Meeting the electric vehicle challenge

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Sebastián Rivera Iunnissi's dissertation research aims to increase adoption of electric vehicles in Ontario.

From an environmental perspective, plug-in hybrid electric vehicles (EVs) are good because they produce little to no greenhouse gases. From a driver's perspective, though, EVs can cause "range anxiety" – that is, worrying if the car's battery will run down before you reach your destination.

"The batteries in EVs don't provide the same freedom as going to the gas pump with a conventional car," says Sebastián Rivera Iunnissi, a PhD candidate in electrical and computer engineering at Ryerson.

As part of Rivera Iunnissi's dissertation, he worked on a project at Ryerson's Centre for Urban Energy to address range anxiety and help jump-start the widespread adoption of EVs in Ontario. Supervised by electrical and computer engineering professor Bin Wu and sponsored by Toronto Hydro, the three-year project was completed in December 2014.

The transportation sector produces more greenhouse gas emissions than the iron, steel, cement and chemical industries combined, according to the Ontario Ministry of Transportation. While EVs reduce pollution, only 5,000 of them are on Ontario roads and the lukewarm reception has been attributed to EVs' limited range, long charging times and the challenges of integrating them into urban grids.

One solution is "fast-charging" stations. Capable of powering up a car battery to 80 per cent of its capacity within roughly 30 minutes, fast-charging stations are few and far between in Ontario. In fact, there are just five fast-charging stations across the province, and three of them are located in car dealerships.

Late last year, the provincial government announced a $20-million plan to create a network of public battery-charging stations within cities and along highways. Most of the money will be spent on fast-charging stations, while the remaining funds will go toward less expensive and slower-charging "Level 2" stations.

Rivera Iunnissi warns, however, the electric system isn't equipped to handle EVs' immense energy demands and the grid could collapse if it's overloaded. With that in mind, he studied how to charge EVs quickly, efficiently and cost-effectively, and without burdening the power system with harmonics, components that can alter and diminish the quality of electricity.

"We need to load the electric power grid responsibly," says Rivera Iunnissi, who hails from Chile and will graduate from Ryerson this spring.

With help from postdoctoral fellows Charles Tan, Venkata Yaramasu and Jiacheng Wang, Rivera Iunnissi devised a converter that rapidly transforms alternating current (AC), which is used by the power system, into direct current, which is used by EV batteries. "The goal is to minimize AC connections so power operators can better co-ordinate where they put charging stations," Rivera Iunnissi says.

He also developed a novel, scaled-down model of a fast-charging station that provides a common DC voltage connection while reducing the AC currents. The arrangement may enable renewable energy sources, such as solar photovoltaic power, to feed charging stations.

Rivera Iunnissi's ideas require more testing to determine their feasibility. But they are worthy of further exploration as Ontario works to achieve a greenhouse gas reduction target of 80 per cent below 1990 levels by 2050.

"I'd like to help the industry move toward fast-charging stations and reduce pollution from the transportation sector," says Rivera Iunnissi.

Provided by Ryerson University