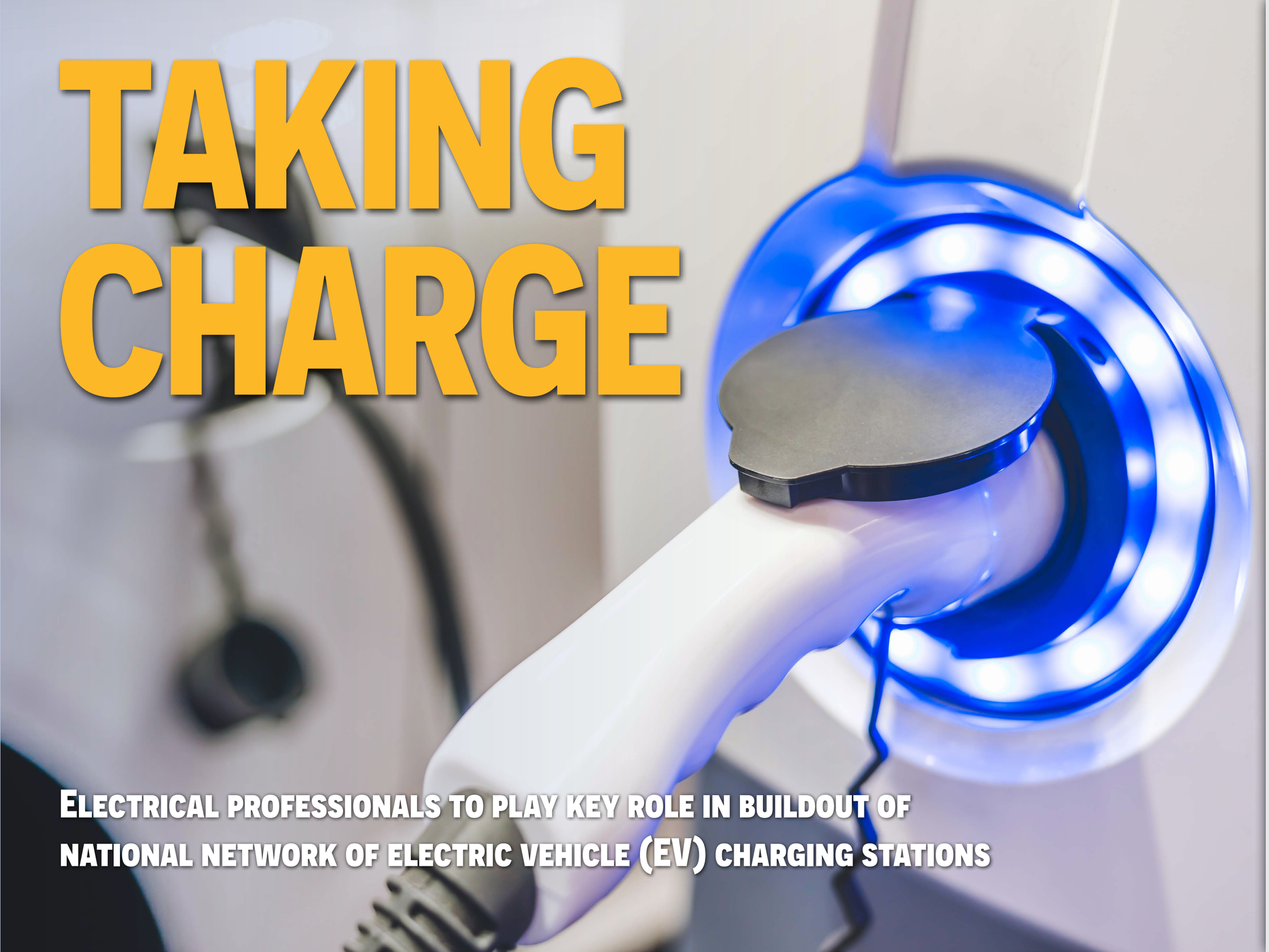
TAKING CHARGE



Electrical professionals to play key role in buildout of national network of electric vehicle (EV) charging stations

TAKING CHARGE

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CHARGING AHEAD

Electrical professionals at forefront of nationwide electric vehicle (EV) infrastructure buildout

BY ELLEN PARSON, EDITOR-IN-CHIEF, *EC&M*

It's hard to believe the world's first drive-in gas station opened in Pittsburgh in 1913. Several decades later, in 1947, the first "self-serve" gas station made its debut in Los Angeles. When you look back at the history of fueling vehicles, there are so many technological milestones along the way. According to market research firm IBISWorld, the United States currently has more than 66,000 gas stations with convenience stores. How does this compare with electric vehicle (EV) alternatives?

Given the recent call for 500,000 electric vehicle (EV) charging stations in the proposed infrastructure bill (and the $7.5 billion of spending that currently goes with it) by 2030, some parallels come to mind. As I contemplate the ongoing buildout of our nation's EV charging station infrastructure for this e-book, I can't help but wonder what was going through these stakeholders' minds in the early days as they pondered the initial concept and challenges of creating such a massive network of gasoline fueling stations. What went into making the world we live in and take for granted now — with a gas station on every corner — a reality? What lessons will we learn from these pioneers as we (the electrical industry) embark on building out a nationwide system of EV chargers that can serve the number of EVs expected to be on the road by this time? And what will the future "fast-charging" experience we've all heard tossed around look and feel like? How quickly will these batteries charge, how far will a charge take us, and what will we do in the meantime while we're waiting?

According to the U.S. Department of Energy, at the end of 2020, there were only about 32,000 public and private EV charging stations in the country. This is a far cry from the proposed 500,000 station goal by 2030. So how do we get from here to there? Although many questions are still unanswered, one thing is certain. Electrical professionals will be at the forefront of this buildout, which creates massive opportunities for electrical engineering firms (whose engineers will design and specify these projects), electrical contracting companies (whose electricians will install and troubleshoot the electrical equipment), electric utilities (whose engineers will tie all of this into the grid), and contractors or third-party firms (whose technicians will service the equipment and keep things running smoothly from a maintenance standpoint).

The editorial team at *EC&M* knows how important the reliability of this evolving commercial network of charging stations will be to the electrical industry specifically and the nation as a whole going forward. That's why we're pleased to bring you this compilation of articles, in cooperation with our sponsor Fluke, packaged together in this convenient e-book. The information and trends offered here should be essential reading for any electrical professional looking to stay on top of the latest advancements in the EV charging arena. The pieces hand-selected for this e-book address how the current infrastructure bill, utility incentives, and real estate business models are shaping the evolving EV infrastructure, how electrical contractors are lending expertise to utility programs subsidizing commercial EV charger installations, important issues that arise with power and voltage requirements, and how properly positioned electrical designers and contractors can take advantage of growth opportunities in this market. I encourage you to read all of the articles as you continue to follow EV charging developments now and in the future.

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BUILDING OUT THE ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

The federal infrastructure bill, utility incentives, and real estate business models are spurring the EV charging infrastructure market.

BY TIM KRIDEL, FREELANCE WRITER

Just how hot are electric vehicles? In the first half of this year, global EV sales nearly tripled compared to the same period in 2020, according to Wood Mackenzie. The research firm also says EVs are now 7% of all passenger car sales, and they're on track to sell more than 6 million by the end of 2021.

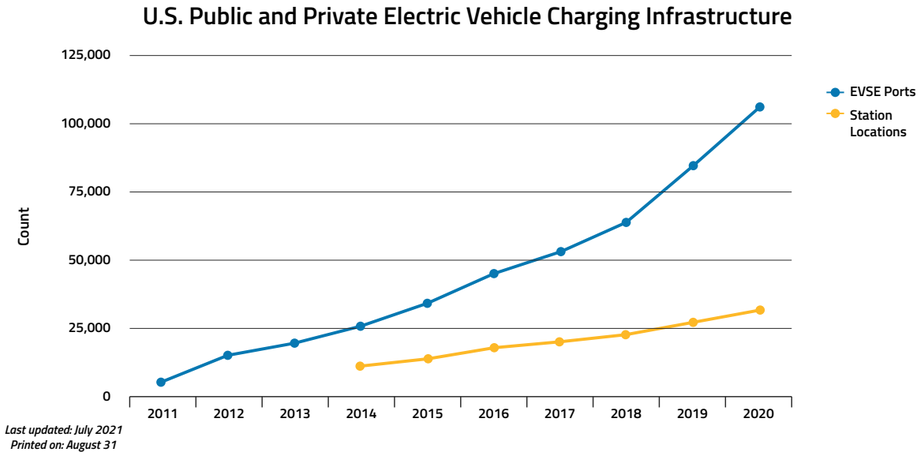
More EVs mean more charging stations will have to be built. At press time, the federal infrastructure bill still included funding for 500,000 EV charging stations, but the final outcome is yet to be seen.

"It doesn't look like this bill is going to be passed anytime before October, at the earliest," says Carrie Sherer, associate director of government affairs at Black & Veatch, which provides engineering and other services for EV charging station operators. "It could be even later in the year."

At the end of 2020, there were only about 32,000 public and private EV charging stations (see **Chart**), according to the U.S. Department of Energy. Although another 500,000 obviously means a lot of additional work for electrical contractors, that figure actually low-balls the business opportunity.

Credit: Photo courtesy of Black & Veatch

Exactly what future EV charging stations will look like is yet to be seen, as the infrastructure is built out. The more ports a station has, the more electrical design and installation work it requires.



Source: Alternative Fuels Data Center
Notes: Between 2011 and 2013, the electric vehicle charging counts reflect only the number of EVSE ports because data was not captured in these years about the number of stations (geographic locations).

This chart shows the growth of U.S. public and private electric vehicle (EV) charging infrastructure since 2011. The number of electric vehicle supply equipment (EVSE) ports has grown consistently, and the number of EV charging station locations has also increased steadily since 2014 when the National Renewable Energy Labratory started tracking thetwo figures separately. Between 2015 and 2019, the number of charging stations nearly doubled. In 2020 alone, the number of charging stations grew by 18%.

According to recent data from the U.S. Department of Energy, at the end of 2020, there were only about 32,000 public and private EV charging stations.

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Here's why: Many of the existing 32,000 stations have multiple ports because they're in public places, for a grand total of about 107,000 ports at the end of 2020. For example, a single five-port station outside a grocery store could charge five EVs.

The more ports a station has, the more design and installation work it requires. For example, the number of ports often is more than a site's existing electrical service can handle. If the site is close to a substation that has enough capacity, then the work might include adding a transformer nearby.

Port type is another factor. For example, at the end of 2020, more than 15% of public ports were DC fast chargers.

"You have DC chargers that are 50kW all the way up to 350kW," says Maryline Daviaud Lewett, Black & Veatch director of business development for transformative technologies. "Then the complexity of the electrical installation is greater. With DC chargers that are a much higher power level, you often need new electrical service in that location."

"SOMETIMES IT'S QUICK BECAUSE THE UTILITY HAS POWER AVAILABLE CLOSE BY, AND THEY HAVE A TRANSFORMER — OR THEY JUST ADD A TRANSFORMER IN THAT LOCATION. SOMETIMES IT TAKES 12 MONTHS TO GET ADDITIONAL POWER. SO YOU HAVE QUITE A BIT OF VARIATION, ESPECIALLY IN THE 350KW RANGE."

According to the Alternative Fuels Data Center, a resource of the U.S. Department of Energy's Vehicle Technologies Office, there are three main charging types. Level 1 uses 120VAC. Each hour of charging provides two to five miles of range, depending on the vehicle. Level 2 typically uses 240VAC in residential installations and 208VAC for commercial, with about 10 to 20 miles per hour of charging. Level 3, also known as "DC fast charging," typically uses 208/480VAC 3-phase input with about 60 to 80 miles per 20 minutes of charging.

HIT THE ROAD

Most new public charging stations would use DC fast chargers so drivers can get in and get out, right? Not necessarily.

For example, the Electrify America network uses only DC chargers ranging from 150kW to 350kW. But other operators prefer to provide a mix of charging types. One reason is because the AC equipment is less expensive to buy, install, and operate. Also, people shopping at a mall might be fine using a Level 2 AC charger if they're going to be there a few hours anyway. But other customers are willing to pay a premium for a DC fast charger because their shopping trip is a quick in and out.

"We are seeing the great majority of interest in Level 2 chargers because that provides energy at a sufficient rate for home or workplace use cases," says Aleksi Paaso, ComEd director of distribution planning, smart grid, and innovation. "We see meaningful opportunity for DC fast charging as a destination service to places that customers spend less time such as restaurants and retail businesses. DCFC infrastructure like Superchargers and other extreme fast chargers will also be necessary for larger and heavier vehicles with long daily ranges."

For owners of apartment complexes and other multi-dwelling units (MDUs), one common concern is the potential cost of upgrading service to support more or faster chargers — or both. A savvy design can knock down that barrier.

"There are things in the NEC that deal with energy management or power control to limit the load so we don't necessarily size things one for one," says Larry Ayer, vice president of Cincinnati-based Biz Com Electric. "If you need sixty 20A chargers, maybe we don't necessarily put in 400A, 3-phase to handle all this. That's helping so we don't oversize things, and it's not that massive [of an impact] for the grid."

Another hurdle is a related to the location of parking for each unit.

"For example, your lease may name your parking spot," says Terry O'Day, COO of Santa Monica, Calif.-based In-Charge Energy, which provides engineering, O&M, and other services. "In these cases, onsite Level 3 (480V) charging might work for an apartment community."

WHAT'S THE BUSINESS MODEL?

Network operators and property owners, such as real estate investment trusts (REITs), also are trying a variety of business models. For example, many gas station pumps have screens for showing advertiser-sponsored videos. Some EV charging station networks are adapting this business model, such as Volta.

"They offer the chargers and the installation for free to the real estate company," says Black & Veatch's Lewett. "They also offer the charging for free to the visitors of the mall. They make their revenue through advertising."

Some REITs view charging stations as a way to attract and retain shopping center tenants by driving business to them: People who need to kill a half hour might grab

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Credit: Photo courtesy of Black & Veatch

Several factors serve as a catalyst to the growing EV charging infrastructure market, including the recent infrastructure bill, utility incentives, and changing real estate business models.

lunch at the development with chargers rather than one across the street without them. And as with paid parking lots and garages, tenants also could validate charging tickets for drivers who make a purchase over a certain amount.

"This is where the charging stations are showing up: where I have to go rather than choosing a stop on the journey," says Craig Irwin, ROTH Capital Partners managing director for equity research. "You fill up where you go rather than going where you fill up. The traditional retailer model for petroleum is that [gas stations] make their money in convenience store. That whole model is transferring over to the large REITs across the country."

For electrical contractors serving the commercial market, this emerging REIT model is something to consider in designs and bids because it affects both the project cost and future proofing.

"The wires that bring electricity to a charger are a much longer-term investment than the charger itself," says ComEd's Paaso, who also is a senior member of the IEEE Power & Energy Society and vice chair of the IEEE PES Industry Technical Support Leadership Committee. "We see that there is significant value that comes from considering charging when planning new construction and pre-wiring parking spots for future charging stations."

PARTNER UP

Like many of its peers, In-Charge Energy uses partnerships to keep up with demand.

"As our industry is growing so quickly, we rely on our electrical contractor partners in those markets and throughout other markets in North America to complete our installation and commissioning, civil work, and maintenance services," O'Day says.

There also will be plenty of work for electrical contracts that serve utilities, such as upgrading the grid.

"Utilities need to continue to develop, demonstrate, and deploy the technologies that can integrate all of the additional load that these vehicles represent," Paaso says. "At ComEd, we're demonstrating technologies — including managed EV charging and a cyber-secure Extra Fast Charging (XFC) EV charging station — to help us do so. This represents just the beginning of what utilities need to do to make this possible."

Utilities also could get some relief if residential batteries can step in to power homes, such as when demand is high or when there's an outage.

"A typical home draws about 5,000 watts," says Biz Com Electric's Ayer. "That could power a home for 20 hours."

SIDEBAR: CARROTS AND STICKS

In addition to the federal infrastructure bill, a host of other initiatives are well underway at the state and local level.

For example, when a Columbia, Mo., grocery store wanted to add a gas station in its parking lot, the city council wouldn't approve the project unless it included a charging station. And earlier this year, Richmond Heights became the first Missouri city to require new single- and multi-family construction to be wired for EV chargers.

Richmond Heights also is an example of the growing number of utility programs that incentivize charging stations. The dual-port, Level 2 station outside its library was funded with a grant from Ameren, whose program provides MDU owners, businesses, and other organizations with incentives that will cover up to 50% of a project's total cost.

Some utilities apply their residential rate to some public EV stations to overcome concerns about bill shock.

"Some of these get charged at the commercial rate, so you'll get smart charged for demand factor when these are really residential-type uses," says Biz Com Electric's Ayer.

Kridel is an independent analyst and freelance writer with experience in covering technology, telecommunications, and more. He can be reached at tim@timkridel.com.

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Credit: Photo courtesy of Electrical Connection

Guarantee Electrical, St. Louis, installed Tesla charging stations in a parking garage at a Streets of St. Charles (Mo.) mixed-use development in 2020.

EV INSTALLATIONS OFFER NEW REVENUE STREAMS FOR ELECTRICAL CONTRACTORS

St. Louis-area group brings electrical contractor expertise to utility program subsidizing commercial electric vehicle charger installations.

BY TOM ZIND, FREELANCE WRITER

A group of St. Louis-area electrical contractors has signed on to assist a Missouri utility launch its new program incentivizing commercial installations of electric vehicle (EV) charging stations.

Electrical Connection, a partnership of the International Brotherhood of Electrical Workers (IBEW) Local 1 and the St. Louis Chapter of the National Electrical Contractors Association (NECA), announced in late January that members were offering a turn-key service to help business customers of Ameren Missouri take advantage of the utility's offer of financial assistance for installing charging stations.

Jim Curran, Electrical Connection's executive vice president, says the group saw an opportunity to leverage specific knowledge some member contractors have gained through participation in an Electric Vehicle Infrastructure Training Program Electrical Connection has maintained for a decade. Member contractors who engage with interested Ameren customers will assist with everything from paperwork and site planning to engineering and installation.

"We approached them and said that with your program to encourage installations and our contractors' training and knowledge, let's work together to reach out to municipalities and businesses with some assistance," Curran says.

Credit: Photo courtesy of Electrical Connection

An RJP Electric worker wires the pedestal for an EV charger at a St. Charles County (Mo.) Economic Development Center property.

"WE HAVE A LOT ALREADY IN PLACE TO BE A ONE-STOP SHOP, SO [WE SAID] COME TO US AND LET US DO ALL OF THE WORK."

Interested contractors will field inquiries from Ameren customers, pursue leads provided by the utility, and educate their own customers about the rebate program. To help market Ameren's program to the business community, Electrical Connection staff joined Ameren in a webinar presented last November by St. Charles County (Mo.) Economic Development Center. To help move it along, an Electrical Connection member contractor, RJP Electric, St. Louis, installed a dual-port charging station at an EDC property free of charge.

RJP and other Electrical Connection members were making headway in the EV charging market before Ameren's announcement. For example, Guarantee Electrical, St. Louis, has been active in the area charging station market and anticipates more opportunities to emerge through the Ameren partnership, says Dena Schmidt, energy solutions project manager for the electrical contracting firm.

"We're committed to help get the word out about the Ameren program because the more charging stations the better for the environment," she says.

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"WE'VE BEEN A TOP TRADE ALLY FOR AMEREN FOR A NUMBER OF YEARS, AND WE WANTED TO BE A PARTNER ON THIS AS WELL."

The company's work has included a bid on a 50-station project for a corporate campus in St. Louis and a completed installation for a downtown St. Charles mixed-use development.

The Electrical Connection initiative to position Guarantee and other electrical contractors for opportunities in the EV market signals that the market holds promise as a source of sustained business for well-placed contractors. The nation's charging infrastructure will have to be built out to support continued growth of the electric vehicle market, a proposition boosted by General Motors' recent announcement to go all-electric by 2025. The path ahead, though, is complex, with many moving parts needing to align, but there's little doubt that over time, charging stations designed and built with electrical expertise will be sprouting up from coast to coast.

Zind is a freelance writer based in Lees Summit, Mo. He can be reached at tomzind@att.net.

Credit: Photo courtesy of Electrical Connection

RJP Electric workers orient charging lines inside an EV charging station the company donated to St. Charles County (Mo.) Economic Development Center.

Credit: Photo courtesy of Electrical Connection

An RJP Electric worker puts the finishing touches on an EV charging station installed at a St. Charles County (Mo.) Economic Development Center facility.

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POWERFUL CHANGES IN HIGH-POWER EV CHARGING

EV charging is going high voltage. Are you prepared?

BY VAN WILKINS, ABM

The evolution of high-power charging for electric vehicles (EVs) is pushing power and voltage requirements higher. Businesses planning to capitalize on consumer desire for faster EV charging need to know those requirements to plan their best EV strategy. In addition, fleet managers will need to adequately plan new power infrastructure, while electrical contractors must be ready to advise on safe installation and efficient project plans.

LEADING THE CHARGE

Faster power to the vehicle means more power through (and to) the charger. Therefore, those involved with operations and training will have to adapt to rising power requirements of new high-power charging technology. It's been common to see a charger with more residential specifications, such as 240V, 20A. Now, 100A circuits are needed for AC charging. For DC fast charging, 50kW and 400V to 500V has been the norm. Now, that's poised to increase to 800V and 900V at 350kW of charging, and the market is already looking ahead to 1,000kW (1MW) and 1,500V.

Many commercial electricians are not required to work with voltages higher than 480V phase-to-phase, and many work mostly with AC power. DC fast charging means more technicians will need to be trained to work on DC at the 1,000V (soon to be 1,500V) level. This means a change in the insulation rating of the wiring needed, a change to the personal protective equipment (PPE) requirements for the job, and a big change to your training plans. Going forward, a variety of employees will need training across the board — not just techs.

For instance, bidding a new job for EV charging will not entail just one charger and one 40A circuit. Correctly bidding the job will mean knowing that 1,000V or higher insulated wiring will be required. Some installations will require a neutral; some won't. Field electricians will have to be trained on the higher voltage equipment, the arc flash risk, and PPE requirements. But don't leave out estimators, designers, and project managers. They're also going to need to know about the different equipment and PPE needed.

INSTALLATION CONSIDERATIONS

Consider this basic installation example: There is 240VAC input to the box. On the other side, it's DC and the voltage steps up to 920V. On the AC side, you'll need a 600V wire. On the DC side, you'll want to spec a wire rated for 1,500V. The PPE you'll need for each side is different, too. On the AC side, 00 (double-aught) gloves are sufficient. On the DC side, you'd need to step up to 0 (aught) gloves.

As EV adoption continues to increase, and more fleets convert to EV, many installations will involve installing chargers where no power infrastructure previously existed. Like the rise in voltages seen in solar — from a lot of single-phase work to higher voltages — the EV charging market is changing. In the rush to stay ahead of the curve, make sure you, and the people you partner with, have the knowledge to safely and efficiently design and install EV charging installations for clients.

For more information, visit abm.com/electrical.

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EV INFRASTRUCTURE OPPORTUNITIES

As electric vehicle numbers grow, demand for a robust battery-charging infrastructure will follow, benefitting properly positioned designers and contractors.

BY TOM ZIND, FREELANCE WRITER

Some projections suggest EV sales could exceed 3.5 million units by 2030.

Charge! That might be the rallying cry for more electrical designers and contractors as they witness the slow unfolding of an electrical vehicle (EV) revolution that will ultimately demand a highly reliable, responsive, and accessible vehicle battery-charging infrastructure.

From private residences, workplaces, and storefronts to shopping center parking lots, interstate highways, and public transportation/truck terminals, EV charging stations are on track to become, much like gas stations perhaps, part of the nation's thoroughfare landscape. And, to the benefit of designs and construction professionals, they'll all require application-specific design, configuration, connection, installation, maintenance, and servicing.

Various entities will be involved in that multi-layered effort, but the basic task of activating the charging units will fall to electrical services professionals. Some electrical contractors have been modestly cashing in for several years as EVs have become more popular. Now, they're joined by others drawn to nascent opportunity in the space as the EV fleet expands and modernizes — and the need for a denser and more capable network of battery-charging port hubs becomes more obvious.

Continental Electrical Construction Co., Oak Brook, Ill., first eyed prospects in the market about seven years ago as it began building a renewable energy business, says Brian Haug, the company's director of energy solutions. A state rebate program sparked local demand, and the company landed some work, but that was short-lived. But it forged relationships with charging unit suppliers — ones that have lately begun yielding a steadier stream of commercial charging station design and installation work. To date, the company has installed some 350 public chargers in the Chicago area.

"Some of the work is direct with commercial customers we've had for years, but most comes from charging unit suppliers like ChargePoint, SEMAConnect, and EVgo who reach out to us for design and installation services," Haug says. "One of those relationships led us to install 100 units for area Walgreen stores."

At a pace of one or two installs a month now, Continental's charger business is a tiny piece of its overall revenue. But it's being marketed to a degree, says company vice president Steve Witz, and could lead to something bigger over time.

Shopping center parking areas are hosting more EV chargers as electric vehicle usage continues to grow.

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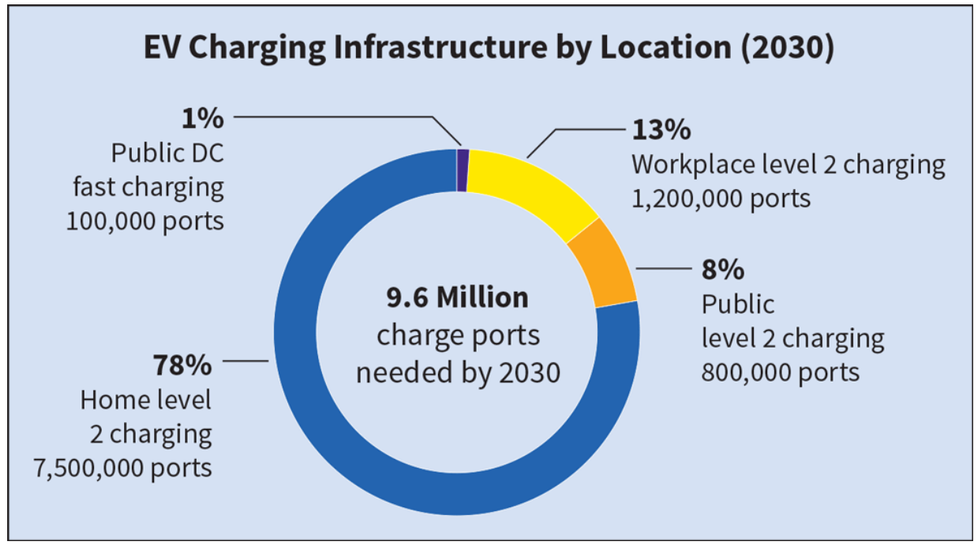
"IT COULD JUSTIFY HAVING ONE OR TWO DEDICATED PROJECT MANAGERS FOCUSING ON THIS AT SOME POINT," HE SAYS.

Ozburn Electrical Contractors, Inc., Covington, Ga., has been diving deeper into the business as the need for chargers blossoms in an Atlanta metro area traversed by a growing number of EVs. Its experience with chargers dates to 2010, but only recently has installation work begun to ramp up, says Company President Terry Ozburn. Partnering with charger suppliers, it has been handling complete installation work, including subbing out related non-electrical tasks like excavation and concrete, at commercial and multi-family residential locations, and even some single-family residences. One of its biggest single jobs has been installing charging stations at 40 area Walgreens properties.

"This is becoming a pretty big market, and we're going to market our services hard," Ozburn says. "Over the next 10 years, there will be a lot more EVs on the road, and the charging infrastructure has to be in place. Someone has to put them [the charging units] in."

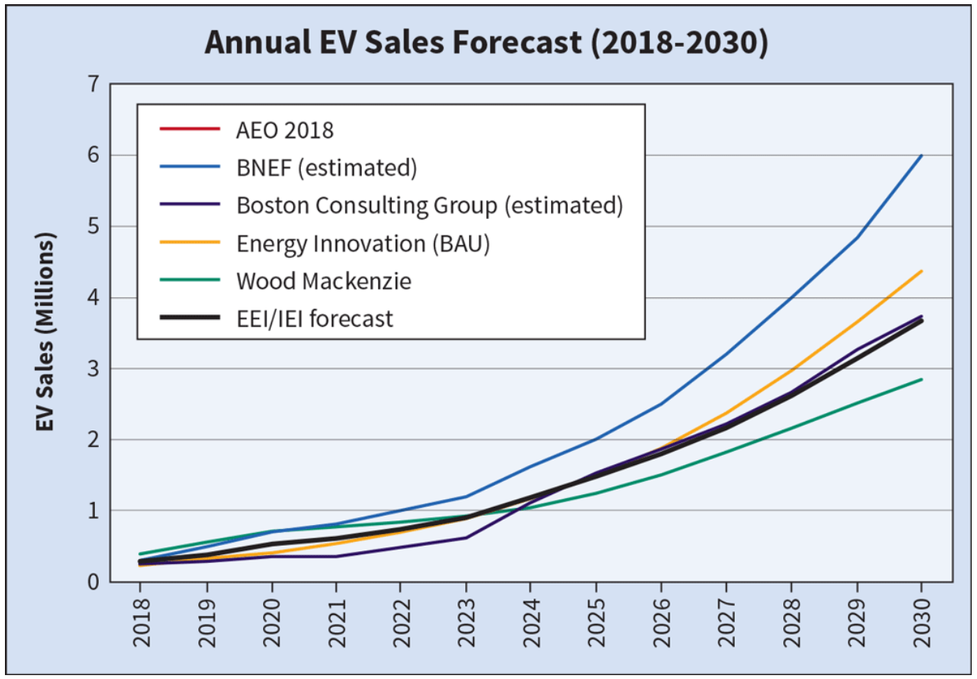
EV NUMBERS GROW

Forecasts, of course, can be bold and end up being way off the mark. But there's an emerging consensus that the EV revolution is well underway and unlikely to sputter.



Source: The Institute for Electric Innovation/Edison Electric Institute

Fig. 1. *EV charging infrastructure in 2030 based on EEI/IEI forecast.*



Source: The Institute for Electric Innovation/Edison Electric Institute

Fig. 2. *EEI/IEI annual sales forecast compared to selected forecasts.*

With more vehicle makers committing to future EV production, battery technology improving, the ranks of battery-charging products and services suppliers growing, and government nudges toward green transportation growing more forceful, the EV future is coming into sharper focus. At this point, it looks like it will require charging resources far more robust than simple connections to 120V receptacle outlets in home garages.

In a report issued in November 2018, Edison Electric Institute and the Institute for Electric Innovation attached numbers to projections that both EVs and charger installations would grow over time (see **Fig. 1** and **Fig. 2**). Distilling data from five independent forecasts, it concludes that by 2030, EVs on U.S. roads are likely to number 18.7 million, or perhaps 7% of the car and light truck fleet. That compares with some 1 million on the road today, an amount that could well double in just the next 18 to 24 months. Come 2030, annual EV sales will be humming, exceeding 3.5 million units, accounting for more than 20% of annual vehicle sales, projections suggest.

As that number swells, the report said, battery charging infrastructure growth and modernization must closely track to alleviate prospective EV owner concerns, including fears of mobility being limited by too few charging locations, or "range anxiety" as it's known in EV circles. Framing the need, and not necessarily the expectation, the

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report said 9.6 million charging ports must be in operation to adequately service what's likely to be both more demanding EVs and drivers. Most ports will continue to be at single-family homes, as is now the case, but 2.1 million, or 22%, will be in the public domain (900,000) or sited at workplaces (1.2 million) by then.

Other projections vary somewhat, such as a recent U.S. Department of Energy study that pegs the overall need notably lower than Edison's based on a more modest 15-million EV estimate — some 627,000 public outlets by 2030. Either way, that's a lot of ground to make up considering that the Edison report puts the number of public-space charge ports now in operation at only around 54,000.

THE NUMBER OF WORKSITE CHARGERS CURRENTLY IN PLACE IS UNKNOWN, THE REPORT STATED. THE CLEAR UPSHOT: THERE'S A LOT OF WORK TO DO, AND OPPORTUNITY FOR THOSE WHO CAN HELP GET IT DONE.

"The significant difference between the current availability of charging infrastructure and the expected charging infrastructure needed suggests a growing 'infrastructure gap' that must be addressed," wrote the report's authors Adam Cooper and Kellen Schefter.

Whether the gap can be narrowed as the EV numbers grow, and ultimately be closed at some fixed future date, is the pressing question for stakeholders. Vehicle makers mapping their EV futures, governmental entities incentivizing or mandating moves to green transportation, electric utilities projecting demand and grid capabilities, and the various parties involved in building out the network are all at the table. Their actions will determine whether goals will be met, a worrisome reality given the independence of the parties on one hand, but their interdependence on the other. But it will ultimately fall to that consortium to create an optimal battery-charging infrastructure, one with adequate numbers and mixes of charger types installed in the right places. No central hand is guiding or funding that effort nationally, but work is well underway on numerous fronts to achieve that goal — and some initiatives approximate a command-and-control approach.

THE BUILD-OUT

One that comes close is being led by Electrify America, LLC, a subsidiary formed by Volkswagen Group of America in 2017. It is funding and shepherding a long-term EV infrastructure push agreed to in a settlement with the U.S. Environmental Protection

Continental Electric Construction Co. got into the EV installation business early on. The company has installed a large number of public chargers in the Chicago area.

Agency for perpetrating a vehicle emissions scandal. Spending $2 billion of its own money over 10 years, it is broadly promoting adoption of EV transportation in the United States, including a dedicated earmark of $800 million for California, with the bulk of the money funding construction of its own multi-faceted, publicly accessible charger network.

In the initial 30-month development phase, on track for completion at the end of 2019, Electrify America was to have built a network of 2,000 so-called fast chargers — a reference to their comparative charging speed over standard chargers seen in home garages and many existing public locations — distributed among 500 stations across the country. Groupings of DC fast chargers (DCFCs) are being deployed in stations with individual port charging power levels up to 350kW along high-traffic corridors in 39 states. In addition, public stations with DCFCs and/or AC Level 2 fast chargers delivering up to 150kW charging speeds are going up in 17 of the nation's largest cities, and AC chargers are being installed at more than 300 multi-family units and businesses catering to employees with EV charging needs.

As its first funding phase winds down, Electrify America is beginning a second round of expenditures that will include more allotments for infrastructure. Through the end of 2021, it plans to spend another $235 million, with 65% going to expanded and targeted-use metro area charging; 32% going to additional highway and regional route stations; and the balance to small experiments with both autonomous vehicle charging

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stations and renewable energy-powered stations. In total, another 200 charging stations could be added.

As simple as charger installation might appear, especially if the comparison is drawn with putting in standard home garage chargers, the Electrify America project, and others like it, is a demanding one, logistically and sometimes technically. It retained two companies, Black & Veatch, Kansas City, Mo., and SAI Group, Salem, N.H., to geographically split the design, permitting, and construction work on the stations, calling on each firm's design-build expertise and project-specific experience. Both function as general construction contractors, supplying their own labor for some tasks but also hiring and overseeing electrical contractors and other subs.

For Black & Veatch, which has responsibility for 24 states and the distinct California work, the task is familiar, having been instrumental in helping EV maker Tesla build its own proprietary high-speed charging network beginning six years ago.

"This infrastructure is heavily oriented to DC fast charging, and we had a lot of experience in-house with national deployment of that kind of network," says Maryline Daviaud Lewett, director of business development with the company's transformative technologies division.

EC OPPORTUNITY

Electrical contractors, often more national in scope and usually hired from a list of pre-qualified firms that bid for the jobs, provide the critical expertise and experience needed to handle work that doesn't always go by the book.

"Contractors need to be experienced in DC power; it can be a lot easier to deploy AC, 240V, 40A systems," says Lewett. "And there can be a lot of configuration and on-site customization, since there's often not enough power on site, so it requires coordination with utilities."

The logistics of getting charging stations installed has been one of the most challenging elements of the infrastructure development work that Rosendin Electric, a San Jose, Calif.-based electrical contractor, has taken on, says Brian Smith, the firm's special projects division manager. In the nearly 100 projects it's performed, including some recently for the Electrify America program, the work is done on a turnkey basis, with the company assuming management of nearly all components, most of which prove more challenging than the electrical, Smith says.

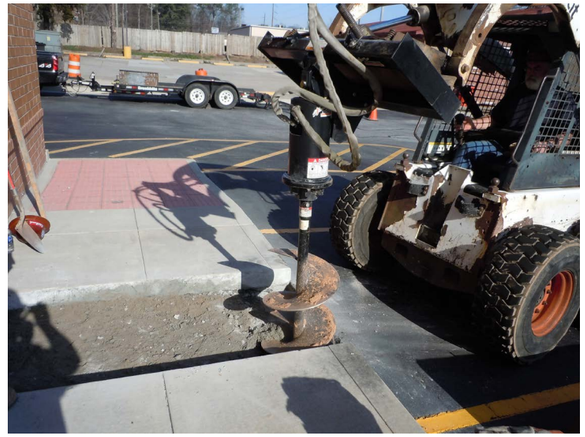
"We do the design and installation, everything except handling the host site agreement," he says. "When we get the job, we walk the project for design and get the civil layout, start work on getting it permitted and then getting it built, running the electrical infrastructure underground. Scheduling, getting the civil work and permits handled is tougher. City building departments are often the biggest hurdle because they often don't know much about this."

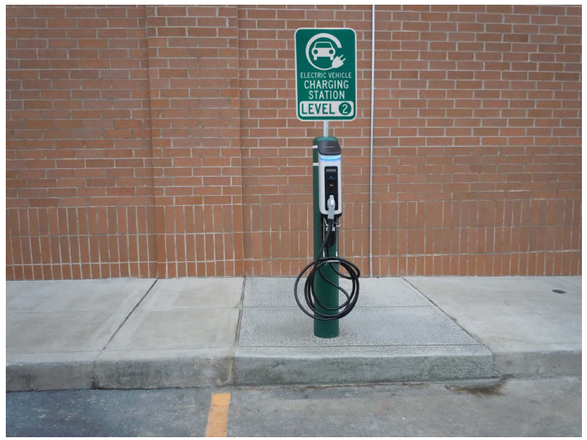
Also, partners in many of the projects Rosendin has taken on have tended to overlook the complicating nuances of getting charging stations up and running.

"In the beginning, most guys doing these initiatives didn't know much about construction," says Tom Gusiff, a Rosendin project manager. "As this has developed, they've brought in more construction-minded people so they're starting to realize more of what it takes to get these things going."

The market looks more hospitable in that regard, Smith says, especially as ambitious initiatives like Electrify America take root, automakers get involved, and utilities with a lot at stake take a more active role in deploying charging stations and planning for how to accommodate and leverage a large EV charging infrastructure. All of that bodes well for Rosendin going after more work in the area.

"In California, based on the number of EVs that have been sold, only 4% of the needed infrastructure is currently installed," says Smith.





Ozburn Electrical Contractors, Inc., has been partnering with charger suppliers on installations, including a large project for 40 area Walgreens properties.

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"IT'S STARTING TO LOOK LIKE AN ARMS RACE TO GET THESE STATIONS IN THE GROUND. THINGS COULD REALLY EXPLODE, QUICK."

But the challenge isn't framed by sheer numbers. The need for a massive infusion of more charging locations, carefully sited to serve expected EV ownership concentrations and traffic patterns and a public and commercial transit infrastructure certain to integrate more EVs, is plainly evident. What's more vexing is the need for an increasingly sophisticated and capable infrastructure that's aligned with coming generations of more powerful batteries, the demand for faster charging, the likely adaptation of solar-powered charging and an electric grid that could be stressed by the load implications of a fast-growing web of power-thirsty battery chargers. Future design and installation work must reflect those considerations, and the skills of companies working in the space as it evolves will be tested. What's coming in EV charging is away from home garage battery chargers, says Dan Bowermaster, program manager for electric transportation at Electric Power Research Institute (EPRI).

"The big gap that exists now is in how to scale this up in a cost-effective way," he says. "Charging power levels on the light duty side were 50kW, and now we're moving into 150kW, 250kW, and 350kW per vehicle, meaning a typical station is going to be 3.5MW. On the DCFC side, the smallest of these stations is going to be the size of a 7-Eleven store. All of this presents a good opportunity for the right contractors."

SIDEBAR: GETTING AHEAD OF THE EV BATTERY-CHARGING CURVE

Electric vehicles remain on the periphery of the nation's transportation infrastructure, but planning for a time when they're much more commonplace could be smart, and in a small number of cases, law-abiding.

Electrical design and contracting professionals might consider that as they consult with clients on new residential and commercial building projects, and perhaps others, that could someday benefit from having EV battery-charging units on the premises. That day may be far off, but the best construction advice might be to either add them in or do the electrical work up front to simplify future installation.

The alternative, postponing a decision, could be the worst option — one that could run afoul of laws being passed in some jurisdictions requiring more new buildings to be EV-charger equipped or ready. One of the latest is Seattle, where all new buildings with off-street parking must offer EV charging.

Electrically retrofitting a built site for chargers, specifically areas where vehicles owned by tenants, employees, or even the public might charge their EVs, could be costly and disruptive. Instead, doing the required electrical work during construction, installing chargers or prepping the site for their eventual addition, is often the better route — and one more new properties are taking.

"We're seeing many apartment complexes, high-rises, and individual business locations being built with the capacity to put chargers in or overtly showing them installed on drawings," says Steve Witz, vice president at Continental Electrical Construction Co., an Oak Brook, Ill.-based electrical contractor that has been handling more EV charger installation work in the Chicago area.

Properties built with electrical infrastructure that allows easy charger unit installation at a future date are becoming more commonplace, especially in urban areas where EVs could proliferate and lead to demand for more powerful charging stations that could supplement home-based charging. Reasons vary — from making properties more attractive to flashing "green" credentials to responding to government mandates — but economics is one key motivation.

A 2016 study, Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco, commissioned by a California utilities group, determined that it would be four times costlier to later add an EV charger-outfitted parking space to a project than it would be to install a complete electric circuit for PEV charging during new construction.

"Installing infrastructure during new construction can avoid retrofit costs including breaking and repairing walls, longer raceways using more expensive methods, and upgrading electric service panels," the report stated. "In addition, the soft costs such as permitting and inspections and project management are much lower for new construction."

The solution for projects wanting to plan for an EV future is EV-ready or EV-capable construction. For the former, that generally means installing electrical panel capacity and conduit to terminate in a junction box or 240V charging outlet; for the latter, installing electrical panel capacity with a dedicated branch circuit and continuous raceway from the panel to an eventual charger location. Whatever the approach, evidence suggests the alternative (procrastination) is not the best route.

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SECURING RELIABLE POWER FOR THE ACCELERATING ELECTRIC VEHICLE MARKET

The drive toward electromobility (also known as "eMobility," the use of electric powered vehicles) has been a long time coming. The first successful electric car was introduced in the U.S. by William Morrison, in Des Moines, Iowa in 1890. Electric vehicles caught on in a big way during the first few decades of the 20th century before taking a back seat to the internal combustion engine.

BY FLUKE

Gas shortages in the 1970s and growing environmental concerns in the 1990s renewed interest and innovation in electric cars. By 2000, the launch of successful hybrid vehicles sparked a consistent and growing demand for electric-powered vehicles.

There's enormous demand for reliable infrastructure to power the growing number of electric vehicles on the road today.

In the U.S., 2020 marked the fifth consecutive year of sales growth for electric vehicles (EVs), with a record 761,000 EVs sold. In 2020, there were almost 1.8 million EVs registered in the U.S.—a three-fold increase from 2016. That number is projected to grow to 18.7 million electric vehicles roaming American roads by 2030.

DEFINING EVSE CHARGING LEVELS

As eMobility adoption moves into the mainstream, it is creating enormous demand for the infrastructure powering those vehicles. One of the prime ways to expand the EV market is to ensure that EV owners have easy access to reliable EV supply equipment (EVSE).

Currently there are three levels of EVSE charging stations:

- Level 1: This is a basic dedicated 120V AC outlet most commonly found in residential settings. The Level 1 EVSE cable connects to the vehicle through an SAE J1772 connector and to the wall through a standard three-prong plug. It provides AC power to the vehicle, which the vehicle's onboard charger converts to DC to charge the battery. A Level 1 charger takes about 10 hours to produce 50 miles of driving range, so it can take a couple of days to fully charge a battery.
- Level 2: These EVSE units are installed on 240V or 208V circuits by a professional electrician. They range from a single unit in a home garage to multiple units for multi-family or office parking areas or public locations. These units charge considerably faster than Level 1, typically fully charging a battery overnight.
- Level 3: Often called DC fast chargers, Level 3 EVSE units require three-phase 480V electrical service and deliver DC electricity directly to the vehicle battery. True to their name, these charge much faster—at a rate of 3 to 20 miles of range per minute. Level 3 chargers are most often used for commercial vehicles, as the cost and high voltage requirements put them out of range for most residential environments.

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THE NEED FOR A ROBUST CHARGING INFRASTRUCTURE

One of the biggest barriers to EV adoption is "range anxiety"—the worry that an EV battery will run down before drivers reach their destination or the next charging station. Expanding the number and geographic coverage of public charging stations is critical to alleviating this anxiety and fueling widespread adoption of EVs.

The good news is that the number of public EVSE charging stations is growing rapidly. In 2014 there were 7,300 EVSE units in the U.S. At the end of 2020 there were more than 25,300 EVSE units, and that growth is accelerating.

By the end of 2020, more than 25,000 public EVSE charging stations were available — and more are coming online.

INCREASED DEMAND FOR EV CHARGING EXPANDS PROFESSIONAL OPPORTUNITIES

With more EVs on the road, it is important to increase the reliability (uptime) and availability of EVSE charging stations. There's nothing worse for an EV driver than to pull up to a charging station and find it offline. More skilled technicians will be needed to install, commission, troubleshoot, and maintain EVSE station operability.

Maintenance is a key priority for Rue Phillips, a 30-year veteran and recognized leader in the solar, EV, and renewable technologies industries. "If we're going to have a reliable EVSE infrastructure, it should be mandatory to have a preventative maintenance plan," says Phillips, president and founder of 365 Pronto.

With more EVs on the road, more technicians are needed to keep EVSE charging stations operating safely.

Because the basic rules of electricity still apply, licensed electricians can easily move into installing and testing EVSE equipment. Both online and in-person programs are available to provide EVSE-specific training and certification. Thousands of electricians have already gained certification, and many more are needed.

RELIABLE CHARGING REQUIRES SAFE, ACCURATE, EFFICIENT TESTING

System safety and functionality are paramount for EVSE charging stations. Until recently, the only way technicians could test EVSE charging functionality was to connect an EV and run a pass/fail test. The problem was that many EVSE technicians didn't have access to an EV for testing. This limited them to testing only the electrical components of the charging station. If those checked out, it still didn't ensure that the charging station was ready to charge a vehicle. As a result, technicians often had to make multiple trips to troubleshoot the same units.

To make testing faster, more thorough, and safer, Fluke has introduced an EV simulator that streamlines testing and troubleshooting for Level 1 and Level 2 EVSE AC charging stations. The Fluke FEV100 EV Charging Station Test Adapter simulates the control pilot charging state of an electric vehicle so technicians can run safety and functionality tests on EVSE equipment without having to connect an EV. The FEV100 can be used for new installations, troubleshooting, or preventive maintenance.

The technician first connects the FEV100 EVSE test adapter to the charging station and runs a protective earth (PE) pre-test grounding safety check to make sure the station is wired correctly and that the PE is functioning correctly. The test adapter also includes a GFCI test function to ensure the GFCI will trip when necessary.

After the safety tests, the technician can attach a digital multimeter, portable oscilloscope, or other standard test tools to verify output voltage, simulate PE errors, test wire insulation, and much more. And they can run those tests while simulating various charging states.

Because the FEV100 simulates a functioning EV, technicians can isolate problems to the charging station rather than wonder whether the problem is with unit or the EV. Technicians can use the FEV100 to quickly troubleshoot non-functional stations and set up periodic maintenance routes to run safety and reliability tests in just minutes per unit. EVSE operators and owners will benefit from increased station reliability and revenue, and customers will enjoy much more reliable charging.

Learn more about Fluke eMobility solutions.

The Fluke FEV100 EVSE Test Adapter simulates the presence of an electric vehicle so technicians can run safety and functionality tests on charging stations without having to connect an EV.

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FOUR SIMPLE STEPS TO INCREASE EVSE CHARGING STATION RELIABILITY AND SAFETY

In the last decade, drivers, fleet owners, and government entities have adopted electromobility (eMobility, the use of electric vehicles) in steadily increasing numbers.

BY FLUKE

While there are more electric vehicles on the road, many drivers remain concerned about finding reliable charging stations along their way — known as "range anxiety."

As the number of EVs on the road increases, many drivers are still concerned about finding reliable charging stations to fuel their journey. EV supply equipment (EVSE) station operators are addressing that "range anxiety" with a commitment to expanding the electric vehicle charging infrastructure. A growing EVSE infrastructure will also increase the demand for services to keep those charging stations operating reliably. Proper installation, responsive troubleshooting, and preventive maintenance procedures are critical to maintaining a reliable EV charging infrastructure.

EVSE charging stations have many moving parts. Most publicly available units include communications systems—for data monitoring and payment collection—in addition to electrical and electronic charging components. This article focuses on efficient ways to streamline troubleshooting and preventive maintenance tasks related specifically to EVSE charging functionality.

VERIFY A FUNCTIONAL CHARGING STATION WITHOUT AN EV PRESENT

Until recently, one of the most common ways to verify that a charging station was capable of sending current to the vehicle was to plug in an EV. If the charging sequence didn't start, the problem could be with the cable, the charging unit, or even the vehicle. Technicians would then test the cable and electrical/electronic components on the charging station using standard test equipment such as a digital multimeter (DMM), clamp meter, insulation tester, or oscilloscope. That process required a fair amount of trial and error and sometimes required multiple visits to find and fix the problem.

To make it easier to test the functionality and safety of an AC EVSE charging station, Fluke has developed the FEV100 EVSE test adapter. The FEV100 connects directly to the Type 1 connector of a Level 1 or Level 2 charging unit and simulates the presence of an electric vehicle. The features built into the Fluke FEV100 allow technicians to run safety tests and verify the voltage output of charging stations in just a few simple steps.

The Fluke FEV100 EVSE Test Adapter is designed to test charging units without using an electric vehicle.

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The Fluke FEV100 connects directly to a charging unit to simulate the presence of on electric vehicle.

1. RUN SAFETY CHECKS AT THE PRESS OF A BUTTON

Before testing the voltage output, the technician can use the FEV100 to:

- **Pretest protective earth grounding.** The pretest button on the FEV100 tests for the presence of potentially hazardous voltage at the ground conductor. If the PE light appears, voltage is present and further testing should be stopped until the source of that voltage is found. If no light appears, the PE system is functioning properly, and the technician can proceed.
- **Test GFCI trip time.** The Fluke FEV100 is the only EV test adapter that includes a GFCI test function to ensure that the GFCI breaker in the charger is working. Pressing the GFCI test button terminates the charging cycle and causes the EVSE unit to display an error.

The FEV100 includes a GFCI test function to ensure that the charger's GFCI breaker is working.

2. VERIFY VOLTAGE OUTPUT IN ALL CHARGING STATES

The FEV100 simulates four charging states:

A. EV not connected

B. EV connected, not ready to charge

C. EV connected, ventilation not required, ready to charge

D. EV connected, ventilation required, ready to charge

To verify voltage transfer to a connected EV, a technician turns the CP switch on the FEV100 to the correct charging state position and connects a DMM to the FEV100 meter. The voltage presence indicator on the meter will light up if voltage is present. The multimeter screen displays the voltage output from the charging station, which should read approximately 240V.

3. SIMULATE ERRORS

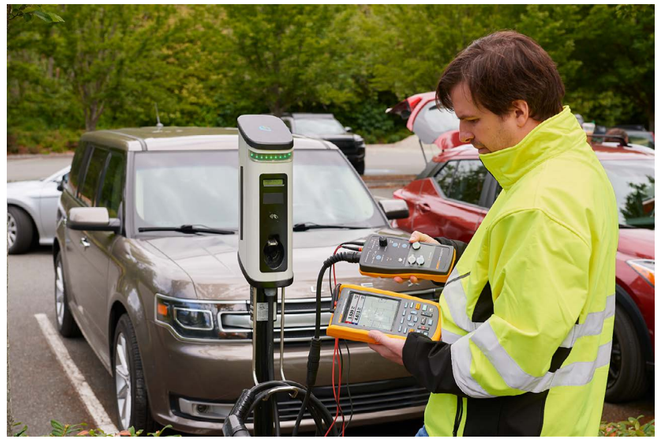
Technicians can simulate a variety of errors with the FEV100 and use a connected DMM to verify that the voltage supply from the charging station cuts off when the error occurs.

- **PE (ground fault) error button:** Simulates a compromised grounding conductor, which terminates voltage transmission and prevents new charging processes.
- **CP error button:** Simulates a control pilot error on an EV and verifies that the charging station will not supply a charge to a vehicle with a CP error.

4. RUN ADVANCED TESTS

By connecting other Fluke test tools to the FEV100, technicians can also run more advanced tests such as insulation resistance, power quality, and waveform and loop impedance analysis in various CP states.

Connect other tools to the FEV100 to run additional diagnostic tests.



Whether you need to troubleshoot, verify an installation, or conduct preventive maintenance on an EVSE charging station, the FEV100 EVSE test adapter saves time and reduces risk. And because technicians can run a complete battery of tests on EVSE units without having an EV present, they can get the job done much faster and with less hassle.

See the Fluke FEV100 in action and learn more about Fluke eMobility solutions.

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Check charging station performance and safety with the **Fluke FEV100 EVSE Test Adapter**

- Vehicle simulation
- Grounding protection
- GFCI testing
- SAE J1772
- Compatibility with the Fluke portfolio of test and measurement tools

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Since its founding in 1948, Fluke has helped define and grow a unique technology market, providing testing and troubleshooting capabilities that have grown to mission-critical status in manufacturing and service industries. Every new manufacturing plant, office, hospital, or facility built today represents another potential customer for Fluke products.

Now, the increasing demands of renewable energy and electric transportation see Fluke growing and innovating in new directions. New technologies require new testing equipment solutions for electricians, installers, and technicians working in residential, commercial, public, and utility-scale environments. Fluke is committed to supporting the critical infrastructure for our sustainable future.

From industrial electronic installation, maintenance, and service, to precision measurement and quality control, Fluke tools help keep business and industry around the globe up and running. Our typical customers and users include technicians, engineers, metrologists, medical-device manufacturers, and computer network professionals — people who stake their reputations on their tools, and use tools to help extend their personal power and abilities.

Fluke has achieved the number one or number two position in every market in which it competes, with a reputation for portability, ruggedness, safety, ease of use, and exceptional quality and reliability.

A wholly owned subsidiary of Fortive Corporation (NYSE: FTV), Fluke is a multi-national corporation headquartered in Everett, Washington, USA. Manufacturing centers are located in the USA, the UK, Asia and The Netherlands. Sales and service subsidiaries are located in Europe, North America, South America, Asia and Australia. Fluke Corporation has authorized distributor and manufacturer representative channels in more than 100 countries and employs approximately 2,400 people worldwide.

RESOURCES

Discover more about our products, resources, and customer support at Fluke.com.

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