Challenges and Opportunities for the Transport System

Adoption of Electrified Transportation

Dr Selena Sheng
Energy Centre

Energy Spotlight 2020
Development of Inductive Power Transfer (IPT) Roadway Transportation Systems

- Electrification of road transport: benefit of reducing emissions
- The overall % is still miniscule compared to the large body of other types of vehicles in the fleet
- Barriers: *Range anxiety factor & high upfront purchase cost (\$ of batteries)* etc.

**Research Project 3714101. 2017 – 2022, MBIE Endeavour Fund 2017 - 2021**

Inductive Power Transfer Technology = Wireless transfer of Power

(Zaheer and Covic, 2016)
Charging Solutions

Plug-in (PC)

Wireless charging (WC)

Stationary Wireless Charging (SWC)

Semi-Dynamic Wireless Charging (SDWC)

Dynamic Wireless Charging (DWC)
Stationary Wireless Charging for EVs

1: Wallbox + inverter
2: Resonant transmitter
3: Electromagnetic field
4: Resonant receiver
5: Rectifier + communication module
6: Battery pack
IPT infrastructure for EVs

The Evolution of Qualcomm Halo
IPT Roadway Project Team

Research Team:
- University of Auckland: Power Electronics & Inductive Power Research, Centre for Advanced Composites Materials, Transportation, Engineering Science, Business School
- GNS Science, Wellington
- Victoria University of Wellington, Robinson Research Institute
Optimisation Modelling & Economic Evaluation for Roadway IPT Implementation

1. Optimise placement strategies to maximise network efficiency and benefit
2. Optimise strategies for sustainable implementation of roadway IPT
3. Evaluation of potential economic and environmental benefits of faster EV take-up through roadway IPT implementation
4. Engagement with Iwi to improve economic & sustainability outcomes

From left to right: Dr Doug Wilson (CEE); Dr Prakash Ranjitkar (CEE); Dr Tumanako Fa’au; Prof Basil Sharp; Dr Selena Sheng; Dr Andrea Raith; Mr Majhi; Mr Ajith Sreenivasan
University joins global consortium for vehicle electrification

6 August 2020 | Faculty of Engineering, Science and technology

Work at the University of Auckland will play a significant role following this week’s launch of the National Science Foundation (NSF)-funded Engineering Research Centre for Electrified Transportation in Utah, USA.

"Sustainable, electrified transportation and the enabling technologies that support this, such as the electrified road, are key to the global future."

Professor Dawn Freshwater
Research Methodology/Scenarios

- SOC State
  - Threshold – 20%
  - Recommended level (40-80 percent)

- EV Category
  - Car
  - Public Transit – Bus

- EV Range
  - Small (<150km)
  - Medium (150-250km)
  - High (>250km)

- Route choice Behavior
  - Single route
  - Multiple route
  - Travel Time
  - Presence of charging facility
  - Presence of toll

- Exclusive path
  - O-D route
  - SOC level, driving experience

- Shared path
  - 40%, 50%, 60% of HBW Trips

- Charging lane Behavior
  - Current trip (2016 O-D Data)
  - By 2026 and 2036

- EV Trip Demand
  - Slow (<20KW)
  - Medium (20KW-100KW)
  - High (>100KW)

- Total Trip projection
  - Efficiency (70%, 80%, 90%)
Auckland Motorway SH1 Corridor

Corridor Information:
- SH-1 and Southern Motorway
- Billing Road Junction to Pokeno Interchange
- Total Length: 87Km (One-way)

Shared Paths
Bus Route 70 – Botany to Britomart
The Impact of COVID-19 on Transport

Figure 1. Variation of transport modes in NZ

Selected Publications

*Papers funded by the Endeavour MBIE IPT project:


*Other projects:

NZTA contract: ART 19/03 Understanding the national picture of supply and demand for the land transport sector.
Thank you!
- 15-year concession period under PPP; private investor: 12.5% return; Government: a toll of 37 cents/kWh while contributing 9.46% towards the initial investment.
- EVs could also achieve a significant reduction in CO₂ emissions compared to ICEs.
- Monto Carlo sensitivity analysis.

Fig. 4. Vehicular emissions.
Outline of Research Topics

• Location problems of Dynamic Wireless Charging Infrastructure for EVs


- A microscopic traffic simulation model is developed for a part of Auckland motorways network using AIMSUN which is calibrated and validated using vehicle data from the loop detectors.
- A SOC model is proposed and integrated into the AIMSUN model to dynamically update the SOC levels of individual EVs while they travel along the road network with or without DWC lane.
- We tested different scenarios for DWC energy parameters (e.g. IPT power of 50, 75, 100, 125KW), traffic flow conditions (free-flow and peak hour flow) while it is assumed that all vehicles start from their origins with a fixed SOC that is 50%.
- By with increase in energy transfer efficiency and keeping the IPT power level constant, the overall energy demand by EVs and charging length decreases.
- With the increase in traffic flow, reserved DWC lane for EVs should be available for other vehicle types as an optional lane to maximise the overall traffic flow.