350 KW, 10 MINUTES AND 325+ MILES

New Developments in Ultra-Fast EV Charging Move Closer to Fuel Pump Parity

Srdjan Lukic | Filippo Chimento | Justin Kolbe

Is EV range anxiety a thing of the past? This was the assertion made by Srdjan Lukic, Ph.D., North Carolina State University Deputy Director of the FREEDM Systems Center, during a recent conference session on EV charging infrastructure: "As technology innovation has enabled vehicle range capability to average nearly 300 miles on a single charge," he said, "range anxiety has given way to charging time trauma.

Anyone who drives an EV is aware of this condition. The time it takes to recharge EV batteries today is not competitive with refueling a gasoline-powered vehicle. This, in addition to the cost and accessibility of ultra-fast charging devices, has the potential to slow the current pace of EV adoption. But this is what Dr. Lukic and his team – in cooperation with industry suppliers – at NC State's FREEDM Systems Center hope to help solve.

The Current State of EV Charging Infrastructure

EV owners do not always have the time or opportunity for a destination 7.0 kW AC charge at home or the office, which currently takes about 8 hours to add approximately 200 miles of range. Even state-of-the-art DC chargers, which are in the 50 kW – 120 kW range, require anywhere from 30 minutes to an hour or more for a full battery charge. (Figure 1) While this is major progress, consumers have become accustomed to speed and convenience, so additional improvement in reliable, cost-effective ultra-fast charging is warranted.

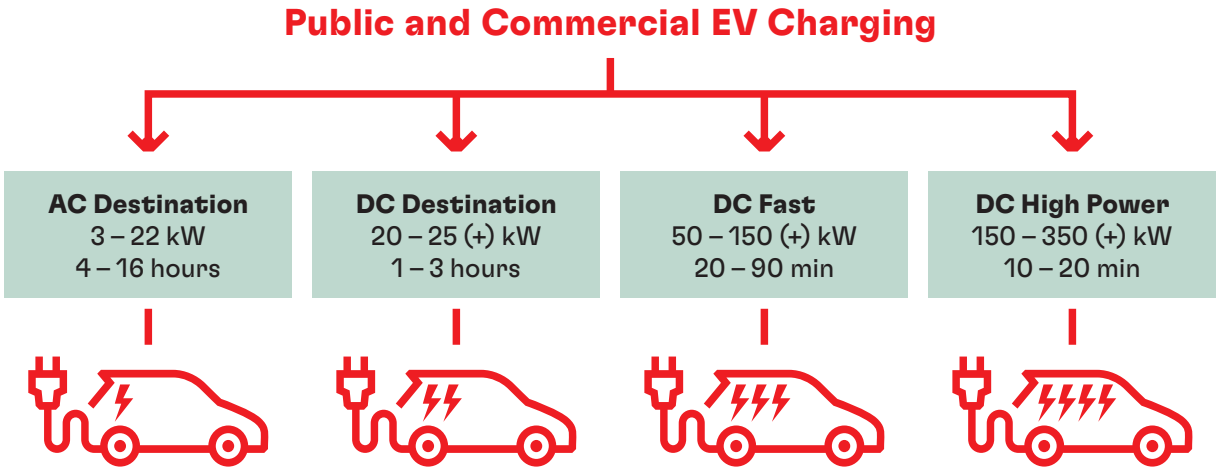

Figure 1: EV Charging landscape (Source: ABB E-mobility)

Not only is charging time unequal to that of refueling a gas-powered vehicle, but access to charging stations – particularly in the Western world – pales in comparison to the proliferation of gas stations. As Lukic pointed out during his presentation and based on data from the International Energy Agency, the density of chargers per 100 square miles is greater in China than anywhere else in the world, with the United States lagging well behind other countries. A large part of this, of course, is due to cost, government structure and state (i.e. government) incentives/subsidies.

In the West, and even with recently passed legislation to increase funding, there will only be about 20% of the ultra-fast charging infrastructure needed to accommodate broad EV ownership and widespread use beyond that of the daily commute. Current cost structures for EV charging development are also potential roadblocks. One estimate from PriceWaterhouseCooper, according to Lukic, predicts that a charging station with four chargers rated at 120 kW each would need to charge a significant premium of three to four times more for energy than the wholesale price to earn a return on investment. Technologies that reduce this up-front cost are, therefore, necessary to move infrastructure growth forward.

Amped Up Innovation

There are many technical challenges to extreme fast charging innovation, including:

- Battery acceptance of so much energy so quickly; this requires exceptional heat dissipation capabilities to avoid battery damage during charging.
- Development of connectors compatible with large currents and ruggedized for constant use. Liquid cooling and durable, thermally-capable potting materials offer potential approaches to thermal control.
- Impacts to the grid, which may be mitigated through peak use coordination with the utility and/or co-located power generation at the charging station.
- Power electronics design for compact, high-power 350 kW systems, as well as the co-location of multiple high-power chargers in a single location.

To address many of these hurdles, researchers at NC State's FREEDM Systems Center are developing a solid-state technology solution for EV charging power distribution and conversion. The work, which is a collaboration with several partners including ABB E-mobility and Henkel, stands to provide advantages to vehicle and fast-charging station owners through reduced system size and higher efficiency.

The 1 MW extreme fast charging station using a solid-state transformer developed by NC State and solid-state DC protection developed by ABB will be demonstrated through a project with the New York Power Authority and expected to be deployed in mid-2022.

The ultimate goal is to deliver extreme fast charging, while significantly reducing the cost and footprint of the infrastructure.

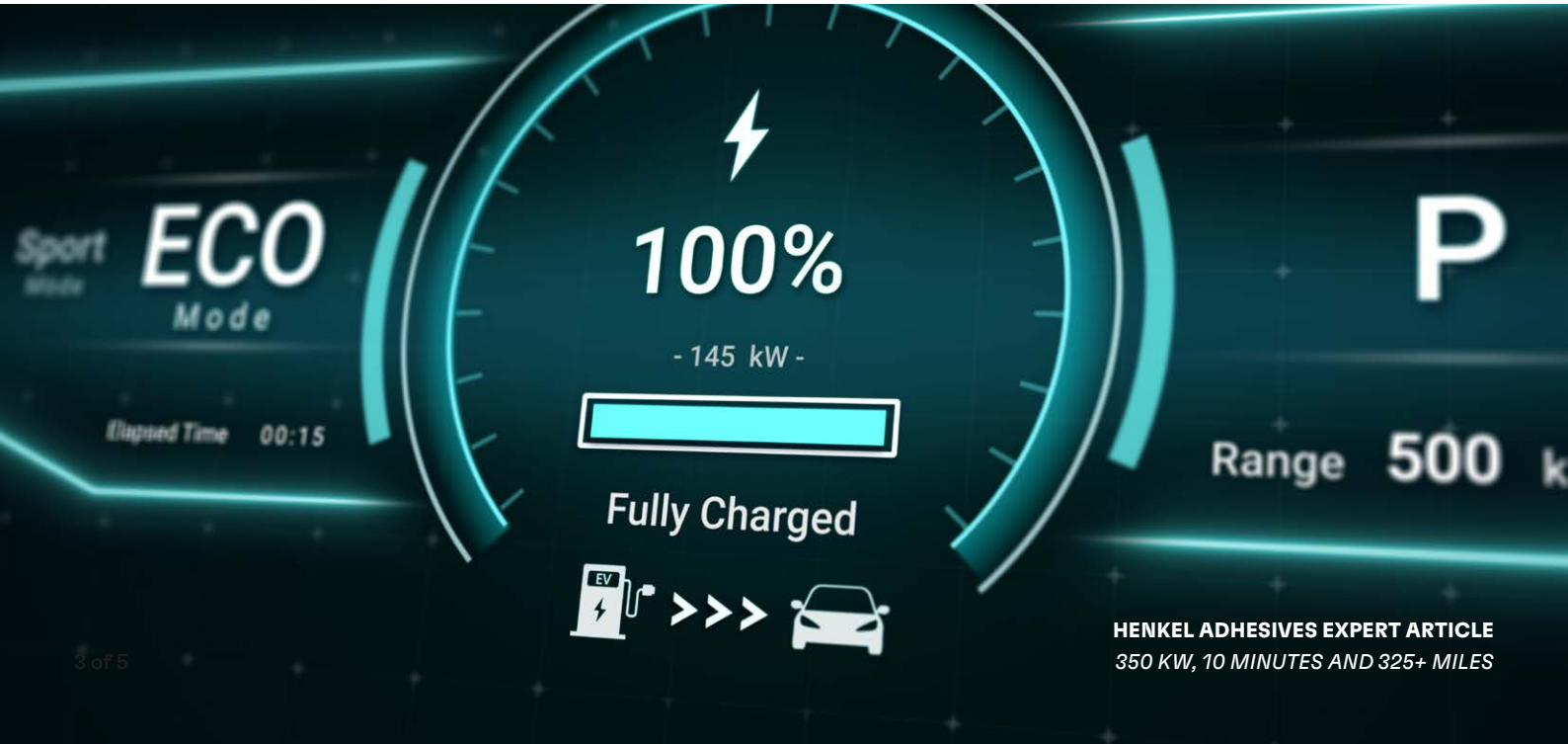

ABB E-mobility – which has hundreds of thousands of AC and DC vehicle chargers installed globally including a just-released 360 kW charger – is instrumental in this project and has an established track record of innovation in the electric vehicle power design and distribution space. During the same Charged EV conference, ABB E-mobility's Filippo Chimento, Head of Global Product Engineering, provided insight regarding technology design. When discussing ABB system architecture, he explained: "The key enablers are first to have modularity so that we can reuse building blocks for power and control power in parallel systems or different systems," he said. "And, importantly, the systems have to incorporate very good thermal management so that all of these blocks can work together and still guarantee the reliability and the lifetimes that we promise to our customers."

This is a key point for cost reduction, as improving the reliability and performance of these systems through materials that offer heat dissipation and electronics protection are important factors with big impact. Henkel Director of Market Strategy for Power and Industrial Automation, Justin Kolbe, concurred: "Extending component and charger life, while delivering dependable operation is essential for energy efficiency and user satisfaction," he said. "Our collaboration with NC State, as well as with many EV charging component suppliers, is helping to develop and deliver material solutions that support these objectives."

Advancing a robust EV charging infrastructure is a complex undertaking that has to satisfy the demands of multiple stakeholders; it is no easy task. While challenges remain, solid partnerships between academia and industry will help move EV charging ever closer to gas pump parity and EVs back on the road in 10 minutes or less.

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Explore More:

- ***Watch*** the NC State + ABB E-mobility + Henkel Charged EV Conference presentation.
- ***Learn*** about Henkel's partnership with NC State's FREEDM Systems Center.
- ***Read more*** about material solutions for EV charging infrastructure.

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