Electric light passenger vehicle uptake in Melbourne: Projections and spatial distribution by 2030

Working Paper

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Acknowledgement of Country

We at RMIT University acknowledge the people of the Woi wurrung and Boon wurrung language groups of the eastern Kulin Nation on whose unceded lands we conduct our research, teaching and service. We respectfully acknowledge Ancestors and Elders past, present and emerging who have always been caring for Country. We pay our respects to Country, the lifeworld that sustains us all.

Our research, education and service are already in a relationship with Country and the people of Country, here and in all the places we undertake our business. As mostly non-Indigenous people, we acknowledge our obligation in this relationship: to uphold the ngarn-ga [understanding] of Bundjil and practice respect for community and culture. Though there is much we still need to learn, especially about ourselves, we affirm our dhumbali [commitment] to that work. We hold as central to our business, dhumbali to a shared future with Indigenous peoples everywhere and especially Kulin Country and peoples.

Background

Emissions from light passenger vehicles produce approximately 7 per cent of Australia's greenhouse gas emissions (Climate Change Authority 2014). Given intensifying efforts to reduce greenhouse gas emissions and to move energy supplies away from fossil fuels there is growing anticipation of a transition from conventional internal combustion engine vehicles (ICEVs) to electric vehicles (EVs). Many jurisdictions globally have signalled phase-out dates for electric vehicles. France for example expects to cease sales of new ICEVs by 2040 (Auverlot et al 2018), California by 2035 (Newsom 2020) while Norway will stop ICEV sales from 2025 (EBIL 2020). Australia presently operates neither an electric vehicle target or a statutory regime for vehicle fuel economy despite acknowledged market failures and agency recommendations in favour of a regime (Climate Change Authority 2014).

Reflecting limited government support, the uptake of electric vehicles in Australia has been slow, with just 14,253 registered as of January 2020. In 2018, the then Minister for Environment and Energy suggested that 230,000 electric cars could be operating on Australian roads by 2025 and 1 million by 2030 (Frydenberg 2018). For the 2025 figure to be achieved nearly 54,000 EVs would need to be registered during each of years 2021-2024, equivalent to a near quadrupling of current registrations annually. This estimate seems unlikely in the absence of marked change in the structural conditions in the Australian passenger transport sector or decisive policy intervention to encourage electric vehicle uptake.

As of mid-2021 the Australian Government continues to lack a formal policy on transition of Australian motor vehicle fleets to electric drivetrain, reflecting chronic weaknesses in its capacity to develop effective energy and climate policy. The Australian Government's Future Fuels Strategy 2021 (Department of Environment 2021) offers little in the way of active intervention to enable transition to electric vehicles in Australia, preferring relative pricing of EVs compared to ICEVs to be the market mechanism that motivates consumer preferencing of EVs in vehicle purchases. Part of the justification for not actively encouraging an ICEV to EV transition is the imputed price of carbon abatement via EV subsidies versus other greenhouse gas emissions reduction options. This framework seems out of step with practice in various comparable jurisdictions where more active positions on existing ICEV fleet emissions standards plus support for early adoption of EVs have resulted in much greater uptake than has been observed in Australia. This deliberate laggard status seems misaligned with the imperatives of transport decarbonisation.

Leadership in electric vehicle policy now appears to have been ceded by the Australian Government to the states. Since late-2020 new electric vehicle policies have been released at the state level in Australia, with each of New South Wales, Victoria and South Australia announcing new policy frameworks and packages of support and subsidies to encourage uptake of EVs, focusing on light passenger vehicles. Victoria was the earliest to move on policy implementation, with a package that includes vehicle purchase subsidies, charging infrastructure rollout and trials of fleet and bus electric vehicles. Victoria's EV package included further innovation via a road user charge of 2.5 cents per kilometre which is aimed at ensuring EVs equitably share in the cost of road provision while also supporting 'optimisation' of car use in the absence of fuel excise (DELWP 2021). The New South Wales policy, released after Victoria, shares many similarities with its southern neighbour, including rebates for EV purchase, phase out of stamp duty for most EVs, plus fleet subsidies and charging infrastructure (DPIE 2021). While New South Wales has committed to introducing a road user charge for EVs at a similar rate to Victoria, the introduction of this charge has been deferred until 2027. At the time of writing South Australia was preparing a similar albeit slimmer EV policy package to Victoria and New South Wales, including subsidies for EV purchase and a road user charge deferred to 2027.

The effects of the various state policies is not yet well understood. However it can be expected that subsidies and stamp duty concessions will motivate a greater proportion of new vehicle purchasers to choose EVs over ICEVs than would otherwise be the case. Consequently it may be anticipated that EV uptake will accelerate over the near term. There will likely be a visibility effect as greater numbers of EVs in use bring familiarity and acceptance of EVs as a vehicle option, spurring further consumer uptake. Questions of EV uptake are important because the increasing use of EVs also implies greater use of EV infrastructure such as charging stations. The distribution of charging stations has implications for spatial load on the electricity distribution network whether from households or from public facilities. This has implications for land-use planning in terms of the distribution and siting of charging stations relative to spatial and temporal demand.

Understanding the extent of EV use within the next five to ten years can assist to understand the likely level of provision of charging stations and to support efforts to optimise the distribution of such facilities, particularly within cities where uptake is likely to be concentrated. Furthermore there is benefit in understanding the socio-economic and spatial factors that contribute to greater or lesser EV uptake. This information may assist with policy refinement to address uptake barriers faced by particular groups as well as understand equity and distributional issues.

Having good information on spatial EV demand within cities can aid policies and planning for EV charging infrastructure. Yet establishing accurate and timely projections of EV uptake in Australian cities is currently a challenging task, given the very low levels of current EV use. Because EVs are currently such a tiny proportion of the overall vehicle fleet it is difficult to build accurate analytical models to understand the relationships between various household and locational characteristics that support EV uptake. Nonetheless early insights can be helpful and as EV numbers increase so too will the capability to improve the quality of analysis. We note that the Australian Urban Infrastructure Network has recently funded a project to collate motor vehicle registration data linked to the Green Vehicle Guide that can provide an ongoing dataset through which to better track EV adoption at national, state, metropolitan and suburban scales (AURIN 2021).

This report contributes to the task of improving knowledge of EV uptake in Australia by providing ongoing results from exploratory research into EV spatial demand using Melbourne as a case study. The research sought to develop an approach that could:

- assess the potential growth in uptake of EVs in Melbourne to 2030
- identify potential spatial differences in EV uptake in Melbourne
- project potential spatial demand for EVs by 2030 based on alternative uptake scenarios
- estimate potential future demand for EV charging infrastructure

The remainder of this report provides the latest findings from our ongoing program of investigation. Some of the material draws on a preliminary results paper published by the Clean Air and Urban Landscapes Hub in 2020 (Li and Dodson 2020). The present version updates that original note with the discussion of recent policy change and further spatial analysis, given the full year 2020 motor vehicle registration data. These are not yet final results and further interpretation will be undertaken in advance of preparation of a research paper for scientific publication. We note that limited data constrains more detailed assessment. Nonetheless the results may be useful in providing insights into potential EV scenarios in a changing EV technology, market and policy environment.

Methodology

This assessment of the potential uptake of EVs and spatial demand for charging infrastructure in Melbourne involves two main elements:

1. Projection of total EV uptake for Melbourne to 2030
2. Allocation of projected EV uptake to 2030 by locality in Melbourne at ABS SA2 level

To assess the potential uptake of EVs and spatial demand for charging infrastructure in Melbourne we have drawn on four datasets:

- Australian Bureau of Statistics Motor Vehicle Census (MVC) 2014 and 2018
- Australian Bureau of Statistics Census of Population and Dwellings (CPD)
- Australian Urban Research Infrastructure Network data on housing and energy infrastructure
- VicRoads road and vehicle fleet data
- Victorian Integrated Survey of Travel and Activity data

Estimating EV growth in Melbourne

To assess EV uptake in Melbourne we drew on changes in the registration of electric passenger vehicles as recorded by the MVC. Australian EV uptake is depicted below (Figure 1). The figure shows that between 2013 and 2020 there was an average 40 per cent annual growth in EV registrations from 4,160 EVs registered in 2013 to 15,700 in 2020. This is an approximate 1,646 of EV growth every year.

The Melbourne EV growth rate was lower than for the nation overall. In Melbourne registrations of EVs grew on average by just 34 per cent during the study period, equating to a longer period for doubling of the fleet. By projecting this growth beyond the study period using the growth rate observed during the study period provides suggests that by 2025 29,970 EVs will be registered and by 2030 101,094 EVs will be registered in Melbourne. This represents a growth of more than 1,000 per cent by 2030.

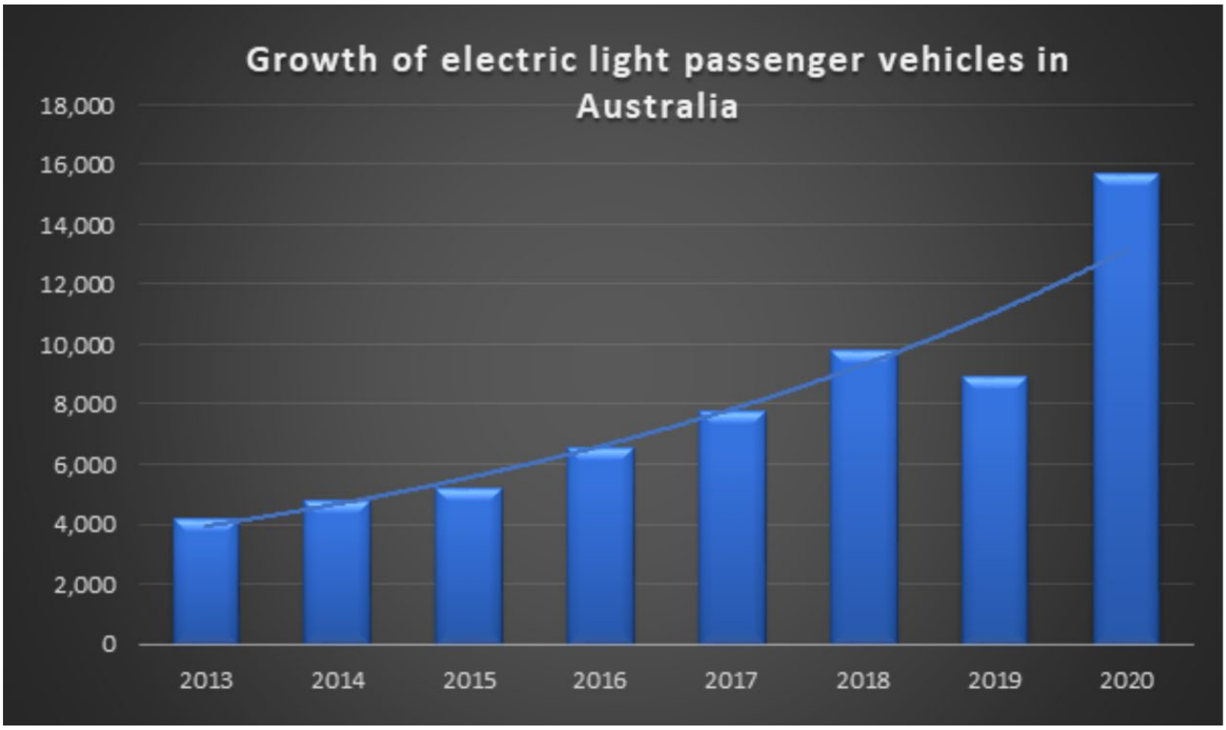


Figure. 1. Annual growth in EV registrations, Australia 2013-2020.
Source: ABS motor vehicle census 2013-2020.

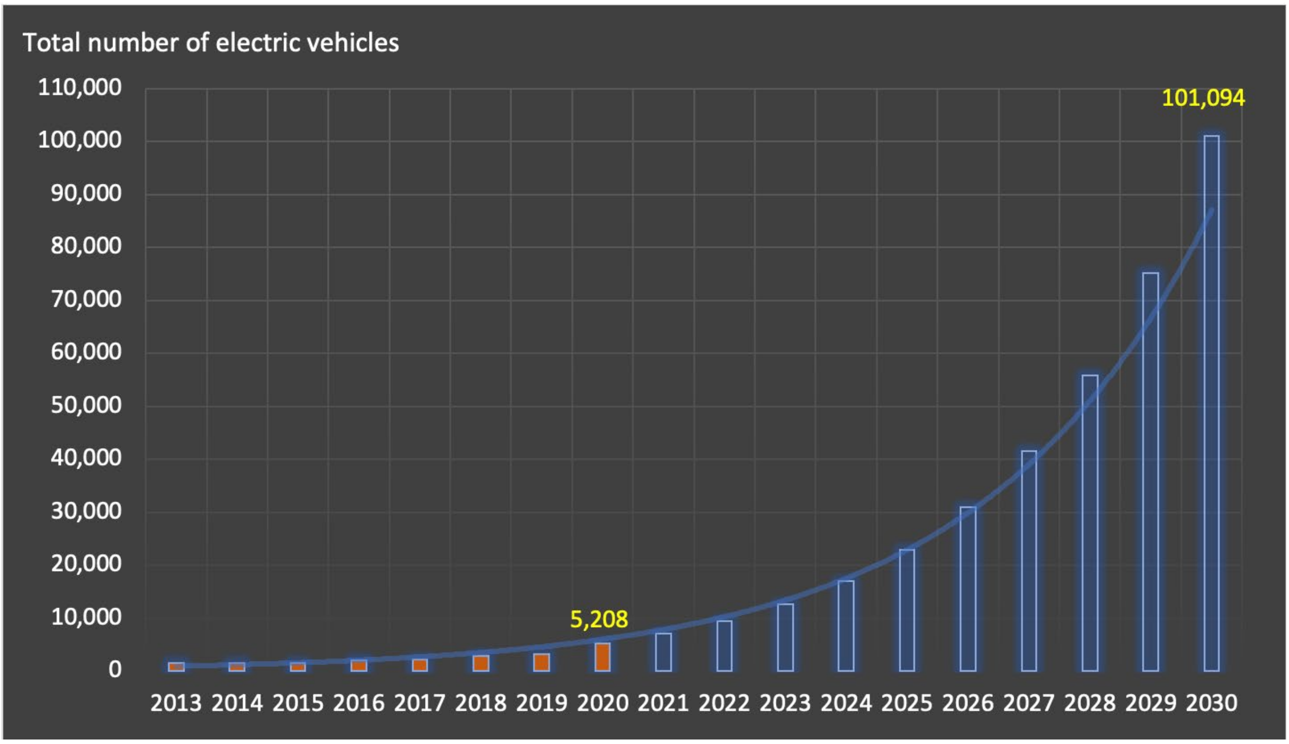


Figure. 2. Projected growth in EV registrations in Melbourne, 2019-2030.

Spatial distribution of EVs in Melbourne

Using ABS MVC data we are able to plot the distribution of EVs at the SA2 level in Melbourne across differing time periods (Figure 3). This analysis shows that there was broad distribution of EVs across the city in 2014, with concentrations in the south-eastern SA2s and in the west. The numbers within any given SA2 however were quite modest, with the highest concentration no greater than the 111 registrations in the Dandenong area. The mapping reveals differentiation across the metropolitan area in terms of EV uptake, with areas of concentration and areas of lower concentration.

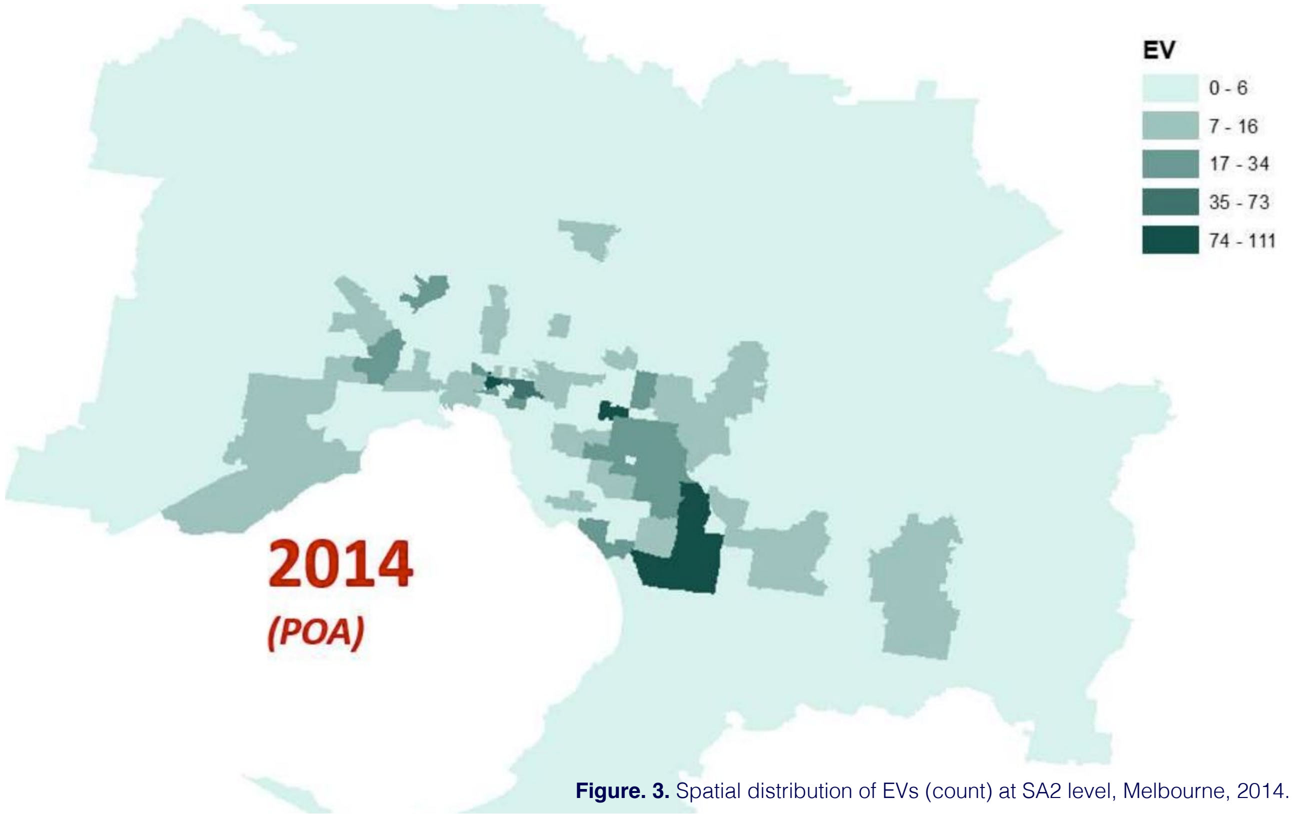


Figure. 3. Spatial distribution of EVs (count) at SA2 level, Melbourne, 2014.

By 2018 the distribution of EVs in Melbourne had expanded across the metropolitan area by number of SA2s and by numbers of EVs within SA2s (Figure 4). As well as the existing concentrations in the south east and west of the metropolitan area, new areas of EV registration became apparent in the north west, north and north east of t the city. The level of EV uptake within any given SA2 in 2018 remained no higher than the maximum recorded in 2014. Hence EV uptake appears to be dispersing across rather than concentrating within SA2s. It should be noted also that based on the total uptake data, no more than 5,208 EVs in total were registered in Melbourne in 2020.

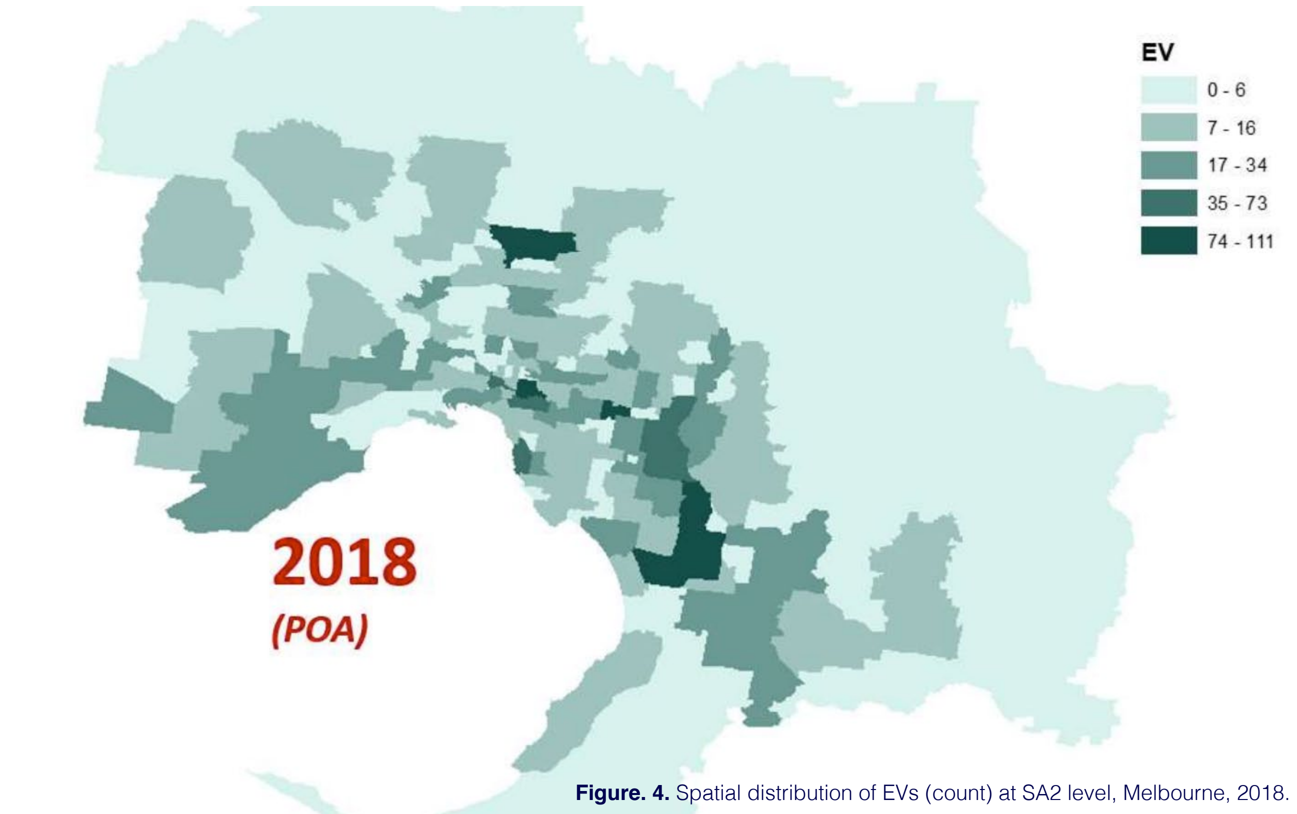


Figure. 4. Spatial distribution of EVs (count) at SA2 level, Melbourne, 2018.

Differential EV uptake in Melbourne

The spatial differentiation in the adoption of EVs across SA2s in Melbourne suggests that underlying socio-economic factors may influence uptake of EVs. Assessing the factors that contribute to higher or lower EV uptake allows a basic projection model to be constructed at the SA2 level.

Factors associated with EV adoption as described in the literature include demographic, attitudinal, transport mode, economic and geographical factors. In our calculations we have included variables representing:

- Car and travel demand, including journey to work mode and distance, via ABS CPD
- Household knowledge and financial capacity, including income, professional employment and education level, via ABS CPD
- Dwelling and energy access, including car ownership, access to EV charging stations and household residential solar installation, via ABS CPD and AURIN
- Vehicle make and model preferences, via ABC MVC
- Trends in EV uptake at the SA2 level, via shift share in EV growth, via ABS MVC

Based on these variables we constructed an index of EV growth that differentiates potential for EV growth at the SA2 level. The results of this index show that there is wide variation in potential for EV uptake. Much of the inner south-eastern areas of Melbourne are rated high on this index, in part due to the higher socio-economic status, in terms of income and education observed in these places. However some outer-suburban areas such as Werribee South, Cranbourne and Mount Eliza also score highly on the EV growth index, perhaps in part due to higher levels of existing travel by car which might motivate a shift to the lower marginal cost of EV travel.

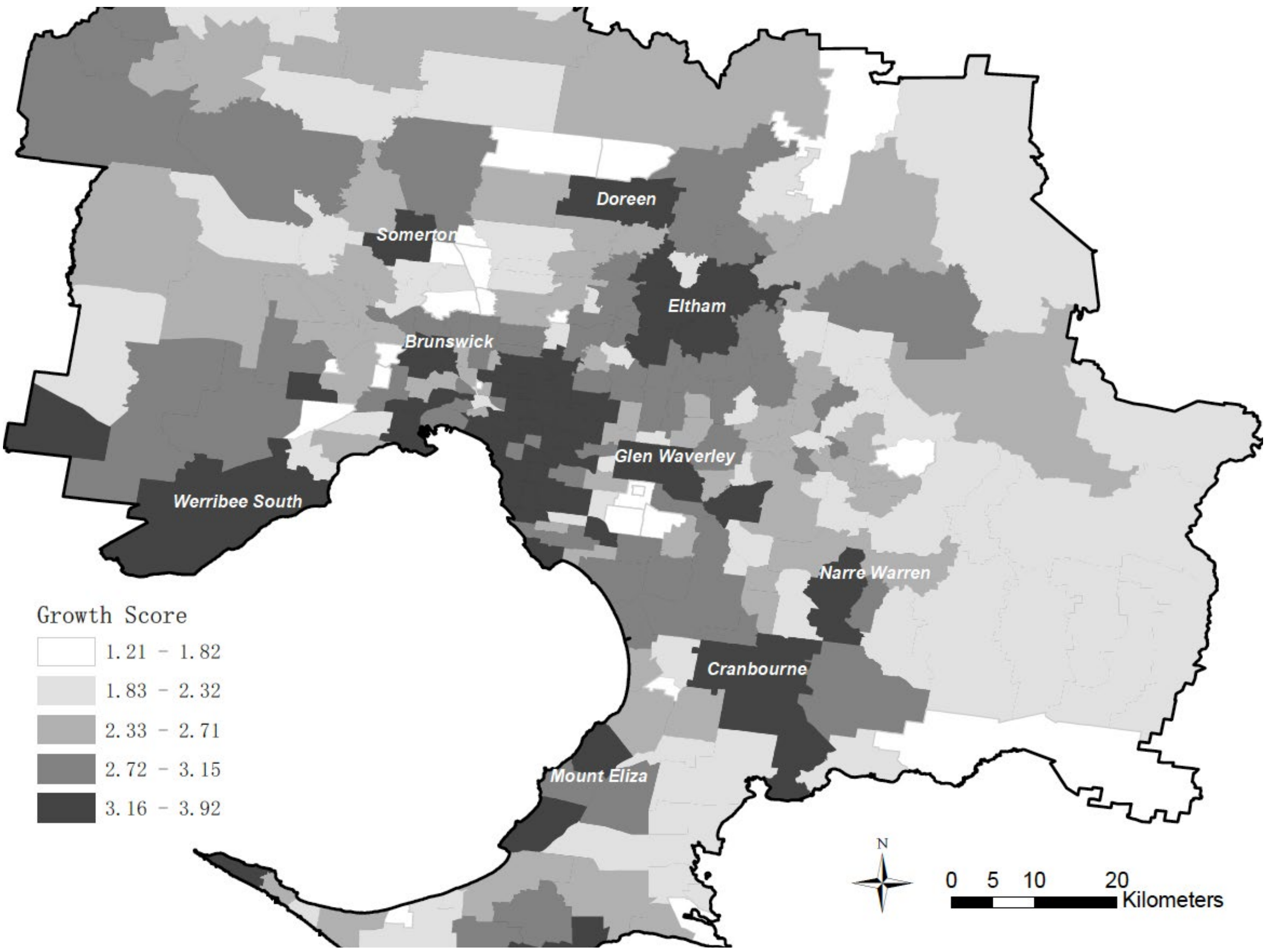


Figure. 4.1 Relative EV growth scores at SA2 level, Melbourne

The EV growth index can be used as a propensity variable to allocate the aggregate projected growth in EV uptake to 2030 (Figure 2) to specific localities (Figure 5). This projection shows that the greatest number of EVs at SA2 level by 2030 in Melbourne is likely to be in outer suburban locations, such as Werribee South, Truganina and Cranbourne, among others. Up to 2,600 EVs might be operating in these SA2s than in others across the city, including in inner urban localities. A further set of outer suburban localities such as Mickelham and Doreen, and Narre Warren are also projected to see uptake of between 800-1400 EVs by 2030. Few inner urban localities are projected to have numbers of EV uptake exceeding 776 EVs by 2030, with the exception of Richmond. Assuming EVs achieve 10 per cent of the Melbourne motor vehicle fleet, the projected distribution will resemble that provided in Figure 6.

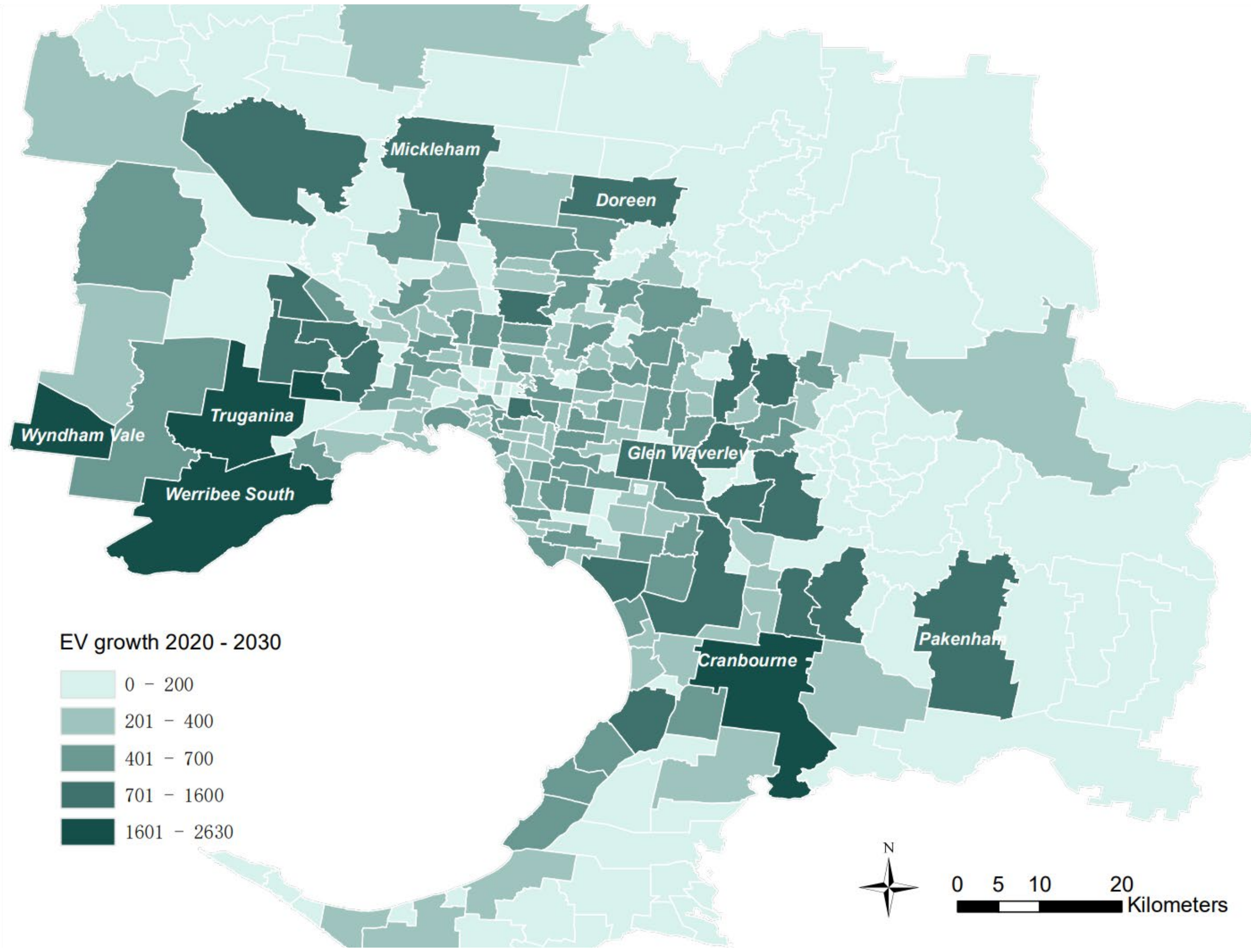


Figure. 5. Predicted growth of electric vehicles (EV) in Melbourne metropolitan areas, 2020-2030

Using these projections it is possible to assess the level of EV uptake if EVs were to comprise 10 per cent of the total vehicle fleet for Melbourne. Our projection suggests that this may occur by 2036. The distribution of EVs by 2036 is broadly similar to that for 2030, but with higher numbers per SA2, accounting for the longer period for uptake to accrue (Figure 6).

Figure. 6. Projected spatial count of EVs at 10 per cent of motor vehicle fleet, SA2 level, Melbourne.

Estimating energy savings from future EV uptake

A major rationale for the adoption of EVs is the reduction in fossil fuel consumption (assuming the electricity used is generated via non-fossil fuel sources). Using the future EV fleet uptake projections at the SA2 scale it is possible to also project likely daily fuel savings, based on prevailing vehicle fleet fuel efficiency. This analysis (Figure 7) calculates the likely fuel savings (in litres) from a 10 per cent uptake of EVs within existing vehicle fleets at SA2 level, based on 2016 ABS Census journey to work mode share for cars and distance travelled.

The projection estimates that if 10 per cent of the current vehicle fleet were converted to EVs the total fuel savings would be around 301,638 litres per working day. Such fuel savings from EV uptake are likely to be greatest in outer suburban areas compared to lower fuel savings in middle and inner-suburban areas. The reason for this differential is the greater level of JTW travel by car in outer-suburban zones which are poorly served by public transport, combined with the longer JTW distances travelled by workers in these zones. By contrast inner-urban areas are projected to achieve lower total fuel savings from the adoption of EVs because of the lower JTW mode share for private cars in these places combined with shorter JTW distances.

Estimating future demand for EV charging infrastructure

The extent of demand for EV charging infrastructure to 2030 cannot be known for certain given the limited existing level of registration of EVs from which to impute future charger spatial demand, combined with the changing technological performance of EVs in terms of range and charging speed. Much current discussion assumes that charging facilities will need to be widespread including at workplaces and major public venues. Yet most EVs will likely be charged overnight at residential locations. With a range of, for example, 400 km per charge and an average journey to work distance for Melbourne of 12 km, most work trips will be easily be able to be accommodated via home charging.

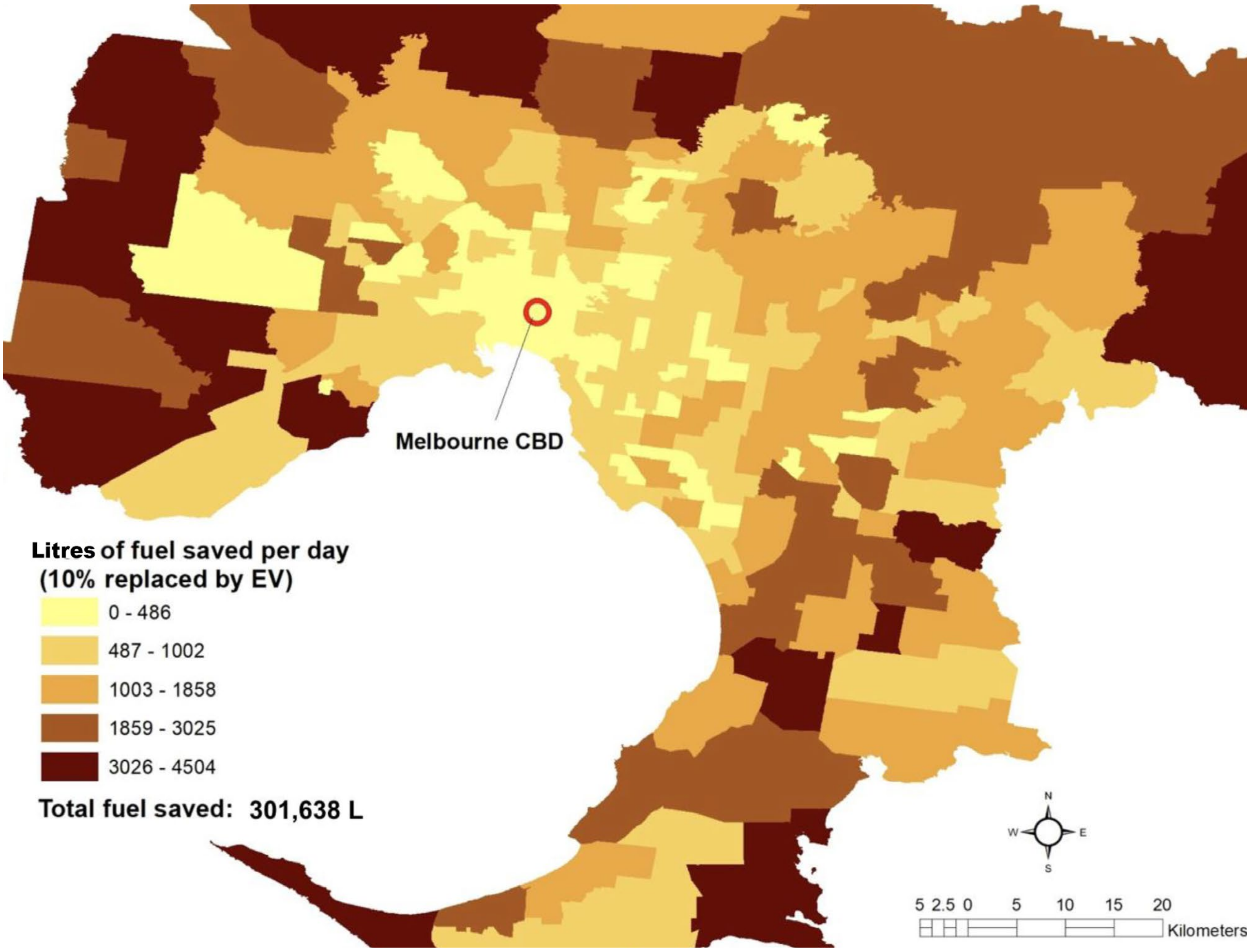


Figure. 7. Journey to work fuel savings from 10 per cent replacement of vehicle fleet with EVs, SA2 level, Melbourne

It is possible to assess the potential spatial demand for EV charging facilities at journey to work destinations. Two steps can be applied to project spatial EV charging facility demand. First, the rate of journey to work arrival by car can be treated as a proxy for future spatial EV charging facility demand (Figure 8). Second, this can be weighted according to future EV uptake scenarios such that journey to work arrivals from origins with high levels of EV uptake are likely to generate higher charging facility demand compared to journey to work arrivals from localities with fewer EVs used (Figure 9). It is also possible to compare this arrival data with existing charging facilities.

The data for total vehicle journey to work arrivals shows that current (2016) journey to work arrivals by car are broadly distributed across the Melbourne metropolitan area, albeit with some differentiation, at the SA2 scale. Areas with high car JTW arrivals are found in outer suburban zones, to the west, north and south east. There are also some high car arrival areas in the central city zone, including Fishermans Bend and in some middle suburbs such as Heidelberg West.

We gathered charging station data from the data portal on the Electric Vehicle Council website. Inspection of the location of current journey to work arrivals by car and EV charging facilities shows there is no obvious direct correlation. Dandenong, which had the highest number of arriving cars had just two EV charging stations, not significantly greater than other locations. Many of the localities with high commuting arrivals by car had no EV charging stations.

This lack of matching between total journey to work arrivals originating from areas with high EV growth rates and EV charging facilities in the arrival areas is also notable (Figure 9). There appears to be little relationship between areas where there is high growth in EV ownership and the provision of charging facilities in the destinations where workers in the high growth areas work. At present this is likely to be a minor issue, given the very low rates of EV ownership and the relatively short length of journey to work trips compared to the total range of many EVs currently in use. However as EV ownership rises there may be a need to reconsider the number and location of charging stations to ensure adequate provision to meet demand.

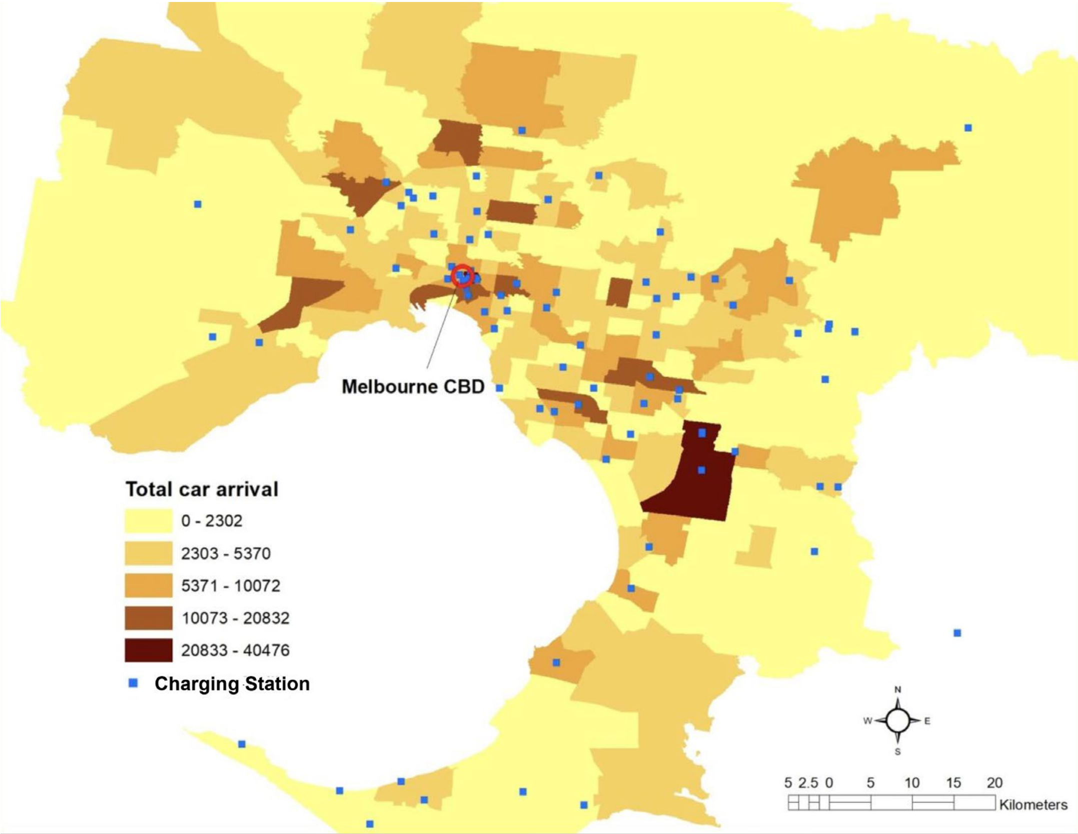


Figure. 8. Total trip arrivals by car at SA2 level, Melbourne, 2016

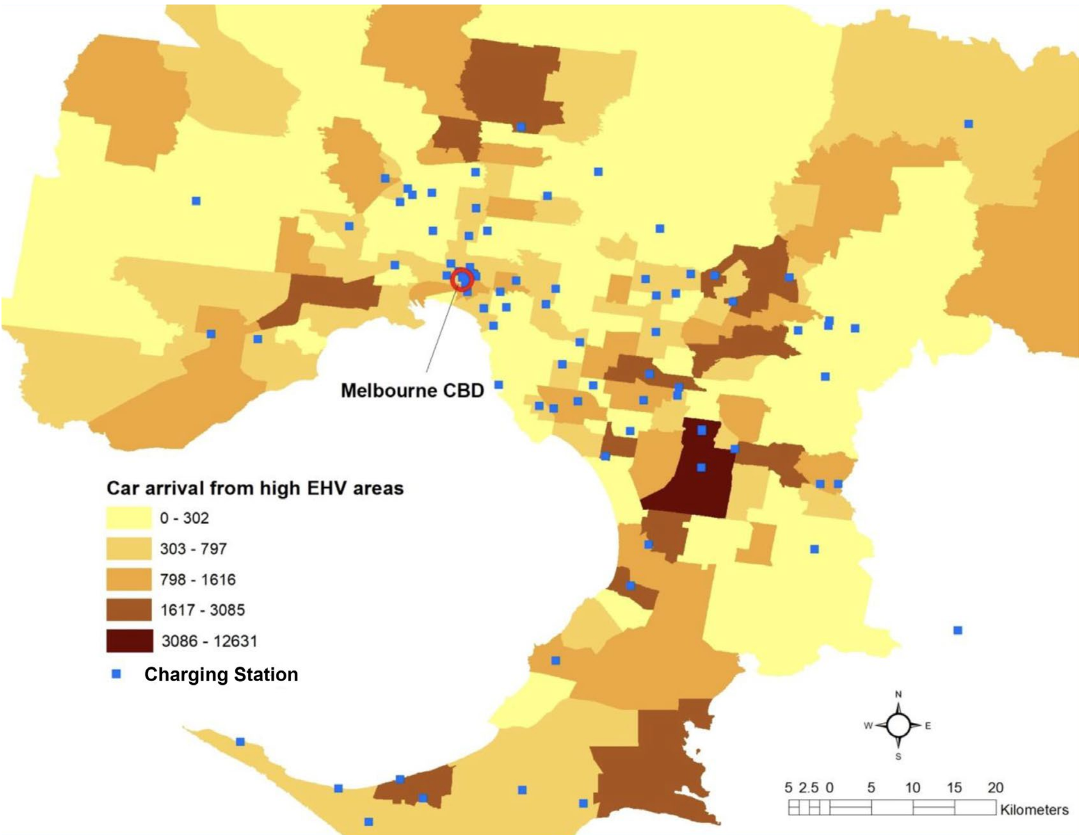
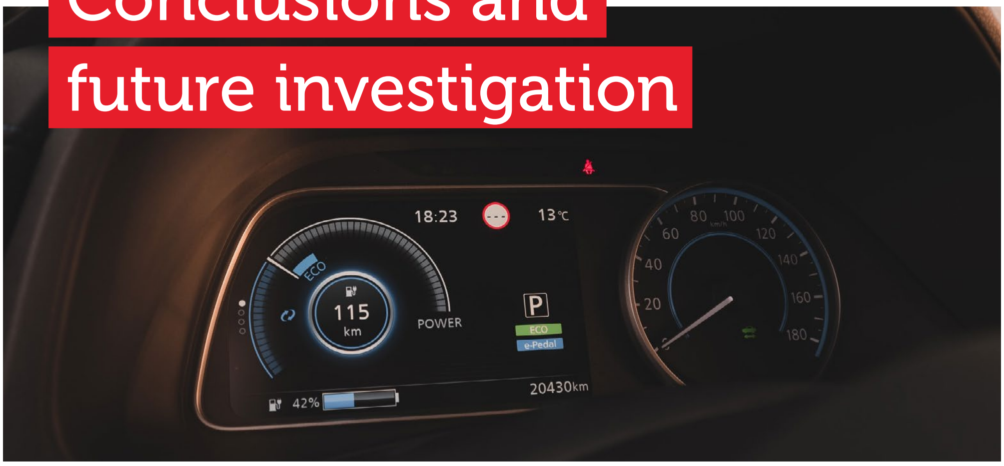


Figure. 9. Total journey to work trip arrivals by locality weighted by extent of EV uptake growth in originating locality, with charging facility locations indicated, SA2 level, Melbourne, 2016.

Conclusions and future investigation



The data and findings presented in this report reflect work in progress. Nonetheless they offer a number of insights into the uptake of EVs and future charging facility demand.

First, the uptake of EVs based on current rates of adoption in Melbourne is likely to be modest until at least 2030. At current uptake rates, the total number of EVs is not anticipated to be more than 10 per cent of the Melbourne light passenger vehicle fleet until 2036. Given the imperatives of rapidly decarbonising the motor vehicle fleet to meet climate objectives this lacklustre performance could be considered as a policy failure. Greater policy effort will be needed if the levels of national EV use suggested by the Minister for the Environment by 2030 (Frydenberg 2018) are to be realised. This will likely require policy to go beyond the Victorian initiatives of subsidies, or the New South Wales stamp-duty concessions, offered in early-2021.

The current distribution of EVs tends to favour middle and outer suburban locations where levels of car use and rates of car ownership are high compared to more central localities. Based on current knowledge of factors that are associated with EV adoption it is projected that EV uptake growth during 2020-2030 will be strongest in outer suburban areas, particularly to the west, north and south east of Melbourne. This pattern is desirable, as outer urban areas tend to exhibit higher vehicle kilometres traveled, thus EVs appear to be being adopted where they have useful effect on automotive CO2 emissions. Nonetheless, such zones also tend to be less affluent than inner urban localities, so consideration will need to be given to equity dimensions of EV transition over time.

Energy savings from the uptake of EVs within Melbourne's light passenger vehicle fleet could exceed 300,000 litres per day if 10 per cent of existing conventional vehicles were replaced by EVs for journeys to work. Given distances driven for journeys to work the savings are likely to be greatest in outer suburban areas.

Future demand for charging infrastructure will potentially be highest in areas with the greatest share of journey to work arrivals. There is no clear relationship between areas of high overall work journey arrivals or of arrivals for work from commuters traveling by car who originate in locations with high EV uptake growth, and locations of charging stations.

This investigation has been exploratory and draws on existing datasets. The authors had attempted to source survey data on EV use held by other parties, however this was not made available. Further investigations to understand the individual, household and spatial variables associated with higher propensity to adopt EVs would assist to extend knowledge in this area. This may include developing better data sets with which to investigate the topic. Governments have a role to play in supporting improved data collection, including ensuring vehicle operational data gathered via advanced onboard electronics is available for research and analysis on an open basis.

There remains scope for the Australian government to exert greater effort in supporting an EV transition. Even if it is not willing to directly subsidise EV take-up the Australian Government possesses other levers that would aid transition. These could include mandating automotive manufacturers offer specified EV fleet shares by particular time periods with set price differentials between EVs and ICEV equivalents. Further action could increase Commonwealth fuel excise to greater multiples of the Victorian EV road user charge than the current approximate double level at which excise is currently set. For example, fuel excise at 129 cents per litre would provide a greater price incentive to switch to an EV than the current 43 cents per litre. This would likely necessitate equity measures given the regressive nature of excise duty. Careful ongoing monitoring of the EV transition will be necessary, with further direct government intervention potentially merited if uptake continues to lag.

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