Community empowerment on the transition of Zero Emission Vehicles in the ACT

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Presented by

Violet Law

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Executive Summary

The global paradigm with international climate policy negotiation and the pandemic provide windows of opportunity for governments, businesses, and the community to search for alternatives in stimulating the economy without compromising the environment. According to the *ACT Climate Change Strategy 2019-25* (ACT Government 2019a), with electricity supply being 100% from renewable sources by 2020, transportation is the largest contributor to greenhouse gas emissions of the Territory. Promoting ZEV uptake is an important strategy to transition zero emission transportation. To this extent, local and international case studies showed that behavioural change and adaptation being the largest barriers to community uptake. This paper presents challenges and opportunities faced by multiple stakeholders from economic, social, and environmental perspectives; and explain their corresponding roles to accelerate ZEV transition in the ACT.

Key recommendations

- Expand second-hand market for ZEVs
- Promote ZEV options with e-bikes and e-scooters
- Explore further government subsidies and fee exemptions opportunities
- Target setting for transport-related emissions and ZEVs sales
- Introduce new business model for ZEVs
- Support research and development on ZEV efficiency
- Promote ZEV-sharing or ZEV-pooling communities
- Support public and private investment on ZEV charging infrastructure
- Advice Australian Consumer Association for quality evaluation of ZEVs
- Organize community-based test drive events for ZEVs
- Issue factsheets or publicity materials on ZEV development and misconceptions
- Provide real-time information on ZEV parking and charging services
- Incorporate ZEV-friendly facilities in urban planning and property development
- Recommend exclusive policies for ZEVs
- Expand zero emission public transport network

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Lastly, kudos to readers of this report who are interested and concerned about ZEVs, climate change and energy. Transportation is the next challenge to further reduce our carbon emissions and it is high time for us to act now. Never underestimate any small effort of an individual, as this is how the community evolves for a sustainable and long-term transition.

Contents

Introduction

The start of year 2020 presented a range of risks and opportunities for Australia and the world. After the disappointment to international cooperation of Article 6 of the Paris Agreement at COP25, Australia suffered from bushfires with the hottest summer on record, followed by the global COVID-19 pandemic (Evans & Gabbatiss 2019; Readfearn 2020). In the Australian Capital Territory (ACT) context, Canberrans experienced the worst air quality in the world and hailstorm in January. Together with the declaration to the state of climate emergency, severity of extreme weather impacted by climate change is acknowledged and realized (Steffen et al 2018; Thompson 2020). Whereas government priorities now focus on economic recovery and stimulus packages, a great opportunity is presented for governments, businesses, and the community to make it green. This includes reviewing existing climate change strategies and practices, and prioritizing health benefits in the design of decarbonization measures.

Aligning responses to climate emergency and long term decarbonization, the ACT government stated their climate change strategy in 2019 with a 50-60% emission reduction target by 2025 and net-zero emission by 2045 (ACT Government 2019a). In 2019, ACT achieved 100% renewable electricity supply which left the transport sector as the largest emitter, contributing over 60% of ACT's greenhouse gas (GHG) emissions and majorly from private cars (ACT Government 2016; ACT Government 2018). In this regard, the transition to zero emission vehicles (ZEVs) is an important milestone to further reduce ACT's transport-related emissions and achieve the 2045 target (ACT Government 2018).

ZEVs refers to vehicles operated with emission-free fuels, this paper scopes ZEVs to electric vehicles (EVs), e-bikes and e-scooters. In 2018, ACT government released "The ACT's transition to zero emissions vehicles action plan 2018–21", outlining their initiatives to support ZEVs uptake (ACT Government 2018). Complemented by the ACT Climate Change Strategy and public engagement exercise "Moving Canberra" in 2019, issues on incentivizing ZEV uptake is seen as major challenge for the transition (ACT Government 2019b). Whereas literature around EV uptake are largely available locally and internationally (Bjerkan et al 2016; Hall et al 2017; Tsang et al 2012), perspective on incentivizing behavioural change and adaptation remain limited. This paper focuses on community empowerment and how different stakeholders can contribute to this conversation, namely the ACT and Federal governments,

industry, NGOs, lobbying groups, academia, and the community. This paper has three research objectives:

1. To identify challenges and opportunities on community empowerment of ZEV transition in the ACT;
2. To study roles of stakeholders on ZEV transition; and
3. To provide policy recommendations on community empowerment of ZEV transition in the ACT

This paper has six sections. Introduction, stating policy context for ZEVs transition and research objectives; literature review, comparing local and overseas examples on ZEV uptake; methodology, describing focused synthesis as the research method used and its strengths and weaknesses; results and analysis, describing key challenges identified by each stakeholders from economic, social and environmental perspectives; policy recommendations, proposing key approaches to community empowerment on ZEV uptake with specific policy suggestions; and conclusion, summarizing key findings and suggesting potential topics for future studies.

Literature review

The conversation around ZEV uptake is not new. Many countries around the world have started exploring emission-free transportation as early since the 1990s (Aasness & Odeck 2015). Until recently, European Union member states, bounded by the Clean Power for Transport Directive, are given specific targets to increase their deployment of plug-in charging facilities and emission standards for new car fleets to promote EV deployment (Mock & Yang 2014; EC 2014). Together with the relatively high price for petrol, natural gas and diesel, policy innovation around ZEV initiatives from the European context have presented as highly effective cases in terms of transitioning ownership and capacity building.

Norway

Norway, as global pioneer of ZEV uptake, has the highest EV share of 22% in 2015, equivalent to over 50,000 cumulative EVs (Lutsey 2015). The capital, Oslo, with over 60% emissions come from transportation, has the highest EV share of 26.6%, with over 10,900 EV sold in a single year (Hall et al 2017; Hockenos 2017). Since over 96% of electricity are generated from hydropower, electrifying transportation is a major climate strategy (Figenbaum et al 2015). At the point of purchase, Oslo provides one-off exemptions to import taxes and registration fees for new fleets and 25% discount upon normal value-added tax (VAT) (Mersky et al 2016; Norsk elbilforening 2016). Study found that purchase-related cost reductions are the strongest incentive to promote EV adoption such that a first-hand petroleum vehicle is now more expensive than an EV (Bjerkan et al 2016). On an ongoing basis, EV owners are entitled to low annual road tax, exemptions from fuel tax, and free or discounted charging services (Hall et al 2017). In addition, Norway is one of the first countries which implemented privilege policies for EV owners, such as access to bus lane during congestion hours, free road and ferry tolls, and free municipal parking (Hall et al 2017). Although not as prominent as up-front cost incentives, privilege policies played an important role in favoring user experiences, particularly to long distance travelers between Oslo and neighboring suburbs.

Apart from incentivizing adoption, the Norwegian government invested in charging infrastructure, expanded charging networks, electrified taxi industry and incorporated EV-friendly building features through demonstration programs with private real estate companies, supported by the European Regional Development Fund (EC 2017). At present, Norway has the most accessible and affordable charging facilities in the world with over 1,400 charging

spots per capita (Lutsey 2015). A study explored transformative practices of Norwegian EV owners found that strong infrastructural capability internalizes misconceptions and improves trust over EVs (Ryghaug & Toftaker 2014).

Netherlands

Netherlands is another world leader in EV promotion. They set a national target of 1,000,000 cumulative EVs sold and at least 30% of total vehicles to be electric by 2025 (Lutsey 2015; Hall et al 2017). One-off subsidies remain the greatest form of incentives. At national level, €4,000 - 5,000 subsidy is given to privately-owned EVs, electric taxis or company owned EVs, and a 20% purchase discount (up to €40,000) is given to first-hand electric vans, trucks, or buses (Hall et al 2017; Silicon Canals 2020). On top of financial incentives, more emphasis is put on non-financial incentives such as privilege parking, infrastructure, and public-private collaborations. For instance, in Amsterdam, Low Emission Zones are classified at congested areas for EVs, residential parking and free-floating parking permit are prioritized for EVs to promote alternative public transit options (i.e. electric taxis and electric buses) and electric car-sharing (Hall et al 2017). In addition, the formulation of the Formula E-Team, initiated by the national government, creates a public-private platform to stimulate policy innovation around ZEV and charging infrastructure (IEA 2016).

In terms of EV charging, Netherlands currently ranks first with over 23 charging points every 100 km (Smart Cities World 2019) and has installed the first four of its 200 fast-charging stations along existing highway fuel stations to favor long distance travelers (McKinsey 2014). Subsidies are also given to private or semi-private charging points for up to €1,000 per spot (Hall et al 2017). The Dutch case considered the spill-over effects of electromobility. Studies showed hybrid policies with target-setting, financial incentives and improving public transit systems are effective means to foster consistent sustainable energy behavior and environmental self-identity (Peters et al 2018; Schuitema et al 2013).

United Kingdom

The United Kingdom (UK) presents another successful case in EV adoption. Although not as prominent as Norway and Netherlands, EVs in the UK represent 1.1% of the total vehicle sale, as of 2015, well above the European average (Hall et al 2017). On up-front cost, private EV users are entitled to £4,500 subsidy for first-hand purchase with exemption from annual circulation tax, whereas electric taxis are given up to £3,000 at the point of purchase (Hall et

al 2017). As to improve user's driving experience, exemptions to congestion charges, free or reduced parking, low annual fee for city-wide charging network, centralized low emission zones and charging points requirement for new property development projects are given to further incentivize EV adoption (Hall et al 2017).

In fact, the British EV policies mostly resonate with the Norwegian and Dutch cases such that incentives focus on subsidizing purchase with extensive changing infrastructure. What makes the UK stand out is the establishment of the London Electric Vehicle Partnership with multiple EV stakeholders including government and local authorities, interest groups and environmental consultancy (Tsang et al 2012). This serves as a platform for information exchange around latest EV-related development and policy initiatives. In addition, centralized information on charging points location and availability from the Transport for London (TfL) provides convenience to EV users (TfL 2020). This is seen as an important means to encourage behavioral change and uptake (Offer et al 2011; Bunce et al 2014).

Australia

In the Australian context, EV uptake has not been prominent, being one of the few developed countries with no emission standards for light vehicles. As of 2017, EVs only made up 0.2% of the Australian vehicle market, with 98.3% operated by conventional fuel such as petrol and diesel (Climate Works 2018; ABS 2020). A study conducted by Beyond Zero Emissions (2016) claimed that the top three barriers to ZEV adoptions are (1) lack of awareness; (2) perceived range anxiety; and (3) perceived high upfront cost. These will be further discussed in the later part of the paper. Whereas specific ZEV policies vary between states and territories, financial incentives remain key for consumers, specifically on model availability at lower price ranges. According to a study conducted by Climate Works and the Electric Vehicle Council (2018), 35.5% of the respondents claimed that they would only purchase an EV if it is the same price as other petroleum or diesel options, and 30.9% responded that more incentives and infrastructure are required to motivate them to transition to an EV. Reflecting on existing ZEV policies in Australia, there is currently no direct vehicle subsidy for the first or second-hand market, which is available in European cases discussed above. Current financial incentives include free or discounted EV registration fees, exemption to stamp duties and investment on public charging networks, etc.

Accounting for financial and non-financial incentives, a Memorandum of Understanding (MoU) on sub-national collaboration on EVs was signed by six state or local governments to

identify opportunities for ZEV transitions, including planning and construction of infrastructure (DoE 2017). However, up to 2019, there is no ZEV-specific target or formal national electric vehicle policy or strategy in place (Electric Vehicle Council 2019).

ACT

The ACT presents the best financial and non-financial incentives for ZEV uptake in Australia. In 2014, they were the first and only Australian jurisdiction to introduce stamp duty exemption for ZEV registration, along with 20% discount to annual vehicle registration fees (ACT Government 2018). And as a response to the limited second-hand market available in Australia, the ACT has set targets for electric government fleets to create a second-hand market with lower price range (Climate Works 2018; ACT Government 2018). For non-financial incentives, the ACT is the only state/territory that provides preferential lane access for EVs (until 2023), and widely promotes the adoption of other types of ZEVs such as e-bikes and e-scooters (Electric Vehicle Council 2019). ACT also announced legalization on safe use of e-scooters in late 2019 (ACT Government 2019).

Methodology

The focus on community empowerment requires understanding of existing policies and practices at the community level. This paper adopts a qualitative research method called focused synthesis which involves selective review and integration of findings relevant to research questions (Majchrzak 1984). This method was chosen as reflected by most of the researches available in the field, stating that a quantitative approach fails to demonstrate the practical experiences from end-users of ZEVs (Bjerkan et al 2016; Higgins et al 2012; Khoo et al 2014). Here, stakeholder engagement is used to illustrate the challenges and opportunities of ZEV transition. In-person and email conversations with the ACT Government was conducted to understand the ACT context and gain insights for future policy directions. Supported by the phone conversation with Evee, an electric-car sharing company based in Canberra to draw on the opportunity to promote EVs through car-sharing. Participation in the Australian Electric Vehicle Association (AEVA) ACT Branch's monthly meetings and focus group discussion to collect feedback on ZEV uptake from an end-user perspective. Attendance to the transport policy forum hosted by the Conservational Council ACT Region (the host organization) discussing ACT transport policy. No direct information from the above engagement was drawn or referenced in this paper. Research findings from stakeholder engagement is supported by a selective literature review, drawing on overseas experiences which presented successful cases of ZEV uptake. Case studies are selected to reflect on policy initiatives that the ACT is not currently implementing to further support arguments in the later part of the paper for policy recommendations.

The combined approach of stakeholder engagement and literature review in focused synthesis present several strengths and weaknesses. Firstly, on strengths, focused synthesis has a relatively high external validity due to engagement of multiple stakeholders, utilizing their skills and knowledge base efficiently (Keown et al 2008; Phillipson et al 2012). Such inductive approach implies findings and recommendations may be generalized outside of the ACT context which is important when comparing with overseas case studies (Bradbury-Jones et al 2017). Secondly, stakeholder engagement seeks to understand practical challenges and opportunities of ZEV uptake on a street-level basis, and to understand individual behavior which would otherwise not be observable in theoretical research (Gerring 2004). On the other hand, for weaknesses, focused synthesis presents low internal validity due to differences between stakeholder interests (Pennings et al 2011). Responses from extensive interviews (i.e. focusing on open-ended questions) are subjected to individual experiences and observational

changes (Yanow 2006). Besides, focused synthesis is selective based on the scope of the research topic and stakeholder group interviewed. For instance, this paper did not engage the Federal government, academics and the public which may potentially overlook interests from those perspectives when developing policy recommendations. This adds further difficulty to draw causal inference noting that there are multiple factors leading to behavioral differences (Shadish et al 2002). Lastly, interpretation of secondary sources in literature review may be limited by cognitive bias of researchers such that it is uncertain whether some information was intentionally hid or manipulated prior to its presentation (Bryman 2008).

Results and analysis

Success in community uptake of ZEV requires behavioral changes throughout the lifecycle of transition from decision-making to purchase, operation, and maintenance of ZEV to disposal. This section explains challenges faced by the community from economic, social, and environmental perspectives.

Economic

Addressing the Upfront Cost Barrier As discussed in the previous section, upfront cost of ZEV is the biggest hurdle to community uptake. As of 2018, the price premium of an EV was around AUD$10,000 – $15,000, largely due to low economies of scale and high battery costs (AEVA 2018). Despite the cost of an EV battery is declining over the years, existing business model is insufficient to lower initial investment for ZEVs. A survey showed 68% Australians rank direct subsidies as most important to encourage transition (Electric Vehicle Council 2019). In the ACT context, 55% households own two or more passenger cars and 20% own three or more (ABS 2016). Early adoption should start with these households, whereby common concerns such as range anxiety and limited convenient charging spots are less applicable (350 Canberra 2018).

Increasing Model Availability Apart from purchase price of EVs, end-users also concern of the availability of EV models, especially to households with only one vehicle and have specific needs (i.e. range, size, etc.). According to 350 Canberra (2018), this is due to absence of purchase incentives which gives negative signals to car manufacturers. Market motives such as transport-related emission targets, sunset dates for petrol and diesel vehicles are required to encourage manufacturers, local or overseas second-hand dealers to invest further to the Australian market.

Social

Addressing public misconceptions Despite ZEVs presents a number of merits such as lower maintenance cost and environmental benefits, misconceptions around non-current EV users remain a major challenge to encourage uptake. Issues such as range anxiety, charging spots availability, ZEV options and features, current government initiatives and maintenance-related information require more advocacy work (Berkeley et al 2017). To this end, car-sharing or test-drives are great opportunities for potential EV buyers to experience an EV

(Mounce & Nelson 2019). In-person communication with local EV owners could be an effective way to provide practical driving experiences which would otherwise not be brought up by salespeople at car showrooms.

Improving users' experiences User experience is claimed to be one of the most important factors in ZEV uptake. Apart from reducing the cost incurred in the transition, driving experiences of ZEVs should also be considered. For instance, secure parking for e-bikes and e-scooters, information on parking spaces and charging spot availability would be essential to encourage uptake. Although not as prominent as upfront financial incentives in consumer psychology terms, privilege policies are effective means of building confidence and trust such that ZEV represents a self-identity for concerns over the environment, without compromising cost and inconvenience (Rezvani et al 2015).

Capacity building for ZEVs' operation and maintenance On the operation and maintenance, despite it being significantly cheaper than petrol or diesel cars, there are insufficient maintenance services available in the ACT. For instance, Canberra has service centres for Nissan and Hyundai vehicles, but the closest service centre for Tesla is in Sydney which is unable to provide emergency maintenance. And on operation and charging, EV owners, who cannot charge their vehicles at home, face difficulties to either install EV chargers at their parking spaces financially or to access to overnight charging spots which may be far away from home (350 Canberra 2018). There is a need to strengthen capacity of EV charger availability in individual homes and apartment dwellings to accelerate the uptake of ZEVs.

Just transition ZEV uptake also raises concerns about just transition, whether policy incentives should favor early adopters who are better-off or those who have higher travel demand. The idea of "social-technical" transition of ZEVs is especially relevant such that low-income communities who are vulnerable should have equal opportunity to contribute, including EV purchasers and workers in the manufacturing and maintenance industry (Newell & Mulvaney 2013; Hart 2019). For instance, a low-income household living far away from civic for lower rent have higher demand for a low-emission passenger car than a well-off household having multiple vehicles and living close to their workplace. Policy initiatives should consider interests from different parts of the community, their respective needs and affordability.

Environmental

Recycling and upcycling of ZEVs Towards the end of lifecycle of a vehicle, issues around vehicle disposal creates concerns towards the environment. There are currently no specialized disposal services available for ZEVs, particularly on retired battery recycling or upcycling. Many overseas experiences on alternative vehicle-to-grid options or retired battery as energy storage provided insights on how to optimize ZEV usage and minimize chemical waste generated (Sovacool & Hirsh 2009; Li et al 2015). In the ACT context, there is a need to develop industry around recycling and disposal to close the loop for a more sustainable, circular economy for ZEV transition that addresses all embedded emissions around the transport sector (Smith 2010).

Reducing transport-related energy consumption Apart from disposal, ZEV transition should consider overall energy consumption and pressure on road traffic. In fact, ZEV uptake should not encourage a 1-to-1 replacement, so as to reduce total number of vehicles, lower road pressure and demand for transport-related electricity consumption. To this end, a hybrid transportation system utilizing electrified public and private transport options should be encouraged. This includes consideration of ZEV options than just passenger cars, promotion vehicle and bike sharing or pooling communities for EVs, and e-scooters for last mile transport (Sipe & Pojani 2018).

Policy recommendations

Based on results collected from stakeholder engagements, this paper recognizes accessibility and affordability of ZEVs being the most important factor to community empowerment, regardless of economic, social, and environmental interests. This requires collaborative efforts from multiple stakeholders (i.e. ACT and Federal government, industry, NGOs, advocacy groups, academia, and community) to incentivize the ZEV experiences throughout. This paper suggests the following recommendations for stakeholders at different stages of the uptake.

Lower upfront cost of ZEVs

1. Expand second-hand market

The adoption of ZEVs in ACT government fleets supplies stock to the more affordable second-hand market. Locally or inter-state available options via second-hand dealers such as ION DNA and Switched On Cycles in Canberra and the Good Car Company in Tasmania should be promoted to expand variety of ZEV options, including EVs, e-bikes and e-scooters. Besides, options to import second-handed vehicles should be advocated. This may include relaxing application requirements to Specialist & Enthusiast Vehicle Scheme (SEVS) to cover currently available vehicles in Australia at Federal level; and to issue a consumer guide on ordering second-hand vehicles from overseas markets via NGOs.

2. Promote ZEV transition options with e-bikes and e-scooters

The ACT has well-established biking networks which provide alternative active transport options. In terms of reducing transport-related emissions, combination of vehicles should be encouraged particularly to households owning multiple vehicles. Transitions to an EV and an e-bike instead of two EVs makes the overall transition more affordable especially to low-income households. To this end, more advocacy work regarding e-bikes and e-scooters is required to educate consumers on the possibilities and benefits of ZEV options. This may include providing a one-stop shop website that gathers information on e-bikes and e-scooters in the ACT, promote local bike tours and organize workshops or talks to invite e-bike dealers and users to share their biking experiences.

3. Explore further government subsidies and fee exemptions opportunities

Overseas case studies showed that direct subsidies to cover the upfront cost of ZEV is the most effective measure to encourage community uptake. Particularly to low-income households with high travel demand, subsidies should be considered at federal or state level through means tests to accelerate the transition. Apart from direct subsidies, current fee discount may be expanded from 20% discount to 3-5 years free annual registrations for first and second-handed EVs at local level, exemptions to luxury car tax for EVs at Federal level, etc.

4. Target setting for transport-related emissions and ZEVs sales

It is advised that Australia needs a long-term decarbonization roadmap for transport nationally, specifically setting emission reduction targets for the transport sector, fuel efficiency standards and sunset dates for petrol and diesel vehicles, as well as sales and coverage targets for EVs and other nation-wide policy initiatives to create market motives for car manufacturers to invest further into the Australian vehicle market. This implies expansion of the ZEV market, ideally by creating local manufacturing lines for EVs, to cater broader consumer needs and appetite at a reasonable and affordable price range.

Lower operational and maintenance cost of ZEVs

5. Introduce new business model

Apart from direct subsidies, alternate business model with battery leasing may be considered to lower the cost of EVs with greater return of investment. A study conducted by McKinsey (2019) suggested that battery leasing via car manufacturers may reduce up to 28.6% of the upfront cost (i.e. without purchasing the battery pack) which is competitive with traditional vehicles (GPEKS 2020). It provides additional benefits on ensuring quality of EV batteries such that operational and maintenance cost may be reduced, and old batteries that are no longer suitable for vehicles can be resold to the stationary storage market for secondary use. This type of business model may be advocated through NGOs, advocacy groups, and the government to attract car dealers and manufacturers.

6. Support research and development (R&D) on ZEV and battery efficiency

Improving energy efficiency of ZEV batteries is an effective means of reducing operational cost such that frequency for charging may be reduced. A recent research conducted by

Monash University discovered a? new method to improve stability of lithium-sulfur materials for battery production which gives higher energy storage densities and performance (Maengarb 2020). More of this type of research should be encouraged through dedicated R&D funding and partnerships between Universities and industries. ZEV-related research needs to be advocated such as expanding existing project coverage in the Emission Reduction Fund at the federal level; and allowing small and middle enterprises (SMEs) to participate in ACT's Energy Efficiency Improvement Scheme on retrofitting EV battery storage systems and charging stations at their neighborhoods.

7. Promote ZEV-sharing or ZEV-pooling communities

Car-sharing is another opportunity to reduce both upfront and operational cost of ZEVs. Local and overseas cases proved that through a car-sharing company, users do not have to worry about maintenance of vehicles while at the same time reducing total number of vehicles on roads and total energy consumption. In the ACT context, e-bikes or e-scooters sharing communities should also be considered to cater different needs, such as serving as last mile or short-distance transport (Schmidt 2020). This option is particularly suitable for low-income households which cannot afford replacing a petroleum car to EV; and for individuals who want to experience an EV for a longer period of time (as compared to test drive) before purchase.

8. Support public and private investment on ZEV charging infrastructure

Improving availability and affordability to existing ZEV charging networks is effective in addressing users' concerns on range anxiety and lowering operational cost. A study showed that as ZEVs become more and more cost-competitive to conventional vehicles, Australia will need AUD$30 billion to install charging infrastructure in the next five years (Ludlow 2020). This requires joint effort between public and private sectors to offer different types of charging services. For instance, a variety of chargers including slow charger for overnight charging, fast and ultra-fast chargers, and electric highways should be considered to cater different needs (Boffey 2018; Harris 2019). This should be coupled with subsidies for charging services and consumer education on choosing the right charging stations and effective usage of chargers.

Clarify public misconceptions on ZEVs

9 Advice Australian Consumer Association for quality evaluation of ZEV and batteries

One of the most common concerns of ZEV uptakes relates to range anxiety, whether an EV can travel long distances without charging and changes of energy intensities of EV batteries over time. The Australian Consumer Association should consider conducting a formal product evaluation on EV and EV batteries available in the Australian market to communicate on the quality of EV batteries. This may result in recommendations for a battery standard to clarify public misconceptions. Alternatively, the battery testing laboratory at the Canberra Institute of Technology (CIT), the first of its kind in the world, may consider expanding their testing scope to EV batteries (including first and second-handed batteries) and provide technical information to potential ZEV buyers on battery quality (Sibthorpe 2016).

10. Organize community-based test drive events for ZEVs

Test drive events could be another way to advocate on common misconceptions over ZEVs. Activities such as "try an EV" day organized by local EV communities could foster more experiences sharing between current EV users and potential EV buyers. More practical driving experiences such as planning a journey, finding charging spots, setting up charging stations at home, selection of vehicles and reaching out to the second-hand market may be provided personally which would otherwise not available through communicating with a salesman at showrooms. Through building and expanding the EV communities, users may seek support from one another for future needs, including upgrading and maintaining their vehicles which could create useful information networks among users.

11. Issue factsheets or publicity materials on ZEV development and misconceptions

General information on ZEVs, such as ZEVs options available in the ACT and Australia, costs, and benefits of adopting different types of ZEVs, existing policy incentives available for first-hand and second-hand market and some frequently asked questions and answers, should be made available to the general public for those who are planning to transition. Factsheets or information packs would be ideal for effective communication and circulation. This may be produced jointly by NGOs, lobbying groups, and local communities. As for current EV users, information on latest ZEV technology and changes to local policy initiatives

should be updated regularly to provide more convenience to information access and optimize user experiences.

Improve ZEV user experiences

12. Provide real-time information on ZEV parking and charging spots availability

Whereas many households can afford having their own charging station at home, many others rely on publicly available charging networks. Real-time information on the availability of charging spots and their locations would be useful for users to plan their journey in advance. This may be communicated via a mobile application managed by power suppliers or shopping centres if charging stations are located inside the carpark. In addition, it is also suggested that EV charging spots in carparks should be separated from those for disabled parking to avoid potential non-EV parking when disabled spots are occupied.

13. Incorporate ZEV-friendly facilities in urban planning and property development

Increasing adoption of ZEVs requires stronger infrastructural support on EV charging. Studies have shown that the most common configurations are likely to have chargers at home and workplace (Ernst & Young 2011). In this regard, apart from introducing alternative options to set up charging stations at home, including those that can charge directly via domestic socket, other ZEV-friendly facilities such as more secure e-bike or e-scooters parking should be incorporated in future urban planning, and commercial and residential property development (EV Connect 2013). This provides incentives for apartment dwellers to consider ZEVs. For those that can be charged directly via domestic socket, cafes and restaurants may also consider providing such services to attract ZEV customers. To achieve this, the government may consider extending ZEV-friendly facilities as a mandatory requirement for development and provide incentives to the installations.

14. Recommend exclusive policies for ZEVs

More privilege policies for ZEV users may be considered to improve user experiences. In the ACT context, on top of access to bus lanes, other exclusive policies such as free or discounted municipal parking, reserved parking spots for EVs, lower electricity cost for EV charging or discounted EV insurances may be considered to further lower the operational cost for EVs (Energeia 2018). Ultimately, the objective to privilege policies for ZEVs is to incentivize user

experiences such that they are comparable to conventional vehicle users. This requires joint effort by insurance companies such as the National Roads and Motorcyclist Association (NRMA), local and Federal government.

15. Explore expansion to zero emission public transport network

Despite ZEV uptake focuses on private transport options, expanding current zero emission public transport network should be considered, particularly to incentivize alternate ZEV options such as e-bikes and e-scooters. This includes electrifying bus networks by ceasing purchase of petroleum buses and incentivize upgrades to electric cabs (Keegan 2018). The intention behind this should align with reducing traffic congestions, and overall transport-related energy consumption. Alternatively, events such as “car-free days” may be considered to allow only ZEVs, conventional bikes, electrified public transport to encourage more ZEV uptake. Such events may serve for awareness raising to the importance of zero emission transport to carbon reduction as well.

Conclusion

Zero emission transportation is the next challenge to long-term decarbonization, in Australia and the world. Community empowerment is an important element to accelerate the transition. Whereas behavioral changes cannot be achieved overnight, the ACT should make use of its unique landscape which allows promotion of a variety of ZEVs. Overseas experiences taught us that discounted taxation and fees are insufficient to incentivize ZEV uptake, but clear targets for transport-related emissions, fuel efficiency standards and sunset dates for petroleum and diesel vehicles are essential to create market and policy motives for more ZEV-friendly measures. Australia urgently needs to tackle this with a comprehensive roadmap on nation-wide and state-wide development of ZEVs. This should be complemented with stronger advocacy work around the benefits and myths on ZEVs, such as via centralizing information base and engaging in test-drive or vehicle-sharing communities.

Further research on ZEV uptake in the ACT may consider expanding scope of study to hydrogen-fueled vehicles, which presents another challenge on extracting hydrogen fuel using zero emission energy sources and building a completely different charging network. Focus studies on alternative business models may also be considered to evaluate the costs and benefits from a car manufacturer or dealer perspective. Yet, regardless of the scope of ZEVs and business models studied, it should be recognized that ZEV transition requires incentivization of user experiences such that ZEVs outcompete conventional vehicles for a better travel experience economically, socially, and environmentally.

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