

Annex B – Key findings from EV Phase 1 Test-bed

Key Findings of Market Perception Surveys

As part of the test-bed, two market perception surveys were administered to understand end-user views on the technology. A pre-test-bed survey administered in 2011 revealed the following:

- Purchase price was the greatest inhibiting factor, with respondents indicating that they would consider EVs only if they cost approximately the same as ICEVs.
- Concerns over range was the next major issue raised, with over 50% indicating insufficient range as an issue, even though only 4% of those surveyed travelled more than 80km a day.
- Respondents were also worried about the availability of personal and public charging infrastructure.

The above three concerns were highlighted again in a post-test-bed survey that was administered to test-bed participants at the end of 2013. While most of the participants (75%) had a positive experience using EVs, 86% of the respondents indicated that they would not purchase an EV from the open market in the near future due to concerns on high purchase price, limited technology, and limited charging infrastructure.

- On price, 66% indicated that price reduction is critical to encourage widespread EV adoption.
- On technology, 91% of the respondents indicated that EVs were easy to drive and operate. However, 75% of the respondents would like to see improvements in areas such as range, battery life, and time taken to charge their vehicles.
- On charging infrastructure, 79% felt that the EVCI and charging stations were easy to use. However, 61% also reflected that they would like to see a better distributed and wider public charging network to meet the charging needs of the EV community.

Key Findings of the CBA Study

Technical feasibility of EV deployment in Singapore

An analysis of the collated driving and charging data suggests that the use of EVs is technically feasible in Singapore. For example, the average EV daily driving distance was 46km, which is close to the national average of 50km for a normal passenger car, and is much lower than the EV manufacturers' reported range of 120-160km per charge. The driving patterns of participants are in line with those of corporate users, who tend to use the EVs as company vehicles for routine activities such as site-visits and meetings, and thus have shorter mileages compared to the national average. There were some instances where participants utilized their vehicles for longer-than-average trips. For instance, one of the EVs recorded a distance of 156km based on a single charge under local driving conditions.

An analysis of charging events shows that 81% of the charging events occurred at the participants' primary charging site, with the remaining charging events having occurred at a

non-primary charging station within the publicly-accessible EVCI. This is consistent with charging patterns of global EV users, who tend to charge mostly at home or at the work place, and use public charging infrastructure for opportunistic charging in-between trips.

The analysis of charging data¹ also suggests that the impact of EV charging today is not significant to our electricity grid, even in a scenario where a large percentage of private cars were assumed to be EVs. Studies by TUM CREATE showed that even if all private cars were assumed to be EVs, it would only increase the daily load on the power system by 4.8%.

Economic feasibility of EV deployment in Singapore

While analysis of the test-bed data suggests that Singapore is suited for the deployment of EVs, the CBA indicates that EVs are currently not economically feasible for adoption, even after factoring in the health and environmental benefits to society². This result is due to the high open market value (OMV) of an EV that is around three times that of a comparable ICEV. As the current tax structure for vehicles in Singapore is ad-valorem and progressive, this results in a greater tax burden for an EV³. Accounting for health damage costs from emissions significantly increases the social cost of ICEVs relative to EVs, but this is still insufficient to compensate for the difference in OMVs.

The CBA indicates that EVs will remain a costlier option as long as they remain a niche technology. Similar to the development of hybrid vehicles, prices of EVs are expected to fall as the price of the technology, including battery prices, continues to decline, and mass production achieves economies of scale. In the meantime, we note that new and innovative business models, such as fleet operations and car sharing, have emerged in other countries, and are able to improve the economic viability of EVs.

Emergence of EV Eco-system

The EV test-bed has laid the foundation for the EV ecosystem in Singapore, which has grown steadily to include new business models and companies. The test-bed saw the emergence of innovative business models like EV leasing and EV car sharing - Daimler, Downtown Travel Services, and Fulco Leasing provided EV leasing services, while Smove operated a small-scale EV car-sharing model with 5 Mitsubishi iMievs catering to a customer base of 450. Singapore's EV ecosystem has also grown to include a more diverse group of companies consisting of EV OEMs, charging station providers, and service providers. Some company examples include Bosch, ABB, Schneider Electric, BMW, Greenlots and Smove.

Outside the test-bed, there has been an increase in the number of e-mobility R&D initiatives and tie-ups within the community. Some examples include TUM Create's EVA electric taxi prototype that can travel 200km on a 15min charge and its VOI multi-purpose electric scooter. Other examples include the Autonomous Electric Shuttle and Toyota's micro EV Auto Body COMS that are used in Nanyang Technological University (NTU) and the National University of Singapore (NUS) respectively (see Figure 2).

¹ Based on the IEC 'Type 1' (also known as 'SAE 1772') standard, operating at single phase 16A 230V.a.c.

² EVs can be cleaner and more energy efficient than ICEVs. Although EVs do not emit CO2 emissions at the tailpipe, they cannot be considered emissions-free if the electricity generation is from fossil fuels. In Singapore, almost all of our electric power is generated from natural gas.

³ For instance, costs without taxes for a Nissan Leaf EV and its equivalent Nissan Sylphy ICEV are \$55,000 and \$15,000 respectively. After accounting for taxes and CEVs rebate, the prices for both vehicles are \$200,000 and \$110,000 respectively. Prices are correct as of May 2014.

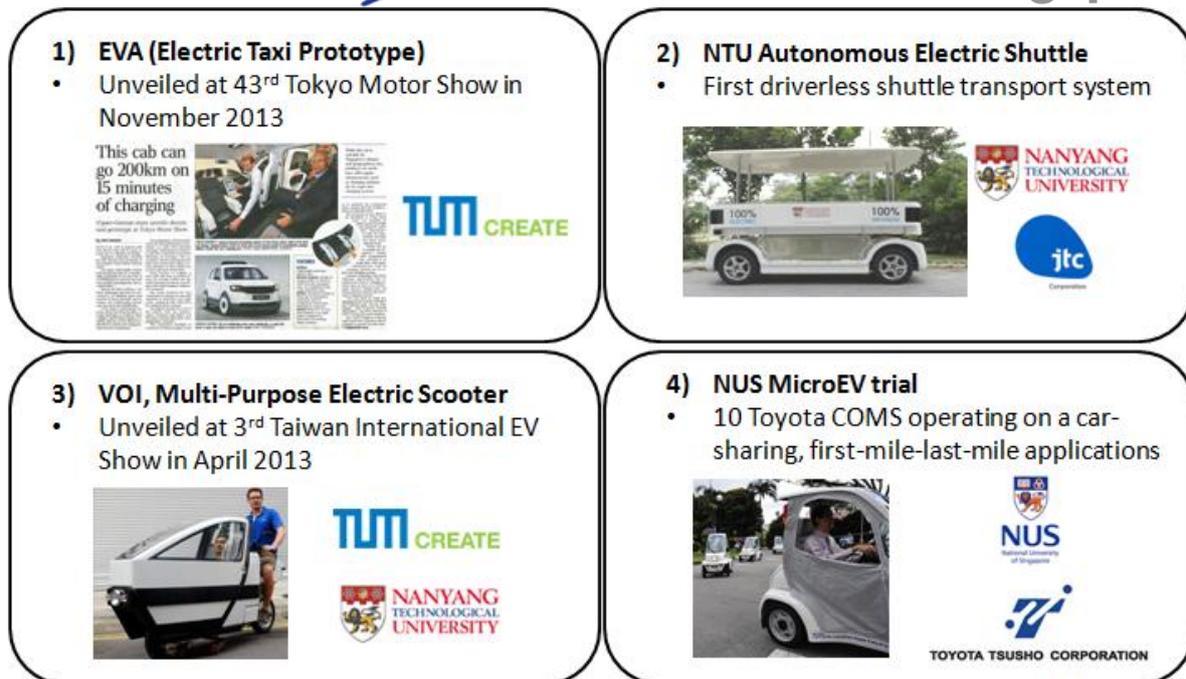


Figure 2: Some examples of research collaboration tie-ups within Singapore.

Moving Forward

High upfront costs will continue to be the greatest inhibiting factor to customer acceptance of the technology. In the short term, innovative business and operational models could help defray some of these upfront costs. However, further R&D is needed to accelerate technology breakthroughs to address the limitations of EV technologies and to bring down overall costs in the long run. Moving forward, the central management and continual development of charging standards, advancement of EV technologies, parking rules and the mapping and management of the public charging infrastructure could help overcome the worries of end-users with regard to the charging infrastructure.

There are plans to have a second phase of the EV test-bed that will focus on vehicle fleets which include EV car-sharing, E-commercial/logistic fleets and E-taxis. It is anticipated that fleets are likely to be early adopters as there is greater economic viability due its higher mileage and potential for greater cost savings. In addition, the natural incentive for these fleet operators to set up dedicated charging infrastructure for their operational needs will contribute towards the overall charging infrastructure development. New and innovative business models will also be explored.

LTA has also embarked on an e-mobility roadmap, and has awarded NTU ERI@N, to identify and prioritize R&D focus areas to lower costs and to help bridge existing technical gaps.

The government will continue to facilitate the introduction of EVs and EV public charging infrastructure, and prepare Singapore for the future possibility of widespread adoption of EVs.