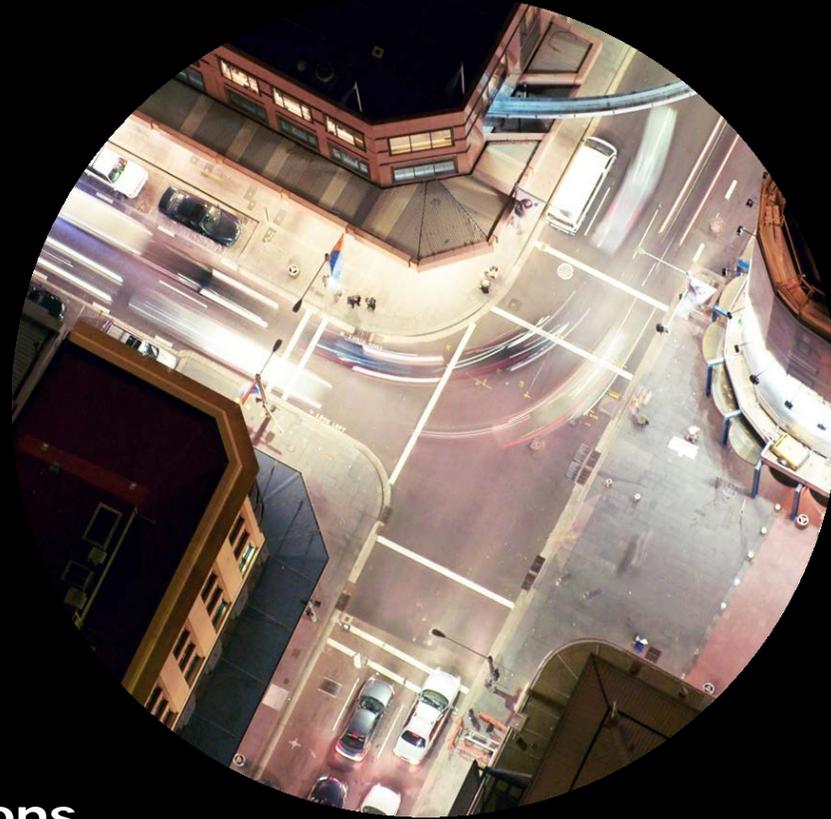


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Access Economics



**Automated and zero emissions
vehicles infrastructure advice**
Socio-economic impact analysis

August 2018

Background

The socio-economic aspects of ZEVs and AVs

- The widespread adoption of zero emission vehicles (ZEVs) and autonomous vehicles (AVs) are likely to be **among the most significant technological changes in the upcoming decades**
- These are emerging technologies, which will not only have significant impacts on travel behaviour and road network operations over the medium to long term, but also **will fundamentally change approaches to where Australians live and work and spend their leisure time**
- However, these potential benefits will be a function of the service model used (private ownership or shared use) and the transition path to full AVs (who gets the benefits)
- One aspect of this work is to consider the socio-economic aspects of ZEVs and AVs – **who will benefit, when and where and what economic activity could be spurred or spurned**
- To analyse the socio-economic impacts of ZEVs and AVs, government must understand what these new technologies can do for citizens **in terms of enhancing and improving access to services**, and also how different socio-economic groups may react to new technologies. This initial reaction must be overlaid against the direct consequences of the introduction of ZEVs and AVs in terms of **changes to employment and industry structure**
- Understanding these two socio-economic effects will enable the Victorian government to identify key socio-economic issues and allow for ZEVs and AVs to achieve their potential as safe, efficient, and accessible transport options that improves the economy and sustainability of Victoria
- Also considers the infrastructure and policy responses that could promote ownership models, technology choices, and uptake rates that maximise the benefits of this new technology

Today's presentation

Agenda

Equity and access to services

How the introduction of ZEVs and AVs will affect equity for different sociodemographic groups in terms of their access to critical infrastructure and services

Employment risks and opportunities

Which jobs will be most at risk, what number of jobs are at risk, and how might the economy respond to these changes

Infrastructure and policy response

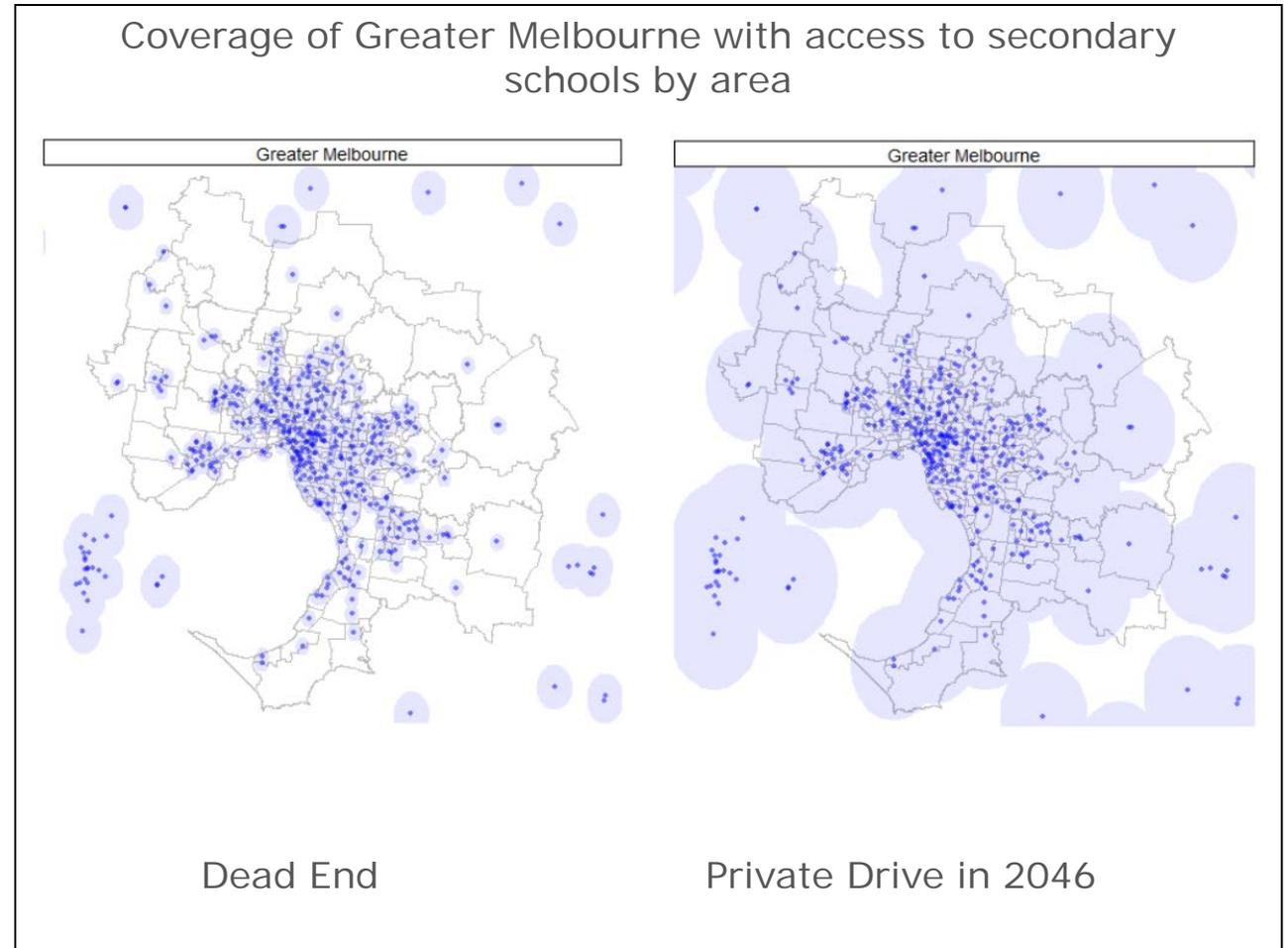
Identification of a number of focus areas for infrastructure investment and government policy to manage the socio-economic impacts of the widespread adoption of ZEVs and AVs

Equity and access to services

Defining accessibility

The ability to reach opportunities

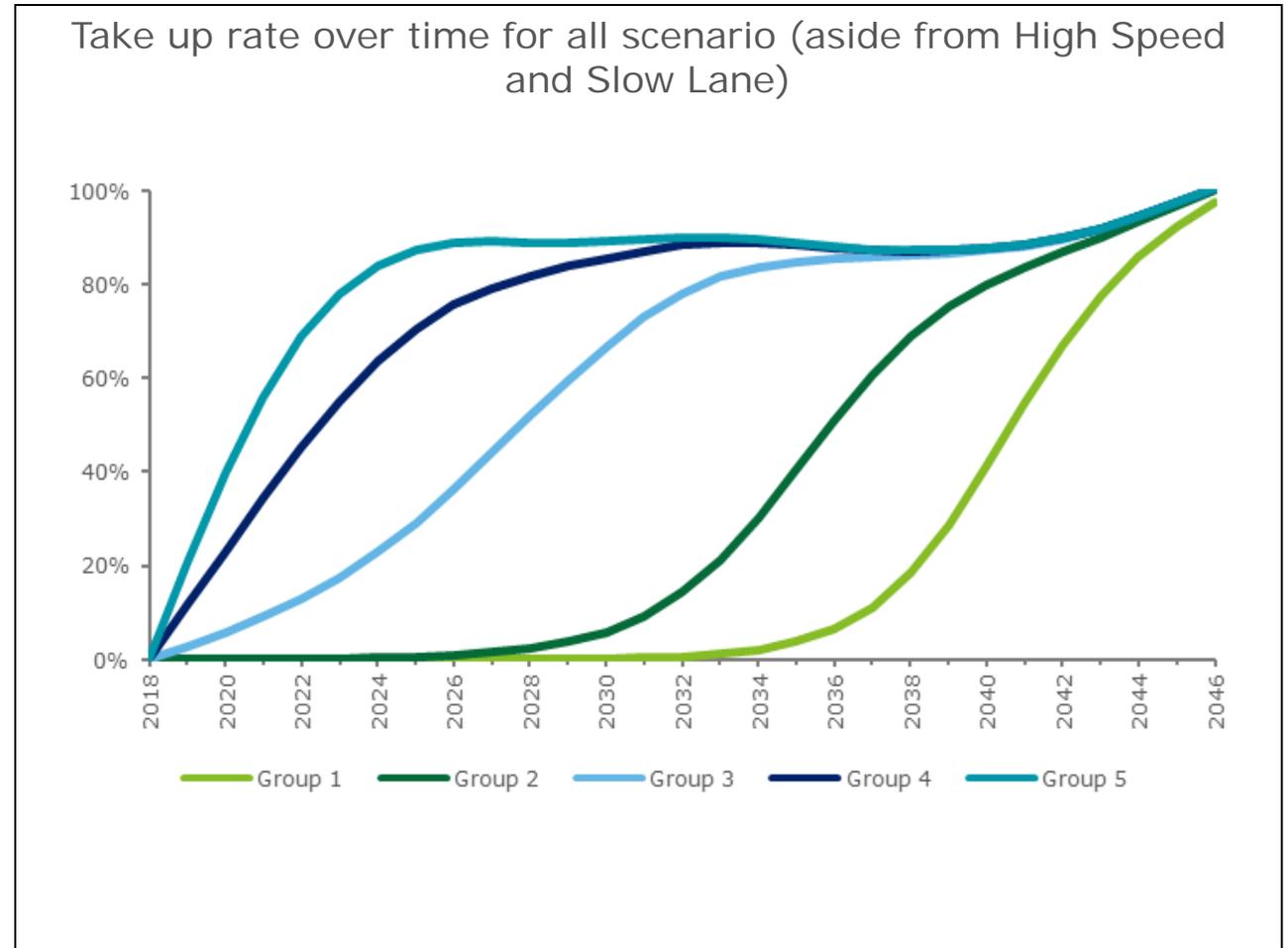
- Created an access to services measure:
 - Estimate the maximum distances people are willing to travel for different trip purposes
 - For each scenario, the size of the catchment areas by SA2 at the end state of the scenarios was estimated
- The measure provides an indication of the level of access to services and opportunities for residents in Victoria under different scenarios over time.
- It included:
 - Public transport (train and tram stations)
 - Education (primary and secondary schools)
 - Healthcare (hospitals)
 - Employment, commercial areas and recreation facilities (Plan Melbourne activity centres and significant urban areas)



Take up rates by income groups

Not everyone will adopt innovation at the same time

- To compare the changes in access to services, the likely adoption rate of the vehicles under each of the scenarios over time was modelled
- The literature review found various factors affecting the adoption rates of ZEVs, AVs, Dynamic Ride Sharing or car sharing services
 - Overall, it was found that the level of education, income and concern for the environment are significant positive factors related to preferences for adoption or actual adoption
- Income was chosen as it captures both the consumer dependent aspects of adoption (preference of high-income individuals), but also partially captures the vehicle dependent aspects (ability of high-income individuals to buy these vehicles if there is a price premium)
- The full range of ABS income groups were grouped into five categories
- Assumed a linear take up in the overall population, with take up starting initially in 2019



Effective take up in 2031

Effective distance travelled by trip purpose and average incomes

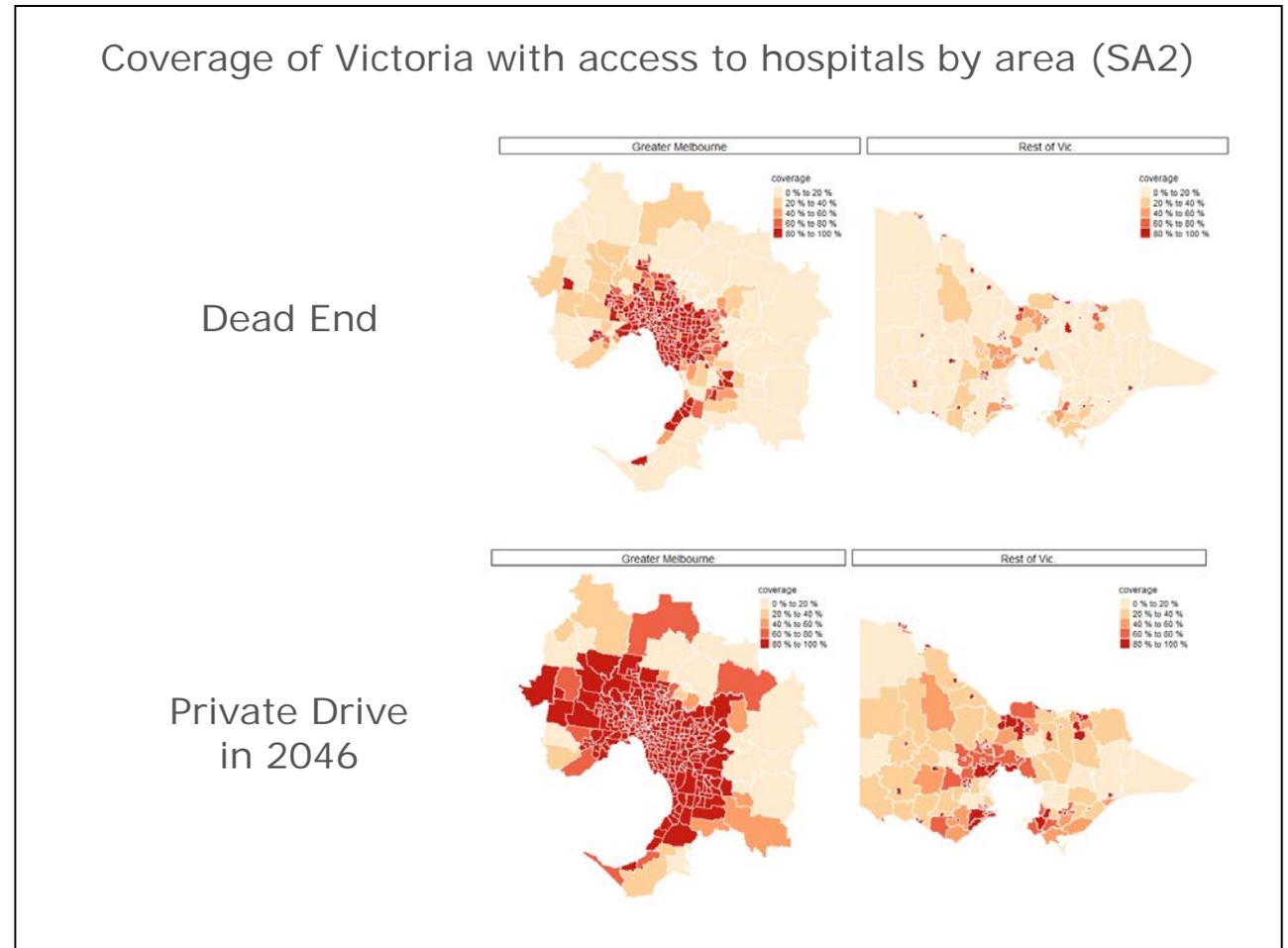
- In 2031, as higher income individuals are expected to adopt new vehicle technology earlier than others, there is some variation in acceptable travel distances
- This is shown by the vertical spread for each scenario (aside from High Speed and Dead End)
 - At the top of the spread are SA2s with high levels of income, while at the bottom are SA2s with low levels of income
 - There is no spread in the effective distances individuals are willing to travel under High Speed in 2031 as all Victorians have transitioned to these new vehicles
 - Discrepancy in effective travel distances (i.e., the maximum trip distance individuals are prepared to accept) is expected to be most severe in Greater Melbourne under Private Drive, Hydrogen Highway and Fleet Street. This is led by the take-up of AVs and subsequent reductions in MUTT and out-of-pocket costs of travel



Change in access to services

By SA2 area coverage

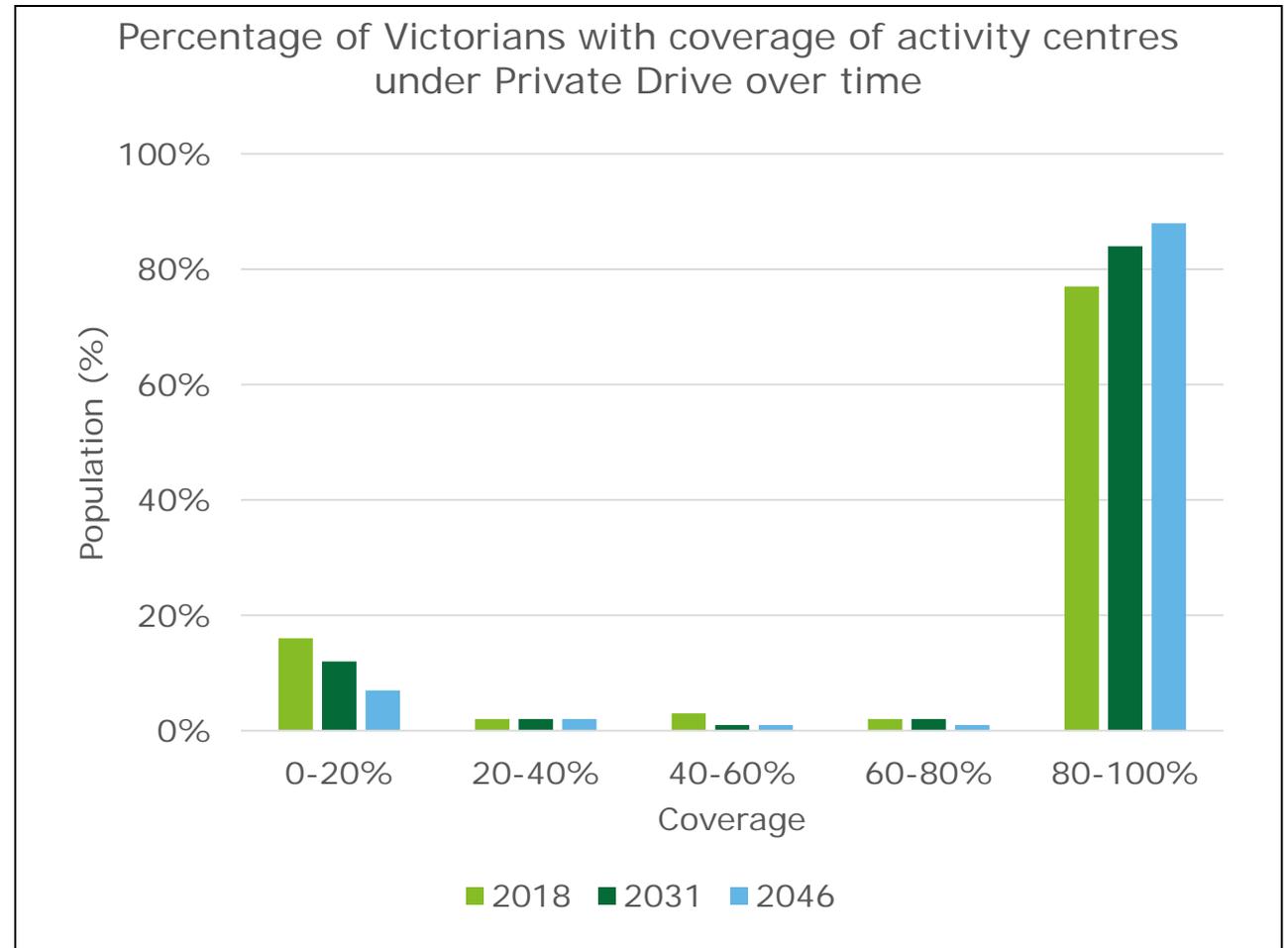
- Translates the change in distances travelled into changes in the access of critical services
- Changes in travel behaviour and catchment areas are likely to vary by different socioeconomic groups and access to ZEVs and AVs
 - Higher socio-economic areas are more likely to adopt ZEVs and AVs, and hence more quickly expand catchment areas and access to critical infrastructure
- For example, while there is currently reasonable coverage for hospitals in some areas of Greater Melbourne, by 2046, the presence of private AVs results in more ubiquitous transport coverage in Greater Melbourne due to greatly reduced costs and increased willingness to travel
- Results for multiple types of critical infrastructure, across years and different scenarios are estimated



Overall increase in access to services by population

Across time and across scenarios

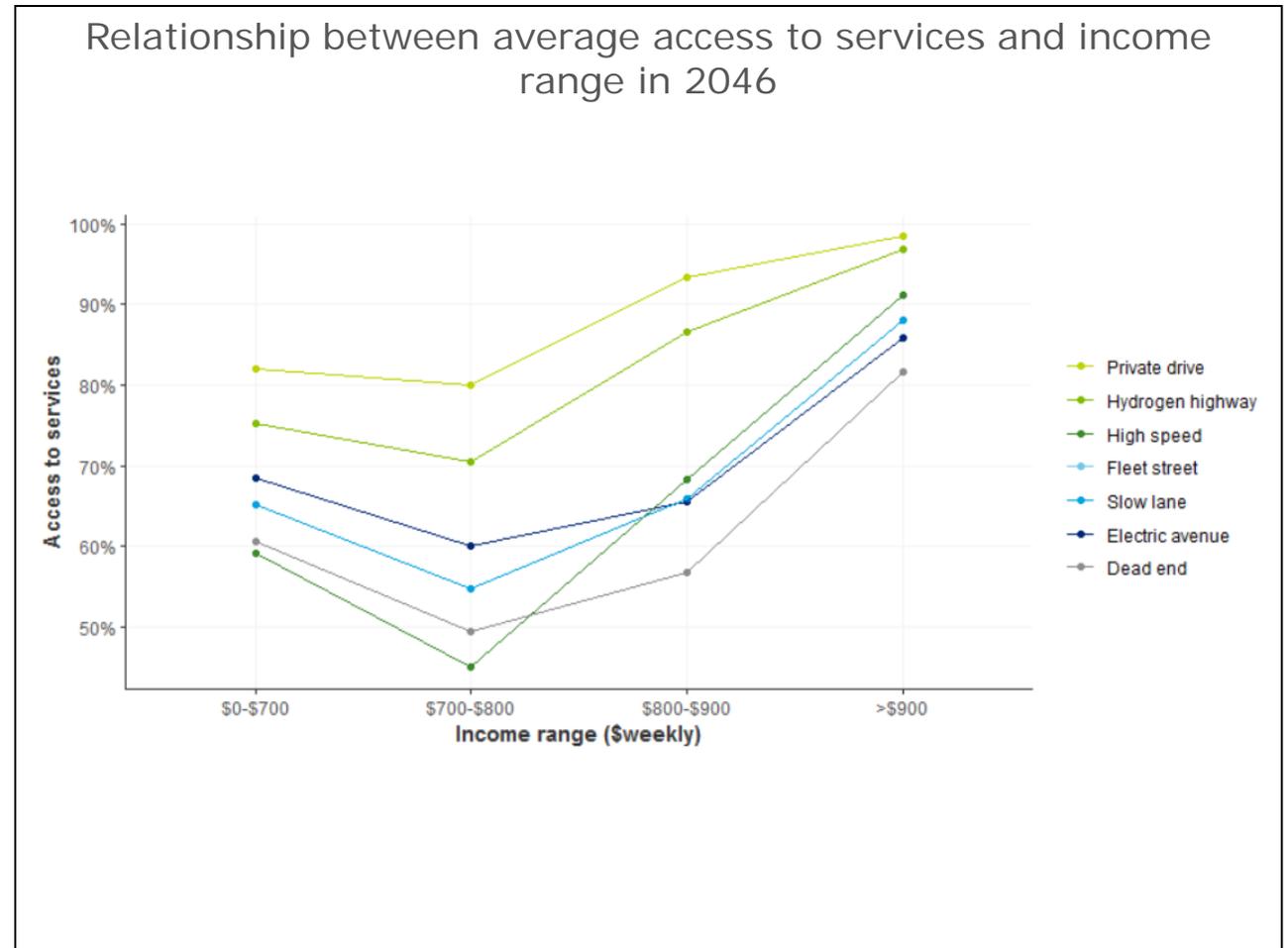
- Examining the distribution of the population coverage over time reveals insights into what happens to individuals with low levels of coverage
- The gradual improvement in overall access to services is shown – comparing the initial distribution, a midpoint, and a full adoption scenario
- In 2018, 77% of Victorians have 80-100% access to activity centres
- This increased to 84% in 2031 after the introduction of ZEVs and AVs, and then 88% after full adoption in 2046
- Notably 7% of Victorians in 2046 still have a relatively low access of 0-20% coverage to activity centres, representing a material number of residents



Access to services outcomes by income group

How improvements in coverage are distributed across income groups

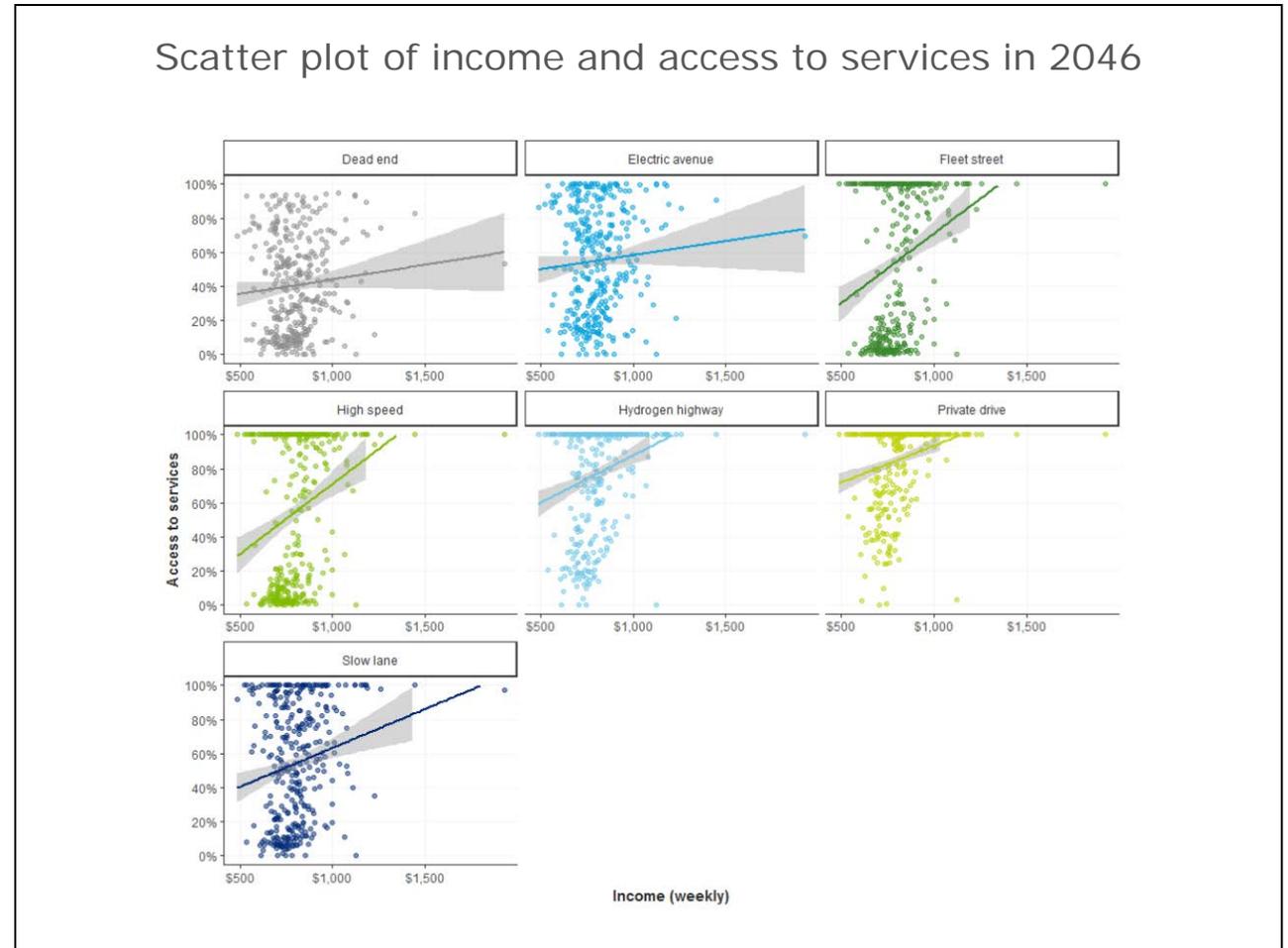
- Examines the relationship between income and access to key services to analyse how improvements in coverage are distributed across income groups
- The largest change in access to services occurs in the \$700-800 group, which is also the group with the lowest initial access to services
- In contrast the income group of more than \$900 receive the smallest marginal benefits, in part due to their very high initial levels of access to services
- Notably, these results suggest that the Private Drive results in not only the largest improvement in access to services by 2046, but also the most equalised access to services in terms of narrowing the gaps between income groups



Access to services outcomes by income group

Relationship between income and access to services under different scenarios

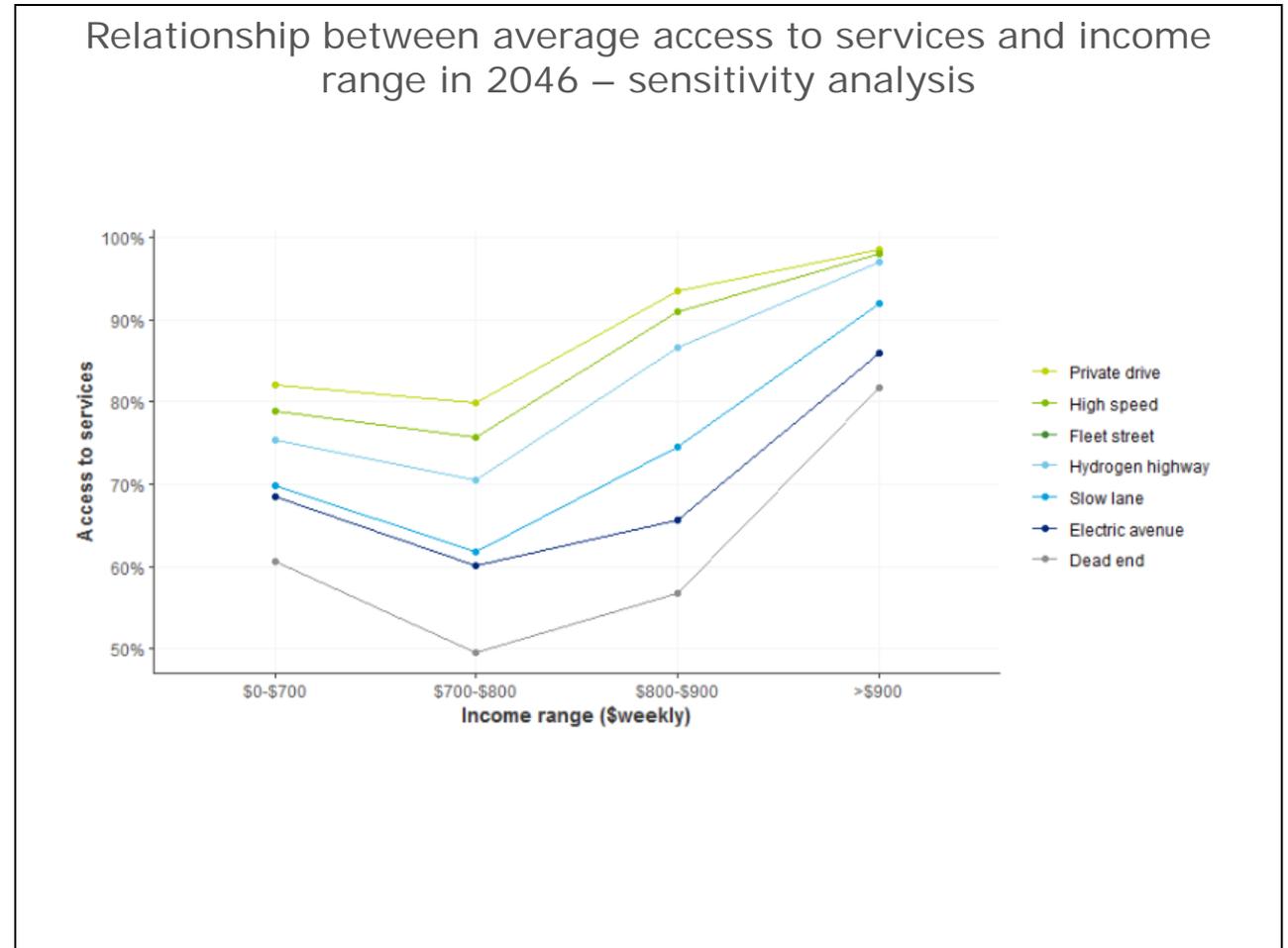
- A regression was used to more precisely measure the correlation between income and access to services
- Filtered out areas with high initial access in order to isolate areas with lower levels of initial coverage
- This regression indicates that, under the Dead End scenario, a \$100 increase in the average weekly income of an SA2 area is correlated with a 1.71% increase in average access to services (not statistically significant at the 10% significance level)
- In this regression, Fleet Street and High Speed revealed the largest relationship between access to services and average weekly income
 - A \$100 increase in average weekly incomes was correlated with an 8% increase in average access to services (statistically significant at the 1% level)



Sensitivity analysis

Alternative policy option of a subscription service

- This subscription sensitivity analysis has implications for the Fleet Street, Slow Lane and High Speed scenarios
- Under a subscription approach, both the initial flag fall and ongoing travel costs are lower - the subscription fee is used to reduce the per journey costs for the passenger - show significant increases in the effective travel distance per trip
- By 2046, High Speed and Fleet Street now exceed Hydrogen Highway in terms of effective travel distance and Slow Lane exceeds Electric Avenue. These results are in contrast to those in the main results
- Comparing these findings to the main results indicates that there is both an upward shift in the level of accessibility as well as a reduction in the slope of the relationship between accessibility and income

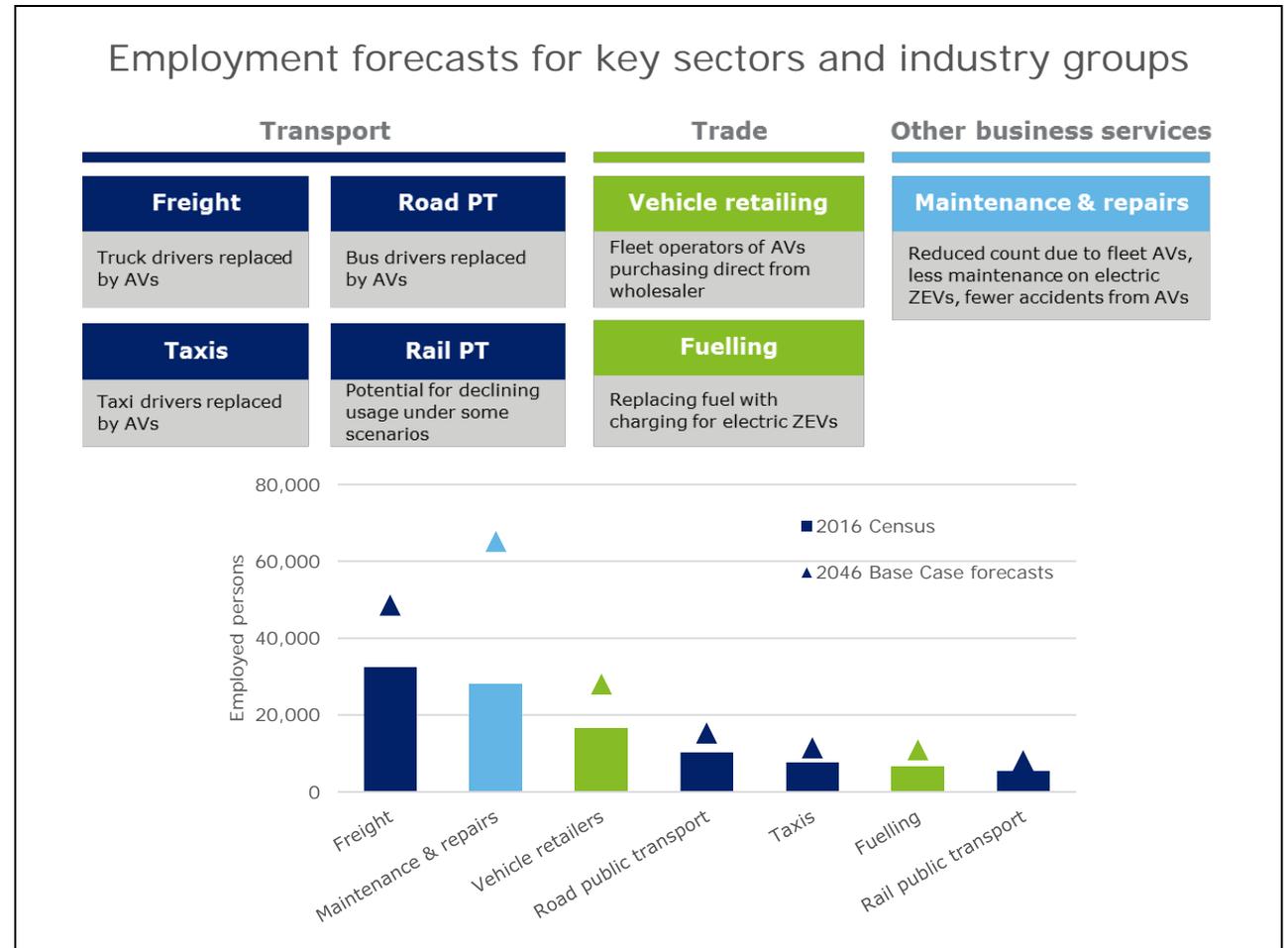


Employment risks and opportunities

Key employment sectors

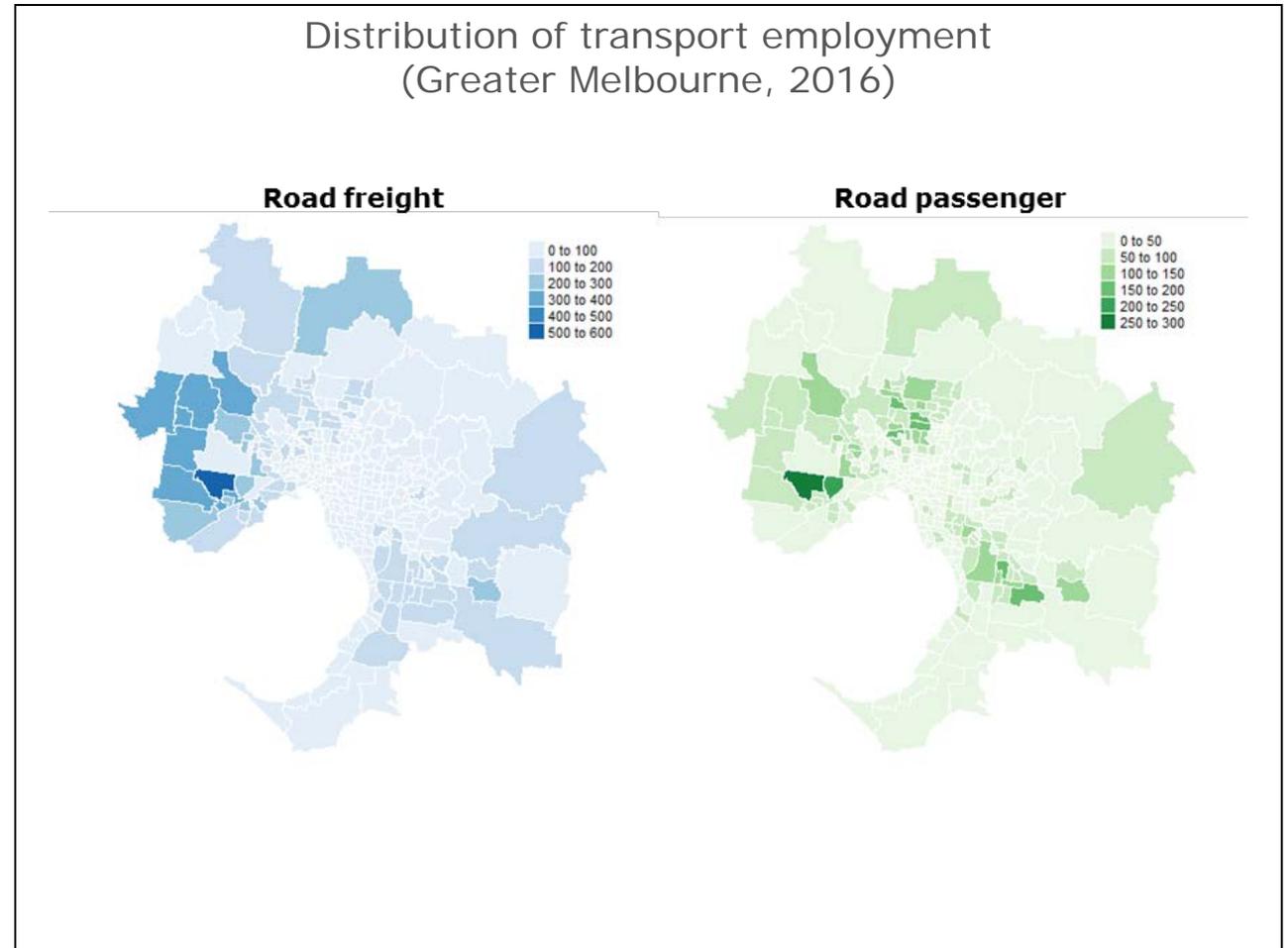
Current employment and how it relates to ZEVs and AVs

- Structurally profound – eliminating the need for certain skills, creating demand for new skills, and potentially fundamentally changing who does what, where and when for many parts of the workforce
- Focuses on seven key sectors across three broader industry groups, representing over 100,000 workers that are most likely to be directly affected by ZEVs and AVs
- Notably, there are likely to be further-reaching flow-on effects from the introduction and adoption of AVs and ZEVs
- While these secondary or ‘further down the line’ industries and sectors are very likely to be impacted, the effects are less certain and may instead involve an adjustment in the type of work, rather than displacement of workers and jobs
- The productivity benefits of moving to AVs and ZEVs are likely to be significant, and produce income gains well above a baseline case (without any transition to AVs and ZEVs). The broad based employment gains which would result from the expected productivity and income gains are also taken into account



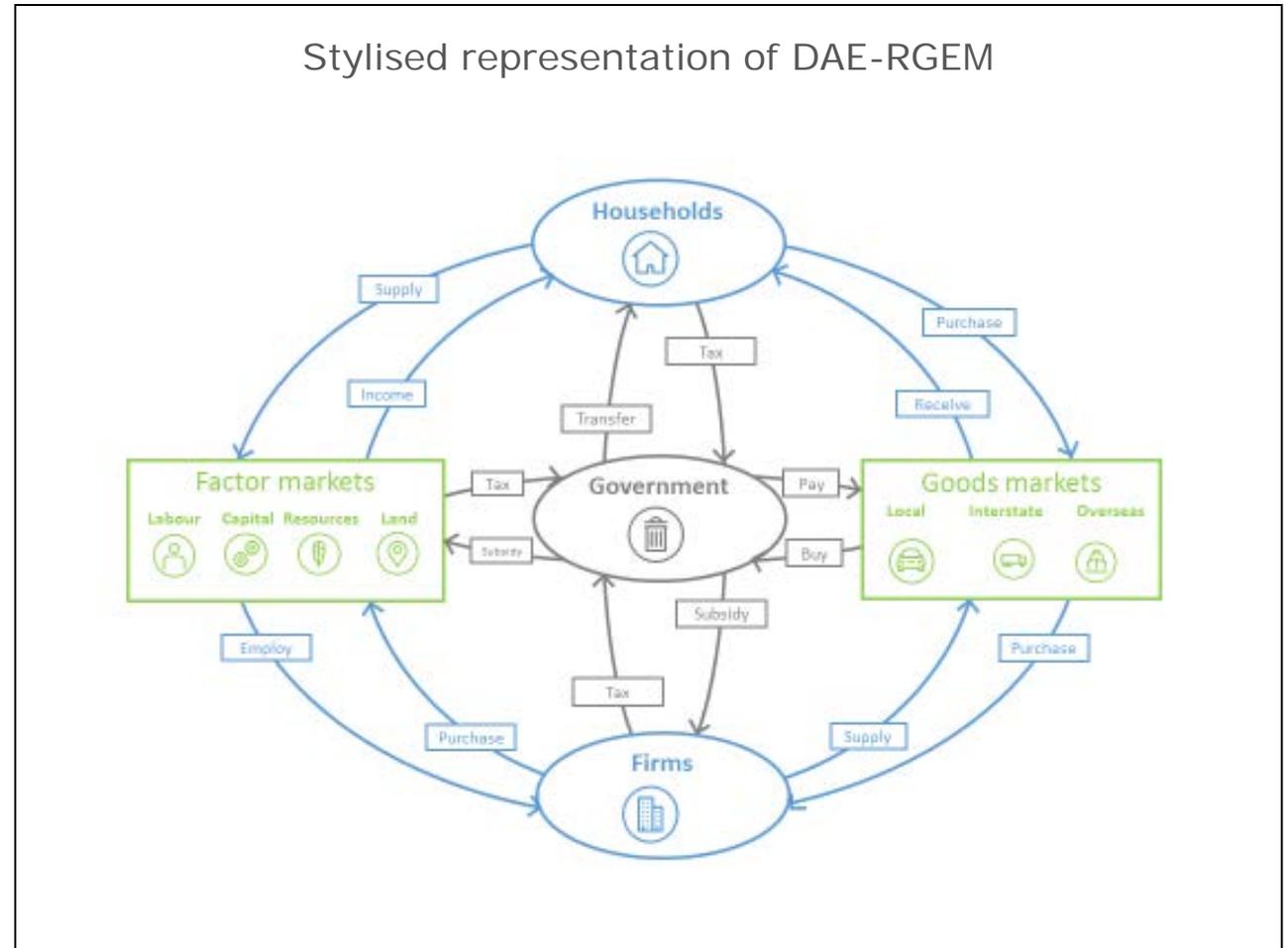
Geographic distribution of at-risk employment

- Not only do these key sectors represent a significant number of Victorian workers, but these workers are also more likely to be more concentrated in the northern and western Greater Melbourne regions
- Understanding regional clustering of occupations is important to the extent that the adoption of AVs and ZEVs may lead to pockets of unemployment, which can negatively impact communities and also increase the difficulty for recently unemployed workers to regain employment
- Notably, employment in the Transport industry is predominately within Greater Melbourne, with fewer workers for the rest of Victoria and less clear employment patterns (i.e. no strong regional clustering of employment)



Approach to CGE

- A Regional Computable General Equilibrium (CGE) model is the best-practice method available for capturing the different impacts that reverberate throughout the economy
- The reason for this is that it is able to explicitly account for behavioural response of consumers, firms, governments and foreigners while evaluating the impacts of a given policy change
- At the same time, it observes resource constraints meaning that the estimated economic impact which comes from a CGE model will account for 'crowding out' whereby increased activity will draw resources from other sectors
- This is especially important in the context of modelling small regional economies where key sectors account for a major share of output and thus changes in these sectors' activity levels will have large ramifications within the region



Direct impact on employment of ZEVs and AVs

- At a high level, these workforce effects can be described by four forces:
 1. Autonomous technology removing the need for human drivers
 2. Autonomous technology prompting a change in ownership structures from private to fleet operators
 3. Autonomous technology changing the way people commute and use public transport
 4. Electric vehicle technology and engines displacing traditional combustion engines
- While these forces are expected to provide significant positive benefit to the overall Victorian economy and society (as discussed later), for the key sectors of interests, the workforce impacts are likely to be negative

Aggregated employment shocks by industry

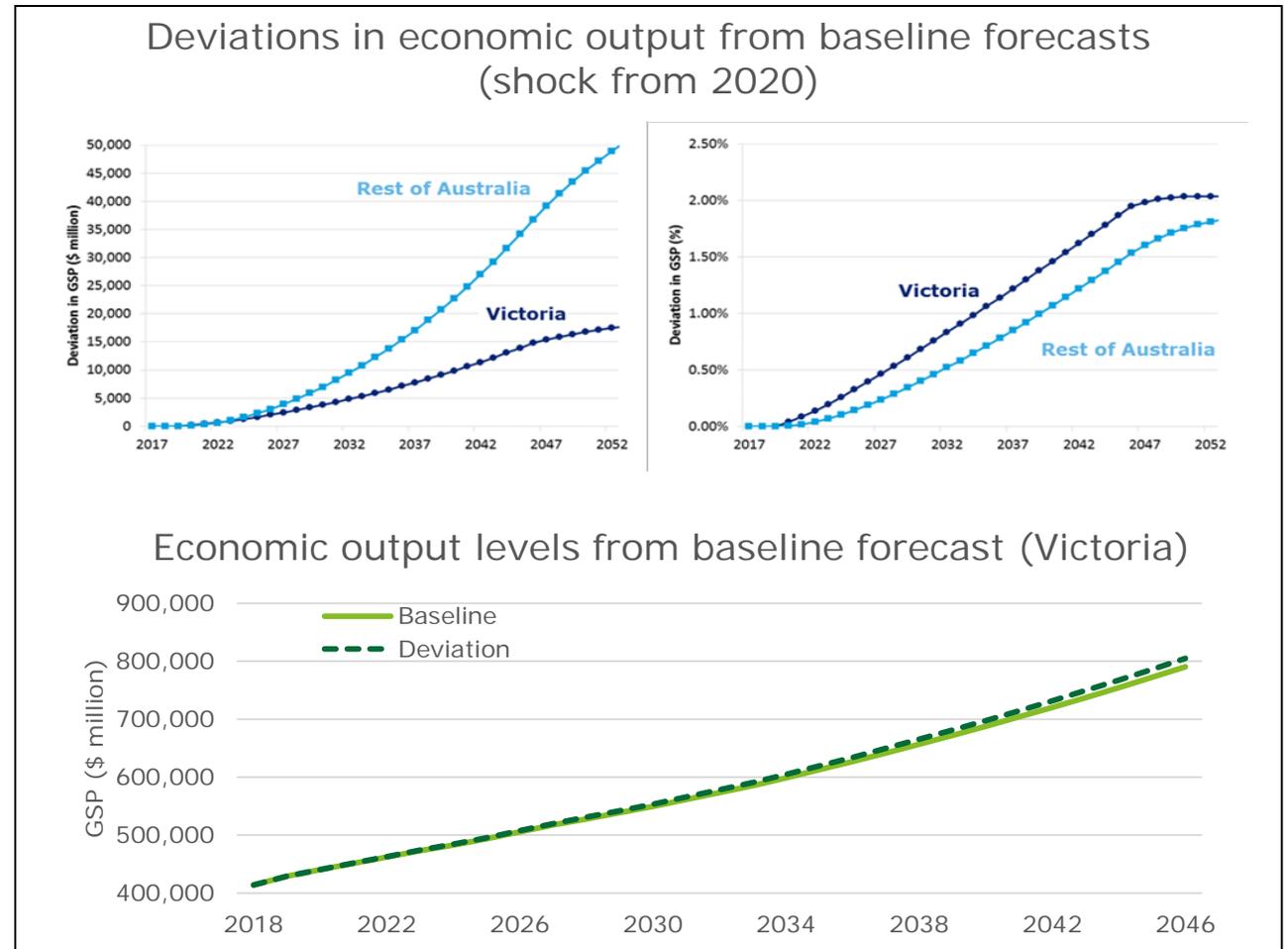
Future employment shocks (2046, 2031)				
Scenario	Transport	Other business services	Trade	Subtotal
Total employment forecast	169,524	1,046,188	937,277	2,152,988
1 Electric Avenue	0	-16,292	-10,931	-27,224
2 Private Drive	-89,761	0	-10,931	-100,693
3 Fleet Street	-89,761	-52,135	-38,967	-180,863
4 Hydrogen Highway	-89,761	20,854	0	-68,907
5 Slow Lane	-44,881	-28,023	-19,483	-92,387
6 High Speed[^]	-75,425	-38,397	-33,023	-146,845

Source: ABS Census 2016, Deloitte Access Economics 2015. [^]Employment shocks for 'High Speed' are calculated using 2031 employment forecasts.

Flow on employment effects

Deviations in economic output and economic output levels

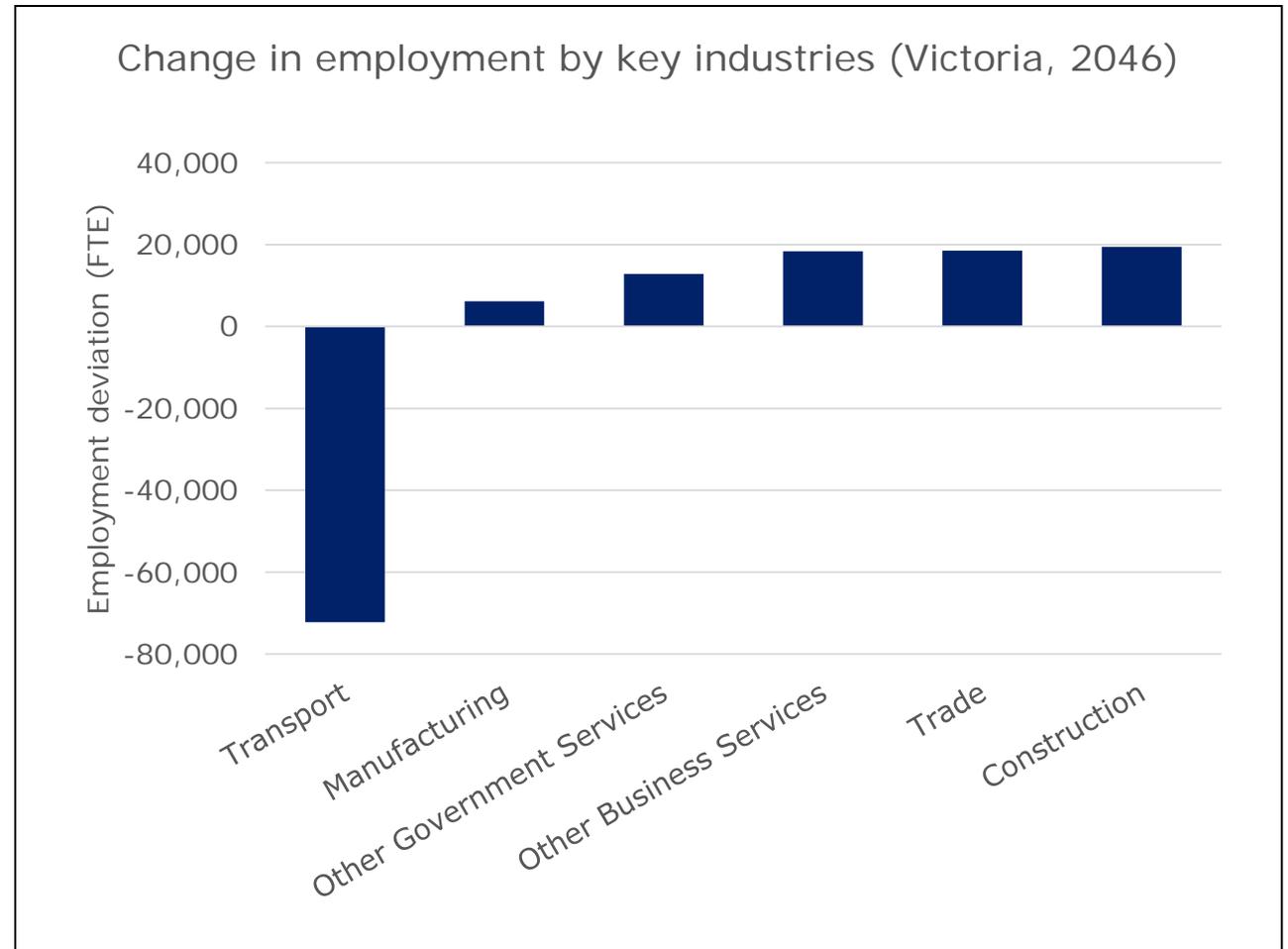
- While employment declines for Transport, the technological advancements and productivity gains result in higher GDP output (compared to a future baseline) for the overall economy for Private Drive, Fleet Street and Hydrogen Highway scenarios
- These productivity gains have compounding effects which result in increasing GDP growth
- Productivity improvements reflect the economy's ability to produce greater outputs from the same set of inputs
- By 2046, output in Victoria is modelled to be \$14.9 billion higher (2.0%), while output for the rest of Australia is \$36.8 billion higher (1.5%)
- There are no material changes to the composition of output, i.e. the proportion of economic activity allocated to each industry, as the Transport industry (which initiates the shock) only comprises around 3% of total value added economic activity



Flow on employment effects

Employment and labour

- As large numbers of Transport workers are displaced, many of these workers will re-engage in other industries
- A large loss in roles for the Transport industry – 72,200
- This is more than offset by positive employment growth of 83,700, predominately across Construction, Trade and Other Business Services
- Overall, this suggests that the introduction of ZEVs and AVs will be a net employment benefit of 11,500 jobs in Victoria



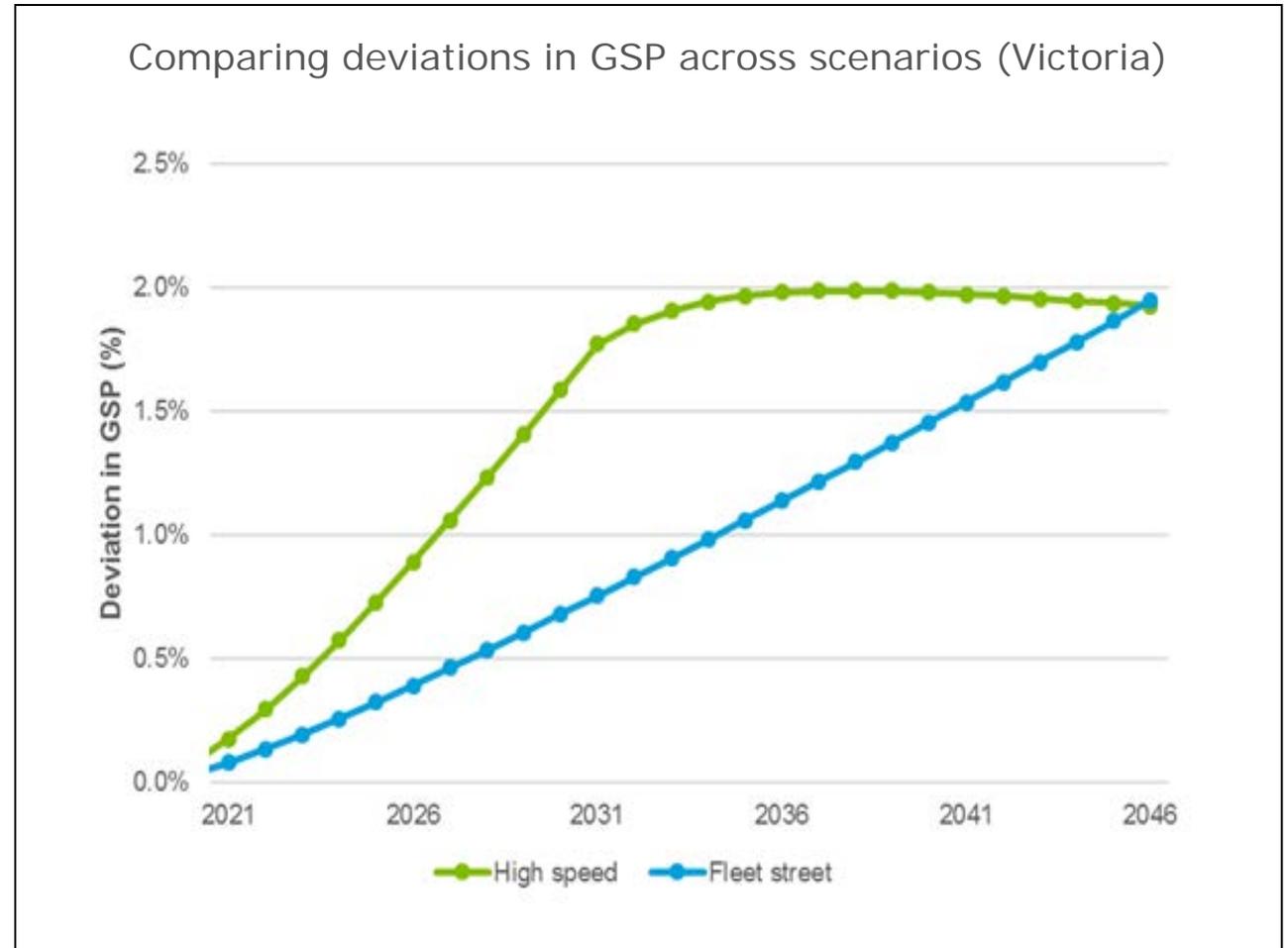
Flow on employment effects

Investment, capital, exports and imports

- Increasing productivity of capital induces the substitution of labour for capital, as the returns to capital increase. This draws in investment to build the capital stock of the economy
 - this is clearly identified in the modelling by the **almost doubling of capital expenditure for Transport**
- Other industries also experience an increase in total capital due to technology spill overs
 - construction (5.7%) has the largest response likely due to the increasing capital and infrastructure requirements induced by a transition to **a more capital-intensive Transport industry**
- Although by 2046 these industries experience increasing capital expenditures, during the initial take-up there are declines in capital spending for Agriculture, Manufacturing and Mining
 - this is likely due to the initial substitution of capital into the Transport industry
 - the larger negative shock for Mining, is likely due to the more capital-intensive structure, and hence greater responsiveness to investment opportunities
- Overall, **the net trade position is expected to worsen (i.e. imports increasing at a greater rate than exports)**
 - It is likely that this is driven by an inflow of investment into the country. This investment is to support the broad range of capital investments required to support the transition to ZEVs and AVs. Greater foreign investment exerts upwards pressure on the exchange rate, thus reducing the international competitiveness of exports throughout the economy and making imports relatively more appealing. Together these two effects result in a declining trade position overall
- Likewise, imports become comparatively more attractive and net trade position declines which also shows that this is primarily driven by a large increase in imports for Manufacturing (\$6 billion, 8.8% from base)
- Although small in absolute dollar terms, the net export position for Finance and Insurance services decreases by over 70%. This is likely due to increasing demand for financial services required to support the increase in capital and infrastructure spending that is modelled to occur

Impacts of a faster transition

- The trends and magnitudes of the economic impacts for this scenario are very similar to the earlier analysis, albeit occurring sooner
- There is a faster growth pattern for High Speed, which plateaus, allowing for the Fleet Street scenario to catch up by 2046
- More broadly, this result is consistent for other economic indicators, that is, a similar change achieved sooner, but in the long run the change is consistent with the other scenarios
- Over the total period, there are greater cumulative benefits under High Speed, as this high positive change is achieved sooner and so generates benefits over a longer period of time
 - the cumulative GSP value over 2021-46 is \$29.6 billion higher for High Speed compared to Fleet Street (in net present value terms)



Infrastructure and policy response

Impacts on current plans

- Review finds that the majority of the relevant planning documents either focus on the impact of ZEVs and AVs on transport infrastructure or the impact of transport infrastructure on socio-economic issues, but rarely considers both together
- Overall, within the majority of the current and planned infrastructure projects, there seems to be a **gap in analysis of the impact of ZEVs and AVs on infrastructure and policy considered from a socio-economic perspective**
- Some key questions for government to consider before defining its role at the intersection of infrastructure, ZEVs and AVs and socio-economics are:
 - *How best to facilitate the conversation on the role of AVs?*
 - *How the definition of passenger transport will change?*
 - *How to position government to maximise real option values?*

Summary of major planning documents reviewed

Project	Organisation	Type	Impact of ZEVs and AVs?	Socio-economic issues?
Public transport	Public Transport Victoria	Current and planned construction		✓
Road investment (partially regional road)	VicRoads	Current and planned construction		✓
National priority projects	Infrastructure Australia	Current and planned construction		✓
National Policy Framework for Land Transport Technology	Department of Infrastructure, Regional Development and Cities	Framework and action plan	✓	
Trials and pilots	Intelligent Transport Systems Australia	List of current trials and pilots in Victoria	✓	
Victoria's 30-year infrastructure strategy	Infrastructure Victoria	Recommendations for future strategy	✓	✓

Governments' role in infrastructure and policy responses

- Facilitating the conversation on the role of AVs
- Changing the definition of passenger transport
- Proactively positioning for real option values, in particular:
 - Regulatory frameworks to ensure that passengers are safe and service provision is acceptable. This may include data transfers, collection and feedback systems, as well as minimum standards or accreditation
 - Standards and harmonisation of legal frameworks and practical applications, such as road signage and protocols
 - Physical investments in areas where early preparation may allow for significant benefits in the future, particularly for groups that may be disadvantaged in terms of take-up

Potential infrastructure options

These areas have been identified through consultation with Deloitte's global ZEV and AV practitioner network, including consultations with experts from China and Germany, and include:

1. Financial and regulatory support to strategically target charging infrastructure
2. Considerations of the potentially perverse impacts of autonomous-only vehicle lanes
3. Developing and improving intermodal and interchange options and facilities for enabling public transport
4. Supporting investment to enhance the value proposition in regional areas
5. Investing in infrastructure to facilitate greater communication AVs and existing transport

Summary

- The adoption of ZEVs and AVs has **benefits for access to services for many Victorians under most scenarios**
- With full adoption in 2046, on a state wide level, **Private Drive had the largest increase in average access to services**, followed by Hydrogen Highway, Electric Avenue, Slow Lane and then Fleet Street and High Speed
- There are groups of people who live in regions with 0% or very low access to key services, even with full adoption in 2046
- After removing areas with high current levels of access to critical infrastructure, there is **a clear positive relationship, between income and access to services in most scenarios**
- **Workers in the transport industry are most at-risk**, particularly those in freight, taxis and hire cars, and road public transport
- The key forces of change are **(1) automation replacing drivers, (2) fleet operations resulting in significantly fewer cars, (3) changing commuter behaviours, and (4) changes in the servicing of electric vehicles**
- How ZEV and AV technologies manifest will likely result in very different impacts for workers
- Notwithstanding these targeted loss of roles, CGE modelling suggests that in response to improvements in capital productivity, **the overall economy will grow faster and demand more workers in total**
- Governments have a number of opportunities to both facilitate these workers to transition into other industries, and also for Victoria to take advantage of these technological advancements
- This suggests that there is **a role for government to play in helping to manage inequality and socio-economic outcomes** where appropriate, and help ease the pains of transition in employment

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