 7,900 mostly Level 2 stations as of late November. “You have to put infrastructure in the ground before consumers can buy (the) cars.”

In addition to charging outlets, investment is being made in new, faster charging technology. Currently, most DC fast chargers deliver electricity at a peak rate of 50 kW. Tesla's Superchargers are the exception, typically outputting up to 140 kW, with newer systems reportedly running as high as 170 kW.

But some new chargers now rolling out more than double the Tesla rate to 350 kW, and auto-



Simon Lonsdale,
Chief Strategy
Officer –
ChargePoint



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Tesla has most widespread charging network in U.S.



makers, which have been cautious about charging too quickly for fear of what that might do to the battery pack, are beginning to develop vehicles compatible with this new ultra-fast technology.

Currently, BEV owners charge at home or work 80% of the time in the U.S., with the remaining 20% occurring at public outlets. But that may not hold true if ultra-fast public charging becomes ubiquitous.

“As (next-generation, longer-range BEVs) come into the market, people are going to make different behavioral decisions,” Matt

Stover, director-business development for Ford’s Team Edison electric-vehicle operation, tells Wards Intelligence. “The infrastructure’s about to come to them.”

Driven mainly by automakers – Volkswagen Group’s Electrify America in the U.S. and the IONITY joint venture from four OEMs in Europe – these new ultra-fast chargers will begin to proliferate in major metro markets and along highways over the next few years, potentially eliminating consumer concerns around range anxiety.

Electrify America plans to install

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Electrify America plans 484 fast-charging stations in U.S. by mid-2019.

at 484 stations 2,000 fast chargers (ranging from 50 kW to 350 kW) in the U.S. by mid-2019 in the first installment of a four-phase project, and IONITY expects to have 400 of the ultra-fast electric vehicle supply equipment (EVSEs) in place in 20 European countries by 2020.

Ultra-fast chargers have been made possible by new liquid-cooled cable technology.

“That really is the breakthrough,” says Brendan Jones, chief operating officer of Electrify America. “If you had to put that much power through a standard

copper cable, it would be so big and so unbendable that you really couldn’t utilize it.”

Any lingering resistance to fast charging is waning rapidly and charging speed is quickly becoming a bragging point for automakers as they roll out new models with higher-voltage batteries. Jaguar’s I-Pace is equipped to DC fast charge at up to 100 kW per hour, although some real-world tests by bloggers suggest it is falling somewhat short of that speed. Audi is set to top the I-Pace with its new e-Tron, which will DC charge at 150 kW, meaning it



Jaguar I-Pace charges in 13 hours using 15-kW Level 2 charger.

can replenish 80% of its 95-kWh battery in about 30 minutes. Mercedes' upcoming EQC BEV earmarked for production in 2019 will charge at a rate of 110 kW.

Level 2 (240V) AC charging speeds also are escalating, with newer BEVs now being introduced with acceptance rates around 11 kW, compared to less than 8 kW for many older models.

Led by European automakers, the faster charging speeds not only are a marketing tool, they will be necessary as new generations of BEVs emerge with bigger-

capacity batteries. With driving ranges of 300 miles (483 km) and more being eyed, it no longer will be possible for owners to fully replenish a healthy portion of a spent BEV battery overnight using a conventional 120V household line.

Filling a depleted I-Pace using a relatively high-speed 15-kW Level 2 charger would take 13 hours, for example, while employing a more conventional 3.8-kW Level 2 would take more than 23 hours, according to charging-equipment supplier Clipper Creek. A con-



ventional 50-kW DC charger will require twice as long a refill with one of the new ultra-fast units capable of charging at the I-Pace's full 100-kW rate – a process requiring 45 minutes to take the battery back to 80% capacity.

ChargePoint's Lonsdale says more longer-distance and faster-charging BEVs are on their way from a wide range of OEMs, and his charging network is among those getting ready to accommodate them. "Very shortly we'll be moving up to a 150- and 350-kW fast chargers," he says.

As recently as May 2018, fast charging was being viewed somewhat more skeptically. During a wide-ranging discussion on advanced powertrain technology at the CTI Symposium U.S.A. in Novi, MI, a panel of industry insiders and analysts questioned not only how much Level 3 public charging was needed but whether ultra-fast charging would make BEVs less, not more, attractive to consumers.

"When you start to do a lot of fast charging, the cost of ownership starts to deteriorate, because



GM CEO Mary Barra wants under-10-minute charge time by 2023.

the cost of electricity in the daytime (generally) is a lot higher than when you are charging (at night because) there's more (demand) on the grid," said V. Anand Sankaran, director-Electrified Powertrain Engineering for Ford.

Other panelists expressed doubt over whether automakers were ready to fully commit to



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IONITY charging network funded by Daimler, BMW, VW and Ford of Europe.



higher charging speeds and the costs necessary to achieve them.

However, in the months since that panel debate, signs have surfaced that the shift to ultra-fast charging is fully under way.

General Motors, for example, in late September 2018 shuffled top management, creating the new position of vice president-electric vehicle infrastructure to lead efforts toward developing the necessary partnerships and identifying investments that would support a more-robust charging

infrastructure. CEO Mary Barra said the automaker was targeting charging speeds that would provide 180 miles (290 km) of range in less than 10 minutes for its 20 new-generation BEVs due by 2023.

German automakers have been fully onboard for much longer, as evidenced by the IONITY charging joint venture that includes BMW, Daimler and Volkswagen Group. Ford, which also has a considerable market presence in Europe, is part of that JV as well, and several other European OEMs



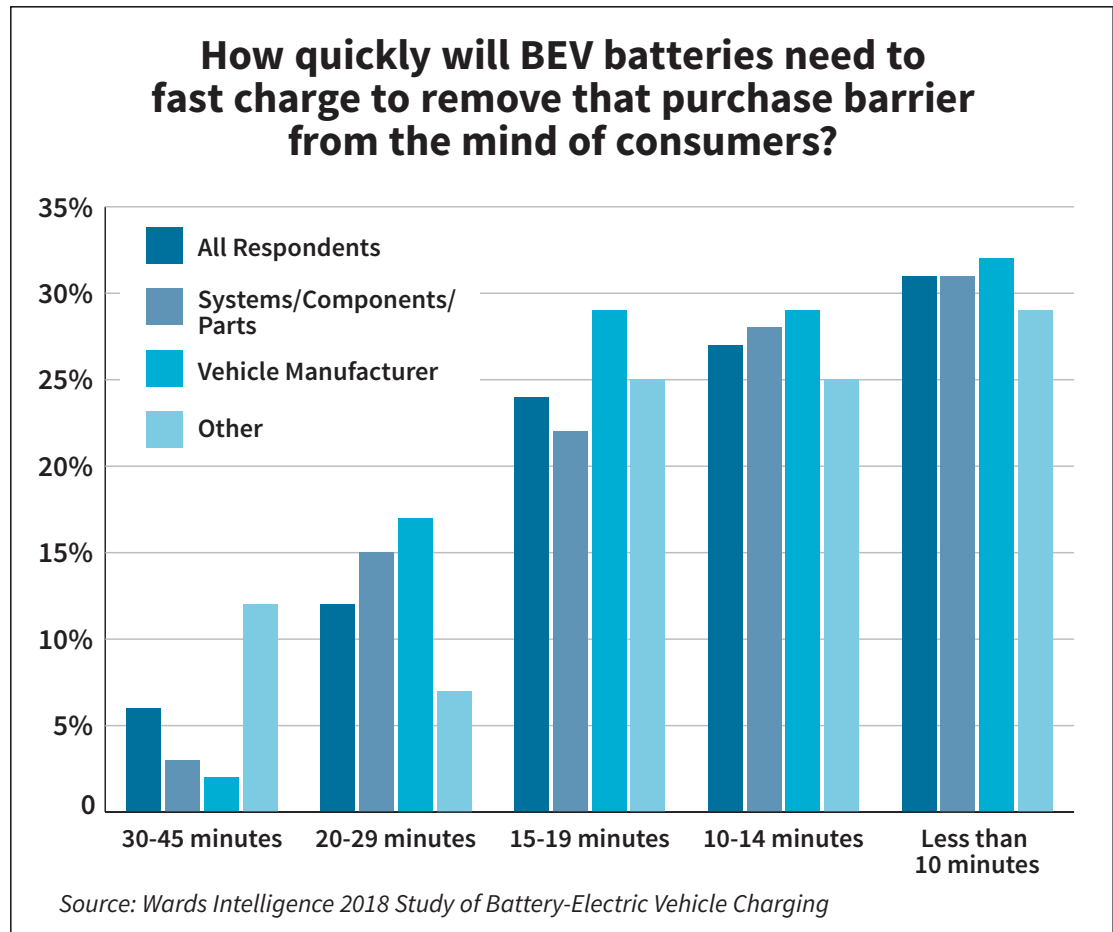
Hyundai Kona Electric longest range non-Tesla BEV in U.S. at 258 miles.

have expressed interest in joining. Asian automakers are likely to follow a similar track toward high-speed charging rates with their new-generation BEVs, as evidenced by the Hyundai Kona and Kia Niro BEVs with faster charging speeds.

Thirty-one percent of respondents to a Wards Intelligence survey predict 10%-20% of BEVs will be capable of ultra-fast charging in 2025, and 25% say 21%-30% of the electric vehicles sold will charge at those higher speeds. Interestingly, those surveyed from vehicle manufacturers are

the most bullish, with 34% saying 21%-30% of BEVs will be able to ultra-fast charge. More than half of OE respondents predict at least 21% of BEVs on the market in 2025 will be capable of top-speed charging.

“We have this (technology) construct that’s been set out there at 150 kW and 350 kW, so from the public (charging) perspective, those are probably where the market’s running to,” Ford’s Stover says. “Because presumably, the quicker I can charge the vehicle, the higher the throughput time on the (charging-system)



asset and the less of a perceived inconvenience...from the perspective of the consumer.”

To date, only one automaker, Porsche, with its planned Taycan sports car due in 2019, has announced plans to charge at the full 350-kW rate available from the new ultra-fast chargers that will be part of the IONITY and Electrify America networks, although the forthcoming Audi

e-Tron GT revealed at the L.A. show is a twin of that car and likely will, too.

Most industry insiders believe few models near-term will match that rate, but many expect the majority of new-generation BEVs will fall in the bandwidth from 100- to 200-kW speeds.

“Between 2019 and 2025, we see the predominant amount of vehicles having a battery range above



Brendan Jones,
Chief Operating
Officer - Electrify
America

200 miles (322 km) and charging speeds above 100 (kW),” says EA’s Jones. Achieving the higher charging rates requires both chemistry changes in today’s lithium-ion batteries – though automakers largely remain mum on specifics – and more advanced cooling systems incorporated into the battery packs.

“Designing the cooling is important, having the algorithm to basically manage well how much and at what speed of charging (occurs) according to the temperature of the battery,” says Jerome Gregeois, senior manager-powertrain evaluation for the Hyundai-Kia America Technical Center.

“It’s all chemistry and cooling,” sums up Ulrich Widmann, chief operating officer-Technical Development for Audi.

Even with DC fast-charging, automakers make sure battery acceptance rates are modulated throughout the process to prevent overheating, typically lowering the speed of charge as the battery approaches capacity. That’s why when discussing charging rates, most automakers

talk about how long it takes to get to 80% capacity, a level – give or take – when most BEVs begin to dial back charging acceptance rates. Next-generation batteries are expected to allow continued fast charging closer to 90% of capacity.

Most agree BEV batteries can weather the impact of infrequent fast charging – once or twice a week – and if that activity is restricted to that frequency, consumers shouldn’t notice significant degradation over the life of their vehicles. Some argue that as BEV range nears 300 miles, commuters will need to replenish the battery less frequently and weekend home charging could meet most of their needs.

But what if BEV buyers begin to use fast charging with the frequency of a gasoline fill-up today? That is a realistic scenario given the expected wider availability of service stations in metro markets that will make it more convenient to fast charge. That expanded availability might also be critical for urban dwellers, who may not have the ability to charge at



Battery packs in Maven's Bolt fleet holding up to repeated fast charging.



home, and will have to rely on ultra-fast charging with regularity. Even single-family-home dwellers may choose to forego the cost of upgrading to a Level 2 charger for their garage and simply rely on the corner ultra-fast charging station.

Cost of a refill will be a limiting factor initially, but as ultra-fast charging stations proliferate, competition likely will temper premiums charged for an electric fill-up.

“There’s some fact and then there’s some fiction around the statement that fast-charging is

bad,” EA’s Jones says. “It really depends on the individual battery. (But) certainly, if you’re cycling through a battery on a daily basis and fast-charging multiple times, it’s probably not a good thing. But fast charging once or twice a week? There’s no evidence that that’s an issue for the most part.”

Maven, GM’s mobility arm, presents an interesting real-world test lab for BEV battery durability. Its Maven Gig program offers electric Chevrolet Bolts for rent to drivers for ride-hailing services, who put the vehicles through a rigor-



ous charging regimen, estimating about 85% of Bolt drivers rely only on DC fast chargers.

After more than 200,000 fast-charging events over 18 months of operation, says Alex Keros, Maven's Future Cities chief, "There's nothing remarkable to report" as far as durability issues.

David Finn, CEO of EVSE supplier Tritium, says his company has observed no serious degradation when fast charging at 50 kW but admits, "We've yet to see proof in the pudding" when it comes to higher speeds.

Asked how fast batteries will need to charge to sway more buyers toward BEVs, 82% of respondents in the Wards Intelligence poll say 19 minutes or less, including 27% calling for a reduction to 10-14 minutes and 31% saying less than 10 minutes is needed.

"We see these projects like IONITY and Electrify America as the starting points, that they're necessities for vehicle manufacturers to sell cars," Tritium's Finn says. "Without them, (almost) no one's going to go to the showroom and buy an electric car. We

won't move through the early adopter (stage)...and cross the chasm into the majority of the market unless we provide a viable alternative to refueling."

Including Tesla's 558 Super-charger stations, there are about 2,500 public DC fast-charger stations available in the U.S. as of early December, says the DOE. The Electrify America program will raise that count sharply by July 2019, adding 484 stations by that time. In early December, 33 EA fast-charge stations were up and running in the U.S.

Other service providers are starting to respond in kind. EVgo, the current leader in fast-charging stations in the U.S. at 748, wants to add hundreds more in prime California markets. ChargePoint is targeting 2.5 million charging spots globally (including primarily more-conventional Level 2 units) by 2025, up from 54,000 today.

"Is there enough Level 3 right now? I would say no," Hyundai's Gregeois says. "We cannot have enough of those. Currently, the network is not close to what the gasoline coverage would be. So,



**Alex Keros, Chief
– Maven Future
Cities**



we welcome more and more DC fast-chargers out there.”

Utility companies are prepping for potential higher demands on the grid as they eagerly await the emergence of this new revenue stream. Smart chargers, receiving real-time grid data from utilities through the Internet, will allow energy providers to pause or throttle down charging during times of high power demand as a way to, for instance, protect neighborhood transformers from being overtaxed.

“We’re already thinking ahead to look at what we call these smart-charging or demand-response programs, to try to signal to the customers, ‘Hey, this might not be the best time to charge,’” says DTE’s Camilo Serna, vice president-corporate strategy. “It might not necessarily mean not charge at all, but just reduce the level of charging (or) the draw from the grid, to just modulate it, regulate it until the conditions are better where you can allow the car to charge at full speed.”

The growth of BEV sales and

development of charging infrastructure are symbiotic. Each will rely on the other to expand, and that likely means market development will be neither smooth nor linear.

There likely will be pockets of both too much and too little charging capacity as BEV demand begins to increase. But most industry insiders expect capitalism to win in the long run – as demand increases for charging services, so will supply, and eventually the equation will balance out. **WA**



Camilo Serna,
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*This story
was written*

*by Senior Editor Christie
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