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The Energy Centre's research team targets top international peer-reviewed journals as their benchmark. The Energy Research Briefings series translates their work into plain language summaries for businesses, government agencies and the community, highlighting the impacts for practice and policy.

Driving into the Future on Electric Roads: Case Study of an Auckland Motorway

Imagine if your electric vehicle's (EV's) battery topped itself up from charging pads under the road as you drove. Dynamic Wireless Charging (DWC) may soon enable electric road systems, saving the hassle of static charging at fixed stations, easing range anxiety, cutting battery size and boosting EV sales. DWC is the next application of inductive power transfer (IPT): energy jumping over air gaps to receivers. University of Auckland engineering professors Grant Covic and John Boys pioneered IPT's commercialisation, and aptly a case study from Auckland* now sheds light on making DWC feasible.

Auckland is notoriously congested, and its evening "rush hour" (actually a 3pm–7pm crawl) was of special interest to these DWC researchers. They studied 90km of the State Highway 1 motorway from Silverdale just north to Pōkeno just south of the city, applying Ministry of Transport forecasts that by 2040, 40% of trips between work and home would be by EV. Ambitiously, they modelled the diverse movements – including lane changing – of passenger EVs, which will increasingly dominate fleets, not just fixed routes with known schedules as for electric buses. Ambitiously too, they calibrated the model to real-world network data.

Computer simulations designated one lane each way to embed signposted live sections of IPT pads. Given the very high cost, questions included the total necessary length of these sections, energy demand and DWC's economic feasibility versus static charging under many scenarios, including different traffic states and IPT wattages (capacities).

Results were, ultimately, encouraging. As a kind of worst case, an EV setting out only 50% charged would need DWC after about 30km to stay 20% charged. The fewer vehicles in a free-flow traffic state demanded only about half as much energy as a crowded state; but, zipping over the pads at the speed limit, needed longer IPT coverage to absorb it.

While traffic creeping through rush hour could maintain 20% charge with less coverage, the system must cater to both states.

Importantly though, if technological advances lift IPT capacity from 50 or 75 to 100 or 125 kilowatts (kW), the extra coverage required for free flow would shrink, since higher capacities charge faster, and total coverage could drop from 34% to 12% of the 90km corridor, or less if the currently leaky energy transfer from pads to receivers became more efficient. By way of comparison, a typical domestic solar power system has a capacity between 1 and 4kW. More than doubling the 50kW base case for IPT pads right up to 125kW could be challenging.

Total DWC cost at 50kW IPT capacity exceeded a static system's, at about $1.6 million/year for free-flow or $1.4 million/year for rush hour. The researchers stressed, though, that DWC's feasibility depended on costing the time spent diverting to, queuing for, and charging at fixed stations: around $370,000/year per EV, but adding more and more to the cost of new stations as EVs became more common. This time cost, and higher IPT capacities if achievable, would make DWC more competitive.

While the study describes Auckland, its "heuristic" method (basically a good-enough first approximation) and ambitious range of variables should advance DWC research and help investors and policymakers everywhere strategise for urgently needed smarter, greener cities.

For the full article by Ramesh Majhi, Prakash Ranjitkar and Mingyue (Selena) Sheng, see "Assessment of dynamic wireless charging based electric road system: A case study of Auckland motorway", Sustainable Cities and Society 84 (2022) 104039.