Connecting Traveler Choice with Climate Outcomes

Innovative Greenhouse Gas Emissions Reduction Policies and Practices in the APEC Region through Traveler Behavioral Change

APEC Transportation Working Group

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List of Abbreviations and Acronyms

APEC	Asia-Pacific Economic Cooperation
BEV	Battery Electric Vehicle
CO_2	Carbon Dioxide
EU	European Union
EV	Electric Vehicle
GHG	Greenhouse Gas
HOV	High Occupancy Vehicle
ICEV	Internal Combustion Engine Vehicle
iMHZEV	Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles Program
iZEV	Incentives for Zero-Emission Vehicles Program
MaaS	Mobility-as-a-Service
MOD	Mobility on Demand
REV	Réseau Express Vélo
RPPS	Range-Based Parking Provision Standard
SOV	Single-Occupancy Vehicle
TDM	Travel Demand Management
TOD	Transit-Oriented Development
TSJ	Travel Smart Journeys Program
US	United States
VES	Vehicular Emissions Scheme
VMT	Vehicle Miles Traveled
ZEV	Zero Emission Vehicle

EXECUTIVE SUMMARY

The transportation sector is a large contributor to greenhouse gas (GHG) emissions. Changes in individual travel behavior, such as shifting away from single occupancy vehicles to public transportation or active modes (e.g., walking, biking, scootering) have the potential to significantly lower GHG emissions from transport. This research report examines tools, strategies and policies that enable travelers to make climate-smart decisions in how they consume transportation. This report also provides an overview of research that includes a literature review of recent developments in traveler behavior research as well as primary research on existing policies and practices in Asia-Pacific Economic Cooperation (APEC) economies, through surveys and interviews, to identify strategies economies can utilize to encourage impactful traveler behavioral changes.

The report pulls insights from APEC economies using a survey of eight primary questions. The research team conducted a literature review to inform the themes of the questions to address strategies that influence behavior. The survey was distributed through APEC delegates to all APEC economies. Ultimately, 14 government agencies completed the survey. The economies that provided completed surveys include: Australia; Canada; Chile; New Zealand; Philippines; Singapore; Chinese Taipei; Thailand; United States. Economies that had multiple agencies complete the survey include: Canada; New Zealand; the Philippines. These discussions resulted in further insight into their survey responses on policies and strategies to encourage travelers to use lower emission mode options.

Several economies noted that strategic land use planning is needed to support policies and projects aiming to reduce transportation related emissions. Respondents stated that planning should be based on high quality data to help inform decision-making. Land use changes to reduce emissions include the elimination of parking minimums, which makes it more cost effective for developers to build and allows for more variety in housing unit types. Land use planning also encourages densification within proximity of transit stations and corridors allowing for people to rely on transit or active transportation rather than single occupancy vehicles.

Economies discussed ways to support public transit to make it a viable choice for travelers over personal vehicles. This included ensuring that investments in transit supported high level of service for rail and buses regarding frequency and routes. It also includes increasing convenience for transit riders such as fare cards that can be used on any public transportation network. Economies also noted that their most effective transit hubs and routes were in corridors that had a high population density.

Active transportation, such as bicycle use or walking, and specific infrastructure supporting it played a significant role for economies. Many of the study participants had active transportation plans with multimodal goals integrated in their comprehensive plans to help justify infrastructure improvements supporting bike and pedestrian uses. A critical component to encouraging travelers to use active transportation as a means for travel is the availability of safe multimodal infrastructure like protected bike lanes.

Many of the economies that responded to the survey had policies to encourage electric vehicle ownership. These policies include incentives such as subsidies and investments in charging infrastructure as well as disincentives like restrictions on internal combustion vehicle purchases.

Additional research is needed to determine the effectiveness of the strategies economies mentioned in this report. Many of the programs and policies are new and data on their impacts is not available. This report concludes with a series of questions for future research to address traveler behavioral change impacts.

INTRODUCTION

This report provides an overview of the research conducted for the Promoting Innovative Greenhouse Gas Emissions Reduction Policies and Practices in the Asia-Pacific Economic Cooperation Region through the Traveler Behavioral Change project. The objective of the Traveler Behavioral Change project is to share knowledge to help economies better understand and implement traveler behavior changes that may result in the reduction of GHG emissions. Policies and practices highlighted in this report are highly relevant to APEC economies seeking to improve mobility options and support sustainable growth. This report contains high level takeaways from research conducted through a literature review, an online survey taken by public and private entities, and virtual discussions with several government agencies across APEC economies.

Overall, the objectives of this project are:

1. Conduct a literature review and interviews with economy stakeholder governments to identify traveler behavior changes that may reduce GHG emissions.
2. Identify practices that improve mobility options and support sustainable growth that can be used by decisionmakers to leverage mode shift for emissions reductions.
3. Facilitate knowledge sharing, including recommendations and best practices of APEC member economies that are employing strategies or tools that shift traveler behavior away from single occupancy vehicles to lower GHG emitting mobility options.

METHODOLOGY

The development of this report consists of a survey, discussions with select survey participants, and a literature review on changing traveler behavior with the purpose of reducing GHG emissions.

Literature review

The research team conducted a literature review on traveler behavior research using a web-based search engine and academic journal portals. The review explored three questions: how travelers make decisions about their travel, how travelers use different modes of transportation, and how travelers respond to changes in travel options and infrastructure. Information regarding these questions helped to inform the development of questions for the survey.

Survey process

The research team developed a survey with eight primary question themes, with some questions including one or two sub questions. Themes of the questions are represented in Table 1. The study team distributed the survey to all APEC economies by submitting it to their respective APEC delegates using the web tool Survey Monkey. The full list of survey questions is in the Appendix.

Table 1: Summary of survey questions provided to APEC economies.

Summary of Question Themes
1. Description of tools, strategies, or policies aimed to influence a change in individual travel behavior
2. Most bike and pedestrian friendly location
3. Highest ridership of public transportation (train, bus, etc.)
4. Disincentives like fees or tolling
5. Disincentives like restricted spaces (i.e., high occupancy lanes or Jakarta's car free day)
6. Land use considerations like housing development policies or parking minimums
7. Electrifying personal vehicles including tax incentives encouraging purchase of electric vehicles
8. Mobile applications (Mobility on Demand (MOD) / Mobility-as-a-Service (MaaS) platforms)

A total of 14 different APEC government agencies completed the survey. The economies representing these agencies include: Australia; Canada; Chile; New Zealand; the Philippines; Singapore; Chinese Taipei; Thailand; the United States. As mentioned previously, economies that had multiple agencies complete the survey include: Canada; New Zealand; the Philippines.

Discussions

The research team conducted additional virtual discussions with survey respondents using the Microsoft Teams platform to learn more about programs and policies highlighted in their survey responses. Those that participated in these discussions include:

- Australia Department of Infrastructure, Transport, Regional Development, and the Arts
- Canada Transport
- New Zealand Ministry of Housing and Urban Development
- New Zealand Ministry of Transportation
- Singapore Land Transport Authority
- Chinese Taipei Ministry of Transportation

LITERATURE REVIEW

The study team conducted a literature review exploring topics related to traveler behavior research. Topics included recent developments, barriers to changing traveler behavior, examples of traveler behavior changes that may result in GHG emission reductions, the benefits of sustainable travel choices for the travelers themselves, and the ways in which policymakers can leverage mobility or mode shift toward GHG emission reduction goals. The review highlights a variety of examples where governmental entities have implemented programs or policies to lower GHG emissions through traveler behavior change.

Literature research methodology

The purpose of the literature review was to better understand the implementation of traveler behavior changes resulting in GHG emission reductions. The literature scan was conducted using various search engines and academic journal portals including Google Scholar, the U.S. Department of Transportation National Transportation Library, JSTOR, Elsevier, and EBSCOhost. Key search terms included "travel behavior," "traveler behavior," "traveler decision making," "transportation decarbonization," "sustainable mobility," "sustainable transportation," "mode shift," and "mode choice." The academic domains in the resulting articles spanned behavioral psychology, public policy, transportation planning, and environmental science.

The resulting articles were reviewed and selected primarily from peer-reviewed academic publications and working papers. The process also included the review of non-scholarly sources such as mobility organization websites and reports. Articles were included if they addressed the concept of traveler behavior or interventions that have been implemented and/or tested for effectiveness. Articles with a primary focus on energy efficiency, renewable energy, or altering single-occupancy vehicles (SOV) to be more sustainable were generally excluded. All the selected articles and web reports were published in English, which excludes relevant findings in other languages. The findings, including policies, programs, and practices, were documented and organized thematically to answer the following research questions:

1. What is the current state of travel behavior research?
2. What changes in traveler behavior can benefit greenhouse gas emission reductions?
3. How can policymakers leverage mobility or mode shift toward this goal?

The following pages provide an overview of the findings from the literature review, including examples of effective interventions for reducing GHG emissions from transportation.

The state of traveler behavior research

Traveler behavior research seeks to explain how people make decisions about their travel, how they use different modes of transportation, and how they respond to changes to their travel options and infrastructure. Understanding traveler behavior means understanding how people move around, and in doing so, can lead to better designed transportation systems that better meet community needs.

While mode choice is a large part of this research, traveler decision-making processes also include whether to make a trip, the choice of route, the departure time, and the specific destination. Factors like cost, convenience, travel time, and environmental concerns all influence decisions to use a given mode of transportation. These travel decisions can be considered "short-term," while middle and longer-term decisions include whether the individual owns a car or their geographic choice of where to live. Short-term decision-making, such as daily trip planning, typically involves only a few choices. Therefore, policymakers can determine an optimal number of choices for users to choose from given the nature of travel decision.

Other focus areas of current travel behavior research are travel demand, traveler behavior modeling, and technology. With travel demand, changes in the built environment will affect traveler behavior, such as the availability of new transportation options (e.g., increased frequency or new modes of transportation on a given route) or changes in land use patterns. Modeling allows policymakers and transportation planners to simulate and thus plan for behavior in different travel scenarios, allowing prediction of impacts of different policies and investments. With emerging technologies, researchers are exploring the impacts on traveler behavior as well as the possible integration into existing transportation networks.

Influencing travelers to choose a low GHG emissions option means increasing the utility of the proposed option relative to others.[i] This can be done through transportation policies, changes to the built environment, or persuading the individual traveler. For example, government entities can implement policies such as a congestion charge or a tax break for low emission vehicles. Governments can make physical changes by investing in the transportation layout and design, including the variety of transportation available, its location, and its accessibility. On the demand side, individuals can be influenced through soft measures and choice architecture to make voluntary changes to sustainable travel alternatives.[ii]

Figure 1: Avenue de Gaspé to Rue Chatelain is a six-kilometer route in Montreal, Canada connecting many institutions with a variety of protected bike lanes.
Source: City of Montreal

Choice architecture is a set of tools or strategies that can change the decisions of an individuals by altering the way choices are presented to the decision maker, without altering the assortment of the choices or their prices.[iii] This is done by framing context around decisions. For instance, if a mobile application for coordinating transportation trips framed the context of commuting options like driving or public transit with how much each option would contribute to the carbon footprint, then users would see their impact and may alter their decision. This mobile application would be an example of applying choice architecture.

Recent research is shifting our understanding of traveler behavior in several ways. For one, the COVID-19 pandemic continues to impact traveler behavior as many individuals changed their commute (by length, time, or frequency), reduced their overall travel, and shifted to working from home.[iv,v]

Additionally, new research using extremely large complex data sets and machine learning has allowed researchers to analyze large datasets and conduct metanalyses of existing research to better understand and model traveler behavior.[vi]

Researchers continue to examine how technology can be leveraged and integrated into existing transportation systems. For example, shared mobility services are being widely explored and applied, and current research seeks to understand the impact of shared mobility services on car ownership, public transit use, and active transportation.[vii,viii]

Finally, recent transportation research uses insights from psychology, and these insights were found to be the focus area most central to our research questions. This research seeks to understand traveler behavior to "nudge" travelers to make more sustainable travel choices.[ix,x]

Traveler behavior changes that benefit GHG reductions

To generate GHG emission reductions, a traveler can choose more sustainable transportation options. Choosing more sustainable options could include trip suppression, mode shift (including active transportation), carpooling and ridesharing, electrification, or trip manipulation. Additionally, there may be solutions to a need that do not require travel. Traveling less frequently, opting out of traveling, or meeting a need virtually are behavior changes that became very common during the COVID-19 pandemic.

As for mode shift, shifting from single occupancy vehicle to public transit is one of the most effective ways to reduce GHG emissions. Public transit is generally more fuel efficient than driving and can reduce the number of vehicles on the road. Shifting to active transportation is a zero-GHG emission producing mode and provides additional health benefits to the traveler. Carpooling and ridesharing leads to a reduction in GHG emissions simply by sharing a vehicle between at least two people. With electrification, the vehicle itself does not emit GHGs and can be powered from renewable energy sources. Finally, trips can be manipulated creatively, such as combining multiple activities, errands, or tasks into one trip to reduce the total number of trips taken (and thus reduce the GHG emissions). Notably, policymakers may also play a role in influencing individual traveler behavior by supporting programming or policies that enhance sustainable transportation options.

While the research questions that informed this literature review were primarily aimed toward the goal of GHG emission reductions, it is important to point out that "pro-environmental" choices are also "pro-healthy".[xi] Reducing GHG emissions and improving air quality leads to positive impacts on both the environment and public health. Again, low emission travel choices can also benefit the travelers themselves through their health and well-being.[xii] The physical activity of active transportation can reduce the risk of chronic diseases, improve mental health, and improve overall quality of life. Switching to public or active transportation can be less stressful than driving in heavy traffic, making for a more relaxed and enjoyable travel experience.[xiii] The traveler can enjoy socializing by meeting and interacting with others.[xiv,xv] Moreover, these alternative modes are often less expensive than owning, maintaining, and driving a personal vehicle, leading to a cost-savings benefit as well.

There are several barriers to changing traveler behavior. Behavior change is difficult to quantify, more value-laden than technological improvements, difficult to implement in models, and is generally slow to occur.[xvi] Policy and regulatory barriers, lack of infrastructure, social norms, convenience, habits, and cost all have a role. An example of policy barriers are zoning laws that encourage car-oriented development rather than more walkable designs. Without existing infrastructure that supports safe and sustainable travel, or poor design, a traveler may decline to bike, walk, or take public transit. With driving a car, a social norm that can carry prestige or status, people may be less inclined to try other modes of travel. Moreover, research shows that people value convenience and may not be willing to choose a travel option that is less convenient or less efficient.

Habits can be difficult to change, and people habitually use the travel patterns they know and are comfortable with, such as a daily routine. Cost also affects changing traveler behavior, as people generally travel in a way they can afford or that is simply less expensive than another option. Traveler behavior is a complex challenge, and it is important to address these barriers by developing policies, supporting programs, building infrastructure, and affecting social norms to enable a more sustainable travel environment.

How policymakers can influence traveler behavior for GHG emission reductions

Public policymakers and researchers have offered frameworks for interventions that effectively benefit GHG emission reductions. A "ladder of interventions" is one way to conceptualize the choices available for policymakers to intervene in influencing traveler behavior and reducing GHG

emissions.[xvii] At the very lowest rung of the ladder, policymakers can "do nothing" or not intervene. The next step up is to provide information and educate the traveler, thus enabling them to voluntarily change their behaviors. Climbing higher, the next three tiers progressively guide travelers, from changing their assumed or default option, to leveraging incentives, to wielding disincentives. The final two tiers of the ladder with the highest levels of intervention pertain to regulation, first by restricting and then by eliminating undesirable choices.

Another way to categorize these strategies is by hard and soft policy measures. Soft measures are those lower rungs, which are generally voluntary and involve education and incentives. Hard measures are typically regulatory in nature and are on the higher end of our imagined ladder. These measures may involve the imposition of penalties or requirements.[xviii]

Education or sharing information about the environmental impacts of transportation and the benefits of mode shift can be used as an intervention tool. These are communication-based tools for voluntary, non-coercive behavior change that complement infrastructure solutions.[xix] At the very least, information can increase awareness of environmental impacts and the benefits of sustainable travel. Building on that, behavior change campaigns or advocacy campaigns combine education and information with social marketing and "nudging" to promote preferred travel options. They may leverage public service announcements, advertising, or social media.

Going beyond campaigns, programs centered on information and education (such as transit orientation, travel feedback, personalized journey planning, or classes on safe city biking) can be used by policymakers. Nudging, a behavior change tool that attempts to influence individuals' choices through subtle, often unconscious cues, is a popular tool studied in the literature with mixed results. While one study found nudging to be a cost-effective, scalable way to promote desirable behavior and complement more traditional policy approaches, there are concerns about transparency, fairness, and unintended consequences. [xx,xxi] Moreover, policies and strategies involving nudges are not always successful. A 2018 review of studies on nudges found that 18 percent of interventions in a set of 116 studies were unsuccessful.[xxii] This number may even be higher given publication bias, which tends to encourage the publication of positive results.

While education and information may provide the incentive to change behavior, many other powerful tools motivate behavior change. Improvements to the existing environment can incentivize travelers to shift their travel mode. Increased funding for infrastructure and services, transit-oriented development, community walkability, subsidies to the cost of service, or other policies to make public transit more accessible and affordable can all make public transit more appealing. Technological improvements like payment integration, trip planning, and ridesharing or bike sharing apps, as well as their integration into the broader transportation network, can encourage mode shift to greener ways of traveling.[xxiii] In the workplace, organizations can encourage remote work and flexible work schedules as an incentive, which reduces both the need for travel and traffic congestion.

There is a long list of financial incentives like public transit passes, bike share memberships, reimbursements for carpooling expenses, and tax credits for carbon-friendly vehicles that can incentivize a shift in traveler behavior and lower the barrier to entry. Gamification and rewards programs are innovative influencers that often have a financial element and can motivate travelers to try something new. Using social norms, competitions, rewards or points, and recognition, these programs motivate travelers to reach certain goals (e.g., trips walked, miles biked, number of public transit trips, etc.). Goals or points are tracked and can be used for rewards, prizes, or discounts. Some examples are Bike to Work Day, National Walking Month, or Transportation Bingo. Studies show that gamification can change the behavior of travelers, promote sustainable travel modes, encourage safe driving, reduce carbon dioxide emissions, and reduce energy consumption.[xxiv]

Lastly, performance measures can be used both for travelers and by policymakers. By setting performance targets related to sustainable traveler behavior and tracking progress toward those targets, individuals and organizations are incentivized to change their travel behavior. It could be as simple as setting and measuring the percentage of trips taken by public or active transportation. This can create a feedback loop for continuous improvement, and performance management processes allow policymakers to demonstrate and provide evidence for the effectiveness of their policy decisions.

Figure 2: A high occupancy lane in the United States
Source: FHWA

Disincentives are more about discouraging travelers from undesirable choices. Many existing disincentives involve a financial consequence. For example, by making driving more expensive and less convenient through disincentives such as congestion pricing, individuals may be encouraged to switch to sustainable modes. In addition to congestion charges during peak travel times, parking fees, including higher ones in high-traffic areas, and carbon taxes on carbon emitting activities are other common examples of financial disincentives. Some disincentives that are not financial in nature could be considered restrictions. Transportation and travel demand management might involve geographic or temporal restrictions such as car free zones, high-occupancy vehicle (HOV) lanes, reduced speed limits, restricted vehicle access, reduced parking availability, and pedestrian zones that change the physical landscape and make it less convenient or desirable to travel by a single-occupancy vehicle (SOV). Lastly, information and marketing can be used as a disincentive. While not as common, public service announcements and advertising about the negative impacts of travel choices on public health or the environment can be used to publicly "shame" undesirable behavior, and advertising regarding climate-harming travel may influence traveler behavior. Other examples of interventions through restriction or elimination include fuel efficiency standards and emissions regulations.

Effectiveness of interventions

The effectiveness of traveler behavior change policies and programs depends on many factors.[xxv] The local context, the target audience, and the specific intervention will all affect a policy or program's success. While "hard" policy measures may be more effective at achieving greenhouse gas emission reductions, they can also be more politically contentious and difficult to implement. "Soft" policy measures, on the other hand, may be more politically palatable and easier to implement, but they may not be as effective at achieving large-scale behavior change. Ultimately, a mix of both hard and soft policy measures may be necessary to achieve meaningful reductions in GHG emissions from transportation. According to Piras et al (2022), the greatest impact comes from a combination of multiple interventions that are tailored to the specific needs and characteristics of the target community and local context.[xxvi] In their study, Piras et al (2022) analyze the combination of a hard intervention (introduction of a new light railway line in the choice set) and soft measure (personalized travel plans) to determine their effectiveness in changing people's travel behavior. Ultimately, people who lived along the light rail line and received and read their personalized travel plans were more likely to switch from using their car to using light rail. Policymakers can leverage rigorous evaluations of interventions for concrete evidence of the effect of specific policies and programs to justify wider implementation.

Public transit is known as an effective alternative to driving in terms of reducing GHG emissions. Increases in both the availability and quality of public transit can lead travelers to mode shift (or lead

to a reduction in SOV use and increase in public transit ridership). The success of public transit as an intervention will depend on quality of service, affordability, and the availability of alternative transportation options. Investing in active transportation infrastructure can be an effective intervention to promote sustainable transportation.

Studies have shown that this can increase walking and bicycling, reduce vehicle miles traveled (VMTs), and improve air quality.[xxvii] This intervention depends on the quality of the built environment, weather conditions, and the overall availability of safe and accessible active transportation infrastructure. Making driving less convenient and more expensive can reduce VMTs, increase mode shift toward sustainable options, and improve air quality. This intervention depends on the availability of non-SOV transportation options, the cost of implementing and enforcing the policies, and equity concerns. Finally, some have found nudging to be an effective method for behavioral change, but others say results are mixed. Nudging can increase awareness of sustainable options, change attitudes and perceptions about transportation, and promote mode shift. However, the quality and reach of the campaign, the target audience, and availability of alternative options all affect its effectiveness.

Examples of traveler behavior interventions

The following section provides a sample of innovative, promising, and/or successful examples of traveler behavior interventions implemented around the globe.

Gamification in Roberto, Italy (Kazhamiakin et al., 2015)

With private vehicles trips as high as 59 percent of those traveled and parking occupancy rates as high as 90 percent, the city center of Rovereto, Italy was overwhelmed with cars. In an effort to improve the mobility situation, the city added bike lanes and a bike sharing system and participated in a STREETLIFE EU Project experiment. Over the course of three phases and five weeks, participants first used the *Viaggia Roveretgoto* app for daily itinerary planning and logging travel behavior. The app then provided sustainable recommendations with ratings for various route options. In the final phase, three different point categories allowed users to collect points and badges for their travel choices. While a small, context-specific experiment, this pilot saw driving decrease by 13 percent while active and public transportation increased.[xxviii]

Performance measures in Stockholm, Sweden (Holmström and Hugosson, 2016)

Like other municipalities, the city of Stockholm, Sweden is using a series of interventions to promote sustainable transportation. They have set ambitious goals for sustainability including being fossil free by 2040. To track progress toward these goals and the effectiveness of their interventions, the city incorporates climate goals into all municipal operations, assigns clear responsibility to municipal committees, sets milestone targets, and tracks performance measures. With road traffic accounting for around 80 percent of climate emissions from transport, Stockholm aims to reduce energy use in the transportation sector by 228,000 tons CO_2.[xxix]

Pricing policies in London, England (Badstuber, 2018)

In 2003, Transport for London implemented a congestion charge that was applied to vehicles entering a designated zone in central London during peak hours on weekdays. Just three years later, traffic itself was reduced by 15 percent and congestion was reduced by 30 percent. In 2018, traffic volume in the zone was lowered by an additional 22.4 percent. The policy has been successful in reducing congestion, making the movement of goods and services more efficient, and improving bus services, and the funds generated were reinvested in public transportation. Some adjustments and exemptions have been made over time to mitigate the effect on lower-income drivers and businesses that rely on

road transportation, and the policy is expected to continue to evolve to new financial and logistical challenges.[xxx]

Parking restrictions in Oslo, Norway (Peters, 2019)

In 2015, the Oslo city council initiated a plan to make the city center car-free by 2019 as part of efforts to create a more pedestrian- and bike-friendly environment. The council made a series of changes, including increasing the number of bike lanes, offering more public transportation options including lowered ticket prices, and pedestrianizing major streets. Notably, the city removed over 700 parking spots and banned cars completely on some streets. Remaining spots and open streets are available for EV charging, disabled drivers, and delivery trucks. The result was a 10 percent increase in pedestrians over the prior year, and with the decrease in traffic the city saw a decrease in air and noise pollution.[xxxi]

Travel demand management (TDM) in Bellevue, Washington, United States (City of Bellevue, 2023)

The City of Bellevue's "Choose Your Way," program is part of a larger TDM that aims to improve mobility and reduce strain on the transportation system by encouraging alternative forms of transportation to driving alone. It offers outreach, useful information, and a variety of incentives when travelers "Choose Your Way" by bike, transit, walking, vanpool, carpool, and to school. Through the "Return to Travel" campaign rewards programs, users who log their trips can track their emission and cost savings, get personalized commute planning, find rideshare partners throughout the region, and become eligible for local and regional incentives, gift cards, and discounts. The logged trips allowed the city to tout users' gas savings of 129,678 gallons and a prevention of 2.45 million pounds of CO_2 being emitted in 2018.[xxxii]

Emissions restrictions in Madrid, Spain (Porter, 2018)

In an effort to reduce air pollution and traffic congestion, Madrid's city council implemented a policy banning high-polluting vehicles from its city center. The low emission zone restricts access to non-resident vehicles that don't meet emissions criteria, including older diesel and gasoline cars and motorcycles. The resulting decrease in traffic ranged from just over 5 percent to as high as 31.8 percent, depending on areas within the zone. This decrease in traffic benefited public transportation with an increase in bus highway travel speed. There are equity and supply chain concerns at the time of implementation. Some policy leaders expressed concerns that this policy would disproportionally affect elderly drivers who tend to own older vehicles and cannot afford to upgrade to vehicles that meet clean emission standards. Literature Review Conclusions. [xxxiii]

Literature review conclusions

This review explored the current state of traveler behavior research, the types of changes that can contribute to GHG emission reductions, and interventions at the disposal of policymakers. It provided an overview of the types of traveler behavior changes known to be beneficial, the benefits to the travelers themselves, as well as examples of promising or successful applications of those behavior changes through policy or program interventions. It also highlighted barriers to changing traveler behavior and gaps in the research. This review informed the development of survey questions for this study.

Overall, this literature review underscores the importance of investing in traveler behavior research and innovative interventions to promote sustainable transportation options and reduce GHG emissions. Traveler behavior is a complex, multi-faced topic. Policymakers and transportation planners can benefit from traveler behavior research to understand relevant influences, design interventions, and craft policies that encourage both sustainable and efficient traveler behavior.

Policymakers can build on the successes of existing interventions while working to address the unique needs and challenges of their communities.

TRAVELER BEHAVIOR STUDY RESPONSES

Among the survey responses received and interviews conducted, several common policy intervention areas emerged. These action areas include 1) land use, 2) transit, 3) active transportation, and 4) vehicle use and ownership. The areas of discussion described in each of these categories are innovative approaches to reducing greenhouse gas emissions from transportation, including approaches designed to result in behavior change.

Land use

Land use influences how people travel by shaping and regulating the built environment, which dictates the modes of transportation available and how they can be used. Land use policies determine the scale, intensity, and density of development. Likewise, these policies determine the mix of uses, such as residential, commercial, industrial, or other uses. Research indicates that compact developments with high density and intensities may reduce travel by single occupancy vehicle, which would result in a reduction in GHG emissions.[xxxiv]

Governments use land use policies and strategies to manage communities and resources and to influence the built environment. Land use decisions impact the environment, public health, economic activity, and social equality. Similar to what is seen in the general literature review research and throughout this report, APEC economies are using land use policies and strategies to influence greenhouse gas emissions in the transportation sector. Some examples of land use strategies include reductions or eliminations of minimum parking requirements for developments and reducing vehicle travel distances by encouraging compact zoning.

Shifting single passenger vehicle modes of transportation to alternate modes, such as bicycling or using electric scooters, can have significant impacts on traveler behavior, especially when linked to development densification with increased access and availability of these modes. Improvements to the built environment through effective land use planning can incentivize travelers to shift their travel to a mode that produces fewer GHG emissions.

From the survey responses, Canada emphasized the importance of mode shift especially when tied to increased densification and noted it was once of the most useful strategies impacting traveler behavior. Canada has plans in place for an integrated, and regional land use plan to promote modal shifts and encourage behavior toward sustainable travel modes. Singapore also recognized the impact of modal shift through the Land Transport Authority's campaign in making walking, cycling, and riding public transportation a way of life since 2008. Mode shift, prompted by land use policies and plans, was a significant driver of Singapore's steady increase in public transportation mode share.

Land use planning can support these strategies by improving location efficiency of daily destinations (increasing development density); increasing convenience of alternative travel modes (transit-oriented development and mode shift); and removing barriers for communities and individuals to reach daily destinations (zoning). The following sections highlight responses from the survey and discussions with participating APEC economies related to their land use strategies toward reduced transportation greenhouse gas emissions. The responses are categorized into the following sections:

- Integrated planning
- Compact urban densities and intensities
- Transit-oriented development
- Parking Requirements

Integrated planning

Integrated planning is a continuous systematic process intended to identify synergies between plans and the allocation of land uses and resources to balance economic, social, and environmental priorities. It encourages communities to critically assess their planning frameworks to align visions and objectives across different plans. These plans touch on a variety of topics, which regulate the built environment to include master or comprehensive plans, land use plans, long range transportation plans, alternative transportation plans, sustainability plans, community plans, etc. Integrated planning incorporates a common vision and set of objectives into these planning documents.

Several survey respondents acknowledge some form of integrated planning aimed at reducing GHG emissions through transportation planning objectives. These efforts ranged from changing land use policies to permitting greater densities and intensities around efficient transit centers to mapping out and prioritizing active transportation networks with a master plan. For instance, the City of Montreal is incorporating active transportation goals into their master plan to include the goal of having 50 percent of commuting trips as multimodal. This goal came from their bike network plan, Réseau express vélo (REV), which aims to expand the city's bike network to 200km by 2027. Much of the multimodal infrastructure is built around key destinations like schools and health care facilities. Integrated planning was necessary to determine not only if the network was feasible, but also in identifying points of interest and routes that people would use to commute. Integrated planning also helps to coordinate resources from different government agencies by identifying and prioritizing objectives. The City of Montreal's Master Plan incorporates goals from their active transportation planning and Express Bike Network program, which aims to have 50 percent of city community trips to be multimodal. The expansive program consists of 17 routes spanning 191 kilometers. The program is complex as it intertwines through many different neighborhoods. Having the goals and vision of program reflected in the master plan ensures that the network can seamlessly integrate with other City objectives.

Vancouver, Canada integrates transit land use planning with bike and pedestrian networks. The City works with the regional Metropolitan Planning Organization to plan for dense housing within a half mile radius of transit stations. The transit is very dependable with short headways and easy modal transfer points. Planners have designed a built environment that preferences transit and active modes for commuting, deprioritizing highways by transitioning them into smaller roads in and around the city. They aim to make transit and active modes more convenient and cheaper than vehicle use.

However, integrated planning can only coordinate resources by providing guidance. Goals and objectives identified in planning documents are enforced by zoning codes and statutes. In New Zealand, lawmakers replaced the domestic legislation regulating development with a new Resource Management law.[xxxv] The goal of the law is to add new housing units by allowing three story three-unit townhouses in almost any residentially zoned district within the five largest cities. The policy also permits six stories of building within walking distance of rapid transit stops. Many of the local councils responded to make use of these new zoning laws by revising their specific planning frameworks to meet these requirements. Increasing housing options closer to places of work and commerce will shorten the distance people need to travel and possibly encourage them to consider other convenient modes. This change may result in a reduction in personal vehicle trips and therefore emissions that would have come from them.[xxxvi,xxxvii]

Compact urban densities and intensities

New Zealand was not the only economy encouraging dense development to bring residents closer to work and places of interests. Australia; Canada; Singapore; and Chinese Taipei indicated that population densification was used as a lever to reduce GHG transportation emissions. There is a direct correlation between trends in population density and per capita emissions. Cities that develop with a greater population density experience a slower rate of growth in per capita CO2 emissions.[xxxviii,xxxix] Compact urban landscapes can reduce the transportation needs of residents by reducing vehicle miles or by providing viable alternatives to personal private transportation options.[xl] For instance, one study found that in metropolitan areas an increase in urban compactness could reduce vehicle mileage by 5 to 12 percent.[xli]

Canberra, Australia is deliberately designed to be efficient with their land use. It has a large network of active modal pathways connected to public transportation networks made safe with wide roads and protective barriers that allow for separation from bikes and pedestrians. The networks are designed so that people don't have to travel long distances to get to work or to city amenities. People with moderate to high incomes use active and public transportation more often, but the Cities' subsidized transit card pass helps lower income individuals use the transit system. There are also concessional loans available for people on fixed incomes to purchase electric vehicles and ebikes.

At the domestic level, Australia has developed a policy framework on how future public decisions are made, with a key section that supports the increase of urban area density and discourages clustering jobs and services in a singular urban center, such as a central business district. The goal of encouraging this type of land use change is to bring jobs closer to low-income areas and help those who spend a significant percentage of their incomes on transit. Part of this effort currently underway, through the Union of the Federal Government, aims to reduce commuting costs by making it easier for public workers to request virtual work.

The cities of Halifax and Calgary use a housing accelerator fund to promote moderate to high densities around transit stations. Transit-oriented development (TOD), discussed in the next section, is a type of development that links higher densities of mixed-use commercial and residential zones with transit amenities. This approach brings people closer to high quality transit options, such as bus and light rail, which connects them to work and points of interest. Which may reduce vehicle miles traveled or encourage modal shift. Several economies, to include Canada, cited TOD and density as a key factor to modal shift from personal vehicles to transit.

Transit-oriented development

Several APEC economies highlighted increasing development density and promoting zoning as strategies to support compact development leading to reduced GHG emissions. The strategies range from domestic level policy development to local zoning efforts and integration of active transportation modes. Five economies, Canada; New Zealand; Singapore Chinese Taipei, and the United States, included transit-oriented development, specifically, in their survey responses as a strategy to shift away from transportation GHG emissions. These economies,

Figure 3: Sendai Station in Sendai, Japan. Source: JICA

spread across the globe, provided different perspectives on contextual factors affecting development and support of transit-oriented development.

New Zealand has made domestic policy level efforts to increase housing density, particularly near transit centers, with mandates of allowing only a minimum of six story housing for new developments. As the central business district is already a compact, walkable area, the policy is geared toward increasing the presence of mass rapid transit in suburban areas with low-density single-family housing. Although the policy has been developed, local opposition from residents and homeownership groups has prevented government housing agencies from permitting any developments. Residents mentioned concerns of changing the neighborhood character and cultural desire for single family homes. Despite the pushback, a demand for denser housing also exists and the central government is continuing to promote this development outside of protective zoning areas, which preserves the local character.

As mentioned previously, the cities of Halifax and Calgary in Canada provide examples of zoning changes to promote density around transit stations. These cities made efforts to encourage densification and effective land use planning around communities, focusing on high-frequency transit corridor areas. The areas were also linked to active modes of transportation to encourage mode shift. The changes address a range of issues from climate change and housing affordability to the negative environmental effects of urban sprawl. Canada has also implemented an accelerator fund to promote density around stations and has strongly integrated housing with new transit.

Singapore and Chinese Taipei are both moving forward with ambitious master plans for transit-oriented development to reach a large segment of the public. Singapore's Land Transport Master Plan aims for a efficient, well-connected, and convenient transit system with MRT stations located within a 10-minute walk of 80 percent of households by 2040. Singapore has already identified transit priority corridors across all regions, which will integrate roads with bus lanes, wider footpaths, and dedicated or shared cycling paths.

Taipei City is also working toward integrating public transportation with housing development, especially in aging communities, through its Revision of the City's detailed Plan for Transit Oriented Development Permit Areas. The plan covers the area within 500 meters of public transit stations and supports various densification activities as well as integration of active transportation modes, such as bicycle transfer facilities, pedestrian-friendly spaces, and updates to metro entrances and exits. With this plan, developers can choose between providing public spaces or making financial contributions. This allows greater development flexibility and incentivized renovation and development around transit stations. Generally, outside of smaller and rural areas, newly constructed buildings in Taipei have a higher proportion of building floor area that is greater than 500 square meters.

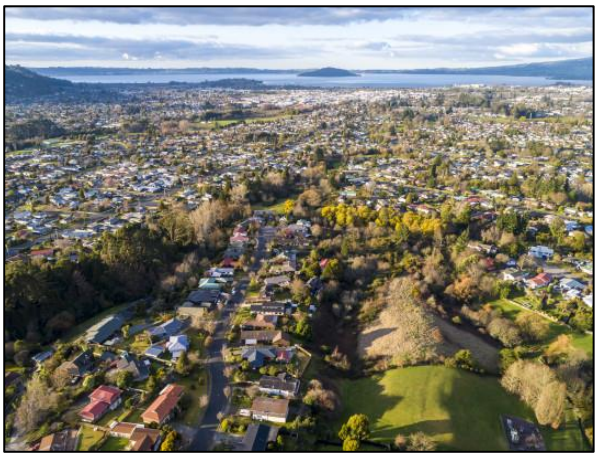

Figure 4: Suburban development in Ngongotahā, NZ
Source: New Zealand Ministry of Housing and Urban Development

Parking requirements

In many places developments are required by law to construct parking spots based on the size of the development. The size is typically measured by the number of residential units or the floor area ratio. Reducing or eliminating parking minimums may encourage developers to build fewer parking spaces with new developments potentially limiting the overall parking supply. Not only are there fewer

parking spaces, but the price of parking increases when the demand for parking is more than the supply, making driving a less desirable option. As discussed previously, a reduction in vehicles, and consequently vehicle miles driven, leads to fewer vehicle emissions, improved air quality, and creates more livable and sustainable communities.

Several economies reported that they reduced or eliminated parking minimums or are in the process of doing so. New Zealand's planning directive removed minimum parking rules from planning documents for 90 percent of the economy.[xlii] Since the directive was implemented in 2020, new developments have been including parking at an average rate of .5 spots per one unit of housing. The prior rate was one parking spot per one unit of housing. In Chinese Taipei, parking requirements in residential areas are dictated according to the specific local urban planning laws. If there are no regulations in place, then the provisions of the Building Technical Regulations are applied to planning designs. Under these laws there is no requirement to provide parking spaces for residential buildings with a building floor area of less than 500 square meters. Furthermore, local governments have the flexibility to adjust urban planning laws to accommodate the characteristics of specific areas by increasing or decreasing the number of required parking spaces.

Singapore uses a Range-Based Parking Provision Standards (RPPS) scheme that regulates parking supply based on density and access to public transportation. The scheme demarcates several geographical zones and prescribes a range for the number of parking lots that should be provided according to the type of development (i.e. commercial, retail) for each zone. For commercial developments in the city area, parking provisions are reduced by a range of 20 to 50 percent from earlier standards. For retail developments near MRT stations, parking provisions are reduced by up to 50 percent reduction from the earlier standards. For all other uses the reduction in parking provisions can be up to 20 percent.

In Canada, the cities of Vancouver and Edmonton removed parking minimums when research showed that they had an oversupply of parking with only fifty percent being used during peak hours. The City of Toronto removed minimum parking requirements, while also setting maximum parking standards. A cap on the number of parking spots per development is a further step in reducing the number of vehicles allowed in one place.

Transit

Public transit is an effective way to reduce GHG emissions compared to a single passenger vehicle through greater fuel efficiency and reduction in the number of vehicles on the road. As noted in the literature review, increased funding for infrastructure and services, TOD, community walkability, subsidies to the cost of service, or other policies can make public transit more accessible, affordable, and appealing.

APEC economies provided responses on various ways transit-related strategies encourage traveler behavior toward increased transit use, including in rural areas. Responses to the survey and interviews align with these strategies and are grouped into the following categories:

- Subsidies for Transit Fares
- Investments
- Transit Access
- Bus initiatives
- Rewards Programs and Campaigns

Subsidies for transit fares

Subsidizing transit fares can encourage transit ridership by making it more appealing and affordable for travelers. Economies can offer subsidized fares for all riders, as well as to specific groups, such as children, seniors, low-income groups, those with disabilities, frequent riders, or students. Increased

transit ridership can decrease vehicle miles traveled and be a lower GHG emission alternative to passenger vehicle use.

Five APEC economies noted the importance of subsidies in changing traveler behavior toward transit ridership. Both Canada and Singapore have implemented subsidies in the form of low-cost transit tickets. In one Canadian province, a transit ticket is set at a cost of CAD2 per passenger throughout the transit system. In Singapore, to keep fares affordable for riders, the government subsidizes all public transportation services by around SGD2 billion per year. These annual subsidies amount to more than SGD1 per journey. The government is expected to increase subsidies by another SGD300 million in 2024. In addition, following the implementation of a fare increase in December 2023, the Singapore Ministry of Transport offers SGD50 public transportation voucher for households with a monthly per-person income of SGD1,600 or less. The voucher can be used to top up fare cards or to purchase monthly passes.[xliii]

Other survey respondents reported that they implement discounts for certain disadvantaged demographic groups. New Zealand provides a Community Connect card for low-income earners and those with disabilities. The elderly and veteran populations receive discounts and free transportation fares at certain periods during the day and week, including weekends and public holidays. The Toronto Transit Commission, TransLink (Vancouver), OC Transpo (Ottawa), the Edmonton Transit Service, Brampton Transit, MiWay (Mississauga), Burlington Transit, and Oakville Transit in Canada all offer fare discounts for seniors, youth, persons with disabilities, and low-income earners.

Figure 5: Australian Public Transit Pass
Source: translink

In the Australian context, public transit and active transportation is used more often by higher income populations. To increase use of transit by lower income populations, Australia has developed a card for low-income riders to receive significant subsidies for bus ridership. Low-income populations can also receive concessional loans for e-bikes and electric vehicles with the low-income card. During off-peak times, users of the smart card system can receive 20 percent off transit fares.[xliv]

Public transportation fare subsidies have been implemented in Chinese Taipei for many years. In response to the net-zero transition policy, Chinese Taipei launched the Commuter Pass Program "TPASS" on 1 July 2023. The central government collaborated with local governments to initiate the program, which integrated resources from central and local to popularize its use. The program's pricing is fundamentally set within the range of 30-50 percent of the average daily commuting expenses people incur when travelling to work or to school via public transportation. With TPASS, individuals can enjoy unlimited rides within 30 days on various transportation modes, such as: metro, light rail, buses, trains, and shared bicycles. In some cities and counties, TPASS can even be used for ferry rides. The success of the subsidized monthly commuter card was demonstrated by a 9.3 percent growth in ridership in only a few months, according to statistics from the Highway Bureau.

Investments

Investment in public transportation is a significant step toward reducing greenhouse gas emissions both at central and local scales, as it provides the necessary funding and opportunities for transit ridership. Investments can include:

- planning, design, and construction of transit infrastructure
- enhancement of existing services and infrastructure
- resources, personnel, technology, and streamlining operations

At the central scale, Canada has made an average of CAD3 billion per year in public transportation investments available and more than CAD23.5 billion total since 2015. The central level investments in projects are implemented in communities at the local levels of government through a cost sharing structure. The approach is meant to be transformative for communities to receive stable support to expand transit systems. Permanent and consistent funding is key to ensuring challenges are addressed, especially in relation to increasing supply and affordability of housing, building sustainable communities, and addressing climate change.

Transit access

Providing convenient, efficient, affordable, and safe transit experiences for travelers has shown to be a useful strategy to increase transit ridership. Multiple APEC economies, including Australia; Canada; and Chinese Taipei have noted that increasing the availability and quality of public transit networks has been a successful strategy to increase use of transit as an alternative to vehicle transport.

Figure 6: One of Singapore's mass rapid trains pulling into a station.
Source: Singapore Land Transport Authority

Canada and Chinese Taipei noted in their surveys and discussions the benefits of improving services and frequency to facilitate transit ridership. In Canada, a high level of service, in terms of frequency and number of routes, as well as low headways, contribute to high ridership. The high utilization of public transit in Chinese Taipei can be attributed to proximity to stations, faster travel speeds, frequent services, and no need to transfer. In 2022, the utilization rate of the public transportation in Chinese Taipei was 14.3 percent. Among the 22 cities and counties, Taipei City had the highest utilization rate of public transportation at 37.2 percent, followed by Keelung City at 32.5 percent, and New Taipei City at 28.7 percent.

Chinese Taipei has also made efforts to simplify its complex bus network and develop systems to track ridership data to tailor travelers needs/demands for routes. The government is constructing five routes totaling 58.2 kilometers and 51 stations to produce a more comprehensive transit network. A restructuring of the bus system to include rapid transit services and support first and last-mile bus route connections has also been implemented to support network gaps. Future plans include the data analysis of passenger boarding real time data to understand travel demand and adjust routes accordingly.

Singapore's rail, bus, and road network serves over 7 million riders per day. Significant rail expansion efforts are being undertaken by Singapore to meet the needs of the current and growing commuting population. Plans are in place to expand the rail network to 360 kilometers by 2030, with a goal of connecting 80 percent of households within 10 minutes of a train station. In addition to expansion efforts, Singapore is putting efforts toward upgrades and innovation of rail as well as commuter facilities. [xlv]

Figure 7: One of Singapore's buses from their electric bus fleet
Source: Singapore Land Transit Authority

Smart cards can also be a way to streamline and simplify use of transit to improve traveler convenience. An example is the Go Card in Australia, which works across any public transportation network in Southeast Queensland, which includes 5 regions.[xlvi] The Go Card is an integrated transit fare payment system for the entire public transit network including bus, train, ferry, and tram. In place of the smart card, the transit system also allows riders to tap their credit cards to use the transit network with ease.

Bus initiatives

The survey responses pointed to bus initiatives making a difference in meeting travelers' needs, including in rural areas. The Chinese Taipei Ministry of Transportation and Communication has developed an initiative called the Happiness Bus Project (formerly Rural Demand Transit System), which provides ride-matching services to local non-profit organizations in rural areas or townships. The system matches idle vehicles (buses) and drivers with those in need through a ride reservation platform. To facilitate the project, the Ministry has modified regulations to allow a wider net of service providers, incorporated technologies to match riders with drivers, integrated resources, and allowed sharing of passenger and cargo services. A Happiness Taxi platform also complements the bus service for those needing passenger vehicle services. As of August 2023, 164 townships have implemented the Happy Bus and Happiness Taxi projects. With these efforts, as well as other transit services, the overall rate of rural public transportation usage in Chinese Taipei reached 91.96 percent - exceeding the annual target of 91 percent - in 2023.

The Chilean government has put forth efforts to electrify its public transit bus fleet to improve services and meet travel demands, as well as reduce emissions and noise pollution. Chile has the largest electric bus fleet in South America and the second largest electric bus fleet in the world as of July 2024.

The APEC economies of Chinese Taipei and Chile are also moving forward with bus electrification efforts at domestic scales to promote low or zero emission transportation modes that meet traveler needs. The Chinese Taipei Ministry of Economic Affairs is promoting an industry-wide transformation and production of low floor electric buses for urban areas through demonstration projects, resulting in over 1400 low floor electric buses employed domestically. Chile is also incorporating electric buses across all regions and has transformed more than 1700 buses in Santiago alone. With bus electrification, the goal of the Chilean government is to improve bus services, enhance travel experiences, meet demands of travel increases, and reduce emissions and noise pollution. As of July 2024, Chile has the second largest electric bus fleet globally.[xlvii]

Rewards programs and campaigns

Programs using social norms, competitions, rewards or points, and/or recognition can motivate travelers to reach certain goals, promote sustainable travel modes, and encourage safety. Tracked points accumulated through using public transit frequently, for example, can be used to receive rewards, prizes, or discounts. Other examples include recognition of campaigns such as a Bike to Workday or National Walking Month, as well as gamification such as transportation bingo.

Singapore and Chinese Taipei have indicated some success in the implementation and use of such programs related to public transportation. Singapore awards cash for points accumulated through the use of public transportation, while Chinese Taipei transit riders can use points to redeem environment-friendly consumer product and service discounts.

Singapore's Travel Smart Journeys Scheme has produced a change in traveler behavior. The Travel Smart Journeys (TSJ) program is an initiative led by the Land Transport Authority of Singapore to redistribute peak hour travel to facilitate optimal use of transit infrastructure. The scheme aims to make public transit more comfortable as well. Through the scheme, travelers are awarded points to use specific bus routes to decant demand away from crowded services. Travelers taking the specified routes can collect points for use of those routes and the points can be exchanged directly for cash.

While Singapore notes the Travel Smart Journeys rewards program has been able to change traveler behavior, Chinese Taipei has experienced successes as well as drawbacks with its environmental product discount rewards approach in changing traveler behavior. The environmental point collection program in Chinese Taipei is a platform whereby users can accumulate "green points" from various activities, including use of public transport. By linking government agencies with private partners through the platform and aligning policies with consumer markets, accumulated points can be used to receive discounts on green products and services. As of September 2023, around 1.5 million accounts were linked to the platform, with 924,000 active users of the environmental point collection system.

The environmental point collection program's successes include:

- Influencing consumer decisions toward identifying and purchasing more environmentally friendly products
- Encouraging continuous participation through a rolling point membership system
- Linking consumers with markets and businesses for long-term cooperation
- Developing a flexible information system to promote environmental policies and industry cooperation.

The program also faced challenges including:

- Difficulties promoting green circular consumption
- Environmental benefits of products have not been factored into consumer decisions
- Environmental product information is not easily accessible
- Difficulties of short-term marketing to change consumer habits in the long term
- Environmental point collection promotion practices.

In addition to rewards programs, APEC economies shared examples of how campaigns encouraging transit use have been useful for traveler behavior change. Chile shared the example of their public transportation campaign to promote the benefits as well as share information about fare payment. As part of the campaign, Chile encouraged private studies to be conducted on the measurement of electric bus pollution. The study showed that the electric buses resulted in 32 percent lower total cost of ownership than the diesel bus counterparts and each electric bus may avoid up to 60 tons of carbon emissions every year.[xlviii]

New Zealand's Ministry of Transport has approached traveler behavior change through the route of a large-scale campaign. The Ministry developed a behavior change framework for application across government agencies and across the transportation sector. The framework, based on existing research and adapted to the New Zealand context, involves viewing traveler behavior change from a systems lens to maximize value of investments in transportation and achieve outcomes through coordinated efforts. Five main categories make up the framework, which are openly available through the government website.[xlix]

Active transportation

Survey respondents described several approaches to inspiring behavior change that increases the use of active transportation, namely walking and cycling. The following sub-sections are the main topics from the survey and discussions with the participating APEC economies:

- Creating a Culture of Active Transportation Safety
- Bicycle and E-Bike Sharing Programs
- Bicycle and Pedestrian Infrastructure Investment
- Rebate Programs, Subsidies, and Campaigns
- Incorporating Bicycle and Pedestrian Planning into Master Planning

Creating a culture of active transportation safety

A critical component to encouraging travelers to use active transportation as a means for travel is the availability of safe multimodal infrastructure such as protected bike lanes. Active transportation, including bicycle use or walking, plays a significant role in the strategies economies used for offering lower emission mode options to travelers. Many of the approaches described by survey respondents to increase the use of active transportation could be considered "proven approaches." That is, these approaches are generally known to encourage cycling, and many revolve around improving pedestrian and cyclist safety.

For example, representatives from Australia described the importance of separated bike lanes and how wide roads provide opportunities to separate cyclists and pedestrians from motorized road users. This is limited to the urban regions in Australia, as the active transportation infrastructure in limited to urban areas.

In Singapore, representatives discussed how residents initially felt that the climate was too hot and humid for cycling and walking. However, over time, and with installation of infrastructure to support active mobility, cycling paths have come to be accepted as a norm alongside pedestrian walkways. Ang Mo Kio, for example, has a 20 km network of dedicated and marked cycling lanes, which includes safety features such as pedestrian priority zones and traffic junctions with safety and

The Revision Taipei City's Detailed Plan for Transit-Oriented Development Permit Areas aims to accelerate the redevelopment of aging communities in Taipei City while integrating public transportation development. The plan covers an area within 500 meters around public transportation stations and encourages the relocation or addition of metro entrances and exits, the establishment of bicycle transfer facilities, and the creation of pedestrian-friendly spaces. The plan also introduces a dual-track system that allows developers to choose between providing public spaces or making financial contributions. This system aims to increase development density around the stations, provide more flexibility in development applications, and incentivize renovation and redevelopment. It is expected to offer more open spaces, optimize the overall pedestrian environment in Taipei City, and serve as a catalyst for urban regeneration.

mapping information. In addition to Ang Mo Kio, plans are underway in Tampines to develop a comprehensive pedestrian and cycling network. The network prioritizes safety and convenience for pedestrians as well as those with disabilities, with features such as wide footpaths, barrier-free ramps, and roads with speed calming measures. The network will also connect to neighboring towns and employment opportunities. [1]

Chinese Taipei is globally recognized as bicycle friendly. An initial cycling route around the island in 2015 has turned into 16 cycling routes by 2021, for both public leisure and recreation. The government has made extra efforts to make the routes safe, comfortable, and optimize environmental features. The government is envisioning 596 kilometers of bicycle lane length in the coming years, in line with their low carbon transportation policies.

The city of Montreal in Canada has one of the highest levels of active transportation and has invested in bicycling infrastructure since the 1970s. The city has been featured in the top 20 bicycling friendly indexes since 2011. The city has around 1000kms of cycling paths, with plans for expansion of additional and safer routes with protected bicycling lanes. Several Canadian cities, including Montreal, have also implemented traffic calming measures since the COVID-19 pandemic. Safe, protected biking infrastructure is one of the ways Canada has enabled mode shift.

Bicycle and pedestrian infrastructure investments

Investments in bicycle and pedestrian infrastructure are critical to ensuring there are sufficient options for active transportation use by travelers. Several APEC economies noted their emphasis on promoting, encouraging, and supporting active transportation infrastructure and plans.

As mentioned in the section above, Chinese Taipei has grown their bicycling infrastructure network significantly from their 2015 island circling route, to 16 additional routes by 2021. In 2022, the government provided additional funding and efforts toward strengthening regional bicycle lane interconnectivity. These investments have proven to be highly successful with global recognition for the aesthetics and user-friendliness of the cycling routes. In addition to these efforts, Taipei City is working on the development of public bicycles and bicycling stations, called YouBike. YouBike aims to provide convenient and environmentally friendly transportation services via pub, with around 1,292 stations offering 13,000 bicycles for public use. Plans are in place to increase the number of bicycles and stations each year, with a goal of 2,000 stations and 26,000 bicycles by 2026. The estimated GHG emissions reduction potential from the implementation of YouBike is expected to be around 7,000 tons annually.

Figure 8:The Rue Berri/Rue Lajeunesse/Rue Saint-Denis bike path, which crosses the island of Montréal from north to south with elements of protected bike lanes
Source: City of Montréal

The Canadian government is providing significant investments and efforts in active transportation infrastructure. The government has allocated permanent funding at CAD3 billion on average at the federal level beginning 2026 for public transit and active transportation infrastructure across the economy. Part of this funding will be prioritized for bike paths, multi-use pathways, sidewalks, and footbridges, as well as larger active transportation systems. The federal funding is available in the form of cost-sharing with Provincial, Territorial, Municipal and Indigenous partners for community delivery. Canada has been heavily investing in active transportation since 2015. Through the Investing in Canada Plan, over CAD236 million was invested in over 300 active transportation infrastructure projects across the economy. Canada also released its first National Active Transportation Strategy and Active Transportation Fund with CAD400 million over five years to build and expand bike lanes, pathway networks, pedestrian bridges, and planning studies.

Bicycle and E-bike sharing programs

The availability of bicycle and e-bike sharing programs can encourage travelers to use these services as an alternative to motorized vehicle transportation. Having the infrastructure and programs in place can make active transportation a viable choice for travelers. The APEC economies of Canada and Chinese Taipei in particular note the benefit and success of bicycle and e-bike sharing programs to move toward less greenhouse gas emitting modes of transportation.

YouBike, the public bicycle and bicycling station system in Taipei City, provides convenient and environmentally friendly transportation services to the public. The city has around 1,292 stations offering 13,000 bicycles for public use, with a goal of 2,000 stations and 26,000 bicycles by 2026. The estimated GHG emissions reduction potential from the implementation of YouBike is expected to be around 7,000 tons annually.

Bike sharing in Canada is run at the municipal level. Montreal, Toronto, and Vancouver municipalities operate public bike sharing programs, including e-bike programs. One of the largest fleets of e-bikes in North America and operated by Bixi Montreal, with 2,395 e-bikes and 184 electric stations in the city. Montreal, Toronto, and Vancouver also each have their own mobile apps to facilitate bike sharing. Around 20 other Canadian cities have e-bike sharing programs run by private companies.

As mentioned in the previous section, Chinese Taipei has a significant bicycle sharing program called YouBike. Approximately 13,000 public bicycles are available across 1292 stations, with goals to increase the number of bicycles and stations annually. Chinese Taipei also uses a variety of multimodal vehicle sharing mobile apps for convenience.

Rebate programs, subsidies, and campaigns

Rebate programs, subsidies, and active transportation campaigns can be implemented to encourage active transportation. Several different types of active transportation programs exist in APEC economies. From the survey and discussions, Canada and Chinese Taipei noted these strategies were useful in impacting traveler behavior and choices.

The government of Chinese Taipei provides subsidies to the e-bike industry, including the phases of research and development, production, and upgrades. The subsidies allow for innovation in the development of e-bikes, as well as provide consumers with a wider range of choices. The government subsidies also enforce a level of safety standard which is in line with international standards to ensure high quality products for travelers. In addition to production side subsidies, the government of Chinese Taipei subsidize bicycle purchases.

The Canadian government provides a number of strategies within this area, mainly at the municipal level, including campaigns to promote active transportation and rebate programs. An example of a strategic campaign is the Translink TravelSmart4Kids campaign, geared toward younger generations to learn how to safely navigate a multimodal travel network. The campaign functions at the municipal level, but is coordinated at the regional level in Vancouver, with the aim to encourage children from the age of 0 to 12 to use active and sustainable modes of transportation such as walking, cycling, and rolling. The greater province of British Columbia also provides a range of rebate programs for different modes of vehicles, including cargo e-bikes.

Incorporating bike and pedestrian planning into master planning

Many of the participating economies had active transportation plans with multimodal goals that align with larger, comprehensive plans to justify infrastructure improvements supporting bike and pedestrian uses. From the surveys and discussions, Canada and Chinese Taipei were two APEC economies to specifically note planning and policy-oriented goals and activities as a way to promote active transportation and work toward reducing transportation-related greenhouse gas emissions.

The government of Chinese Taipei has been working to promote transportation policies that integrate bicycles with public transportation, evaluate the bicycle network, reduce the use of private vehicles, and use active transportation modes to serve as first and last mile connections to public transit.

Figure 9: Bicycle Crossing in Singapore
Source: Singapore Land Transit Authority

City-level governments in Canada have been incorporating active transportation and bicycling into city master plans. Montreal's master plan aims to have 50 percent of the city commute trips multimodal and have bicycle networks built around key areas such as schools and healthcare facilities. Canadian cities are also incorporating active transportation in land use planning for communities and along high frequency transit corridors to link public transit with alternative modes of non-vehicular travel. Canada also notes the role of academic research communities in informing policies and plans on the benefits of integration and prioritization of active transportation in communities.

Vehicle use and ownership

Figure 10: EV charging stations set up by Audi in Chinese Taipei's six special municipalities.
Source: Chinese Taipei Ministry of Transportation and Communications

Passenger vehicles are large contributors to GHG emissions. In Canada, roughly 10 percent of total GHG emissions came from passenger vehicles.[li] The same can be said about Australia's total emissions with 11 percent produced by personal vehicles. On average a new vehicle purchased in 2019 produced 181g CO_2 per kilometer.[lii] For some economies emissions from personal vehicles produce an even greater share of GHG emissions. In Chile and Korea that share is roughly thirteen percent or their total GHG emissions respectively.[liii] The amount of emissions personal vehicles produce is based on how efficient they are and how many are driven. The primary ways of reducing emissions attributed to personal vehicles are to encourage mode shift (public transportation, biking, etc) or regulating consumer choices to more efficient personal vehicles.

Encouraging personal vehicle users to make more climate-friendly choices is a key focus area among the economies surveyed and interviewed. These choices include the use of electric vehicles, ridesharing, and reducing personal vehicle mileage, among others. The following sub-sections represent the types of responses economies provided for how they influence personal vehicle use.

- Influencing the cost of owning a vehicle
- Electric Vehicles adoption
- Ridesharing

Influencing the cost of owning a vehicle

For many people using their personal vehicle is a cheap and convenient option for traveling and commuting. When considering what mode to use, travelers weigh the implicit and explicit costs of using that mode. This occurs when purchasing a vehicle or choosing between their vehicle and another means to get around. Therefore, to encourage a change in traveler behavior between a personal vehicle and another mode, the modal substitutes need to be perceived as a lower cost option. This is achieved by either offering lower prices for those substitutes or influencing the cost of owning an internal combustion engine vehicle (ICEV) either directly or indirectly.

Indirect means of influencing the cost of owning a ICEV involve the built environment and market forces. Market forces determine the affordability of consumer vehicles based in large part on the supply of vehicles for purchase and the demand for purchasing those vehicles. However, the people not only consider the cost of a vehicle, but the cost of owning a vehicle. This includes the cost of fueling the vehicle as well as other factors such as parking prices. For some economies, the cost of owning a vehicle in certain areas, in particular dense urban areas, is a detriment to choosing their personal vehicle as an option for traveling.

Economies can directly influence the cost of owning a vehicle. This ranges from taxing the sale and ownership on ICEVs, like Canada's Green Levy Tax, to regulating the ownership and use of them, which includes quotas and tolling. Singapore reported that the high cost of owning a personal vehicle could be one of the factors driving modal shift. In Singapore, vehicle permits are controlled by a quota to limit the vehicle population, which causes their price to rise when demand increases. They reported

seeing an increase in mode share for public transportation, with the most recent census showing that over 57 percent of residents take a combination of bus and transit for their commutes.

Tolling adds to the cost of owning a vehicle. Especially for ICEV when battery electric vehicles (BEVs) are exempt from tolling. In Australia, driving in Sydney is a less convenient option than other forms of transportation because of the amount of toll roads throughout the city. It is estimated that in 2023 commuting by car could cost AUD20 in tolls in contrast with AUD4 using public transit. But tolls not only add to the cost of owning a vehicle, but also can regulate the rate of traffic. Singapore's electronic road pricing system uses a dynamic pricing system based on traffic conditions. Their tolls aim to keep traffic moving at defined optimal speeds. Although they do not specifically aim to reduce the number of vehicles on the road, theoretically dynamic toll pricing can help to limit the concentration of GHG emissions from collecting in a given geographic area during the most congested times of the day by discouraging drivers with lower propensities to pay a high toll.

Electric vehicle adoption

For many economies, battery electric vehicles (BEVs) are becoming an affordable option compared to vehicles with internal combustion engines (ICEVs). In 2018, BEV sales amounted to more than two percent of new light-duty vehicles and had more than 70 percent sales growth from 2017 to 2018 resulting in five million BEVs worldwide.[liv] Despite being an electric vehicle BEVs still produce GHG emissions throughout their life cycle. BEVs have lower life cycle emissions than ICEVs. Emissions from an average medium-size BEV registered in 2022 has a lower than comparable gasoline cars by roughly 66 percent in Europe, 60 percent in the United States, and 19 percent in India.[lv]

APEC economies understand the potential on BEVs in reducing overall transportation GHGs. Almost all economies reported that they had policies to either encourage the adoption of BEVs or discourage new ICEV purchases.

Identified policies for encouraging BEV adoption:

- Tax credits, deductions
- Exemptions from taxes or fees
- Rebates
- Fees or taxes on new internal combustion vehicles
- Loans
- Disincentives for purchasing internal combustion vehicles

Most of these approaches involved a form of subsidy for purchasing BEVs in the form of tax credits, deductions, or rebates. For example, in Canada, there is a tax write-off for zero-emission vehicles to support business adoption. The iZEV program aims to contribute to a clean transportation system and make it more affordable and easier for Canadians to buy (or lease) new zero emission light-duty vehicles. It offers up to CAD5,000 in purchase and lease incentives. Canada also offers up to CAD200,000 purchase and lease incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (iMHZEV). Several Canadian Provinces leverage federal tax incentives with their own. For example, in British Columbia, there are multiple rebates programs, including for cargo e-bikes, buses, medium- and heavy-duty trucks, and other vehicles. Similarly, the United States offers first time buyers of BEVs a USD7,500 credit. However, there are several qualifications to meet before receiving the full tax credit, such as where the final assembly of the vehicle was, that may limit the use of the credit. APEC economies understand the potential on BEVs in reducing overall transportation GHGs. Almost all economies reported that they had policies to either encourage the adoption of BEVs or discourage new ICEV purchases.

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Some economies exempt BEVs from fees and taxes. This occurs in several different ways to include exempting a BEV owner from paying a vehicle registration tax or toll on a bridge. For instance, Chinese Taipei exempts BEVs from the Automobile Fuel User Fee and the Commodity Tax and Vehicle License Tax. In addition to this, local government-owned parking lots in Chinese Taipei also provide partial exemption or discounts on parking as well as for charging fees for EVs. In the province of Quebec, Canada drivers using electric vehicles do not pay tolls when crossing the many major bridges of the area. Some economies are cautiously exempting BEVs from taxes knowing that in a few decades they may make up a large proportion of personal vehicle types. This results in a smaller tax base to fund roads and other programs dependent on tax revenue.

By 2030, Singapore aims to have no new ICEVs sold in the economy. People are anticipating this change and purchases of BEVs are steadily increasing. The 2023 rate of BEV adoption is 18 percent compared to one percent in 2020. The government is supporting this trend by offering early adoption rebates for BEV purchases.

BEV owners in the Philippines, particularly in Manila and other larger metropolitan areas, are exempt from the vehicle number coding scheme the Unified Vehicle Volume Reduction Program (UVVRP). The program restricts both private and public utility vehicles from using roads on a specific day of the week based on the last digit of the vehicle's license plate. At the moment, this does not affect electric vehicles.

Vehicle rebates discount the price of vehicle offered by the manufacturer, which governments can fund. Singapore aimed to narrow the upfront cost gap between electric cars and ICEVs by offering an early adoption rebate. The incentive, offered from January 2021 to December 2025, allows owners who register fully electric cars to receive a rebate of 45 percent off the Additional Registration Fee, capped at SGD15,000. During the COVID pandemic New Zealand implemented an electric vehicle rebate. The Clean Car Discount placed a charge on the registration of emitting light vehicles and provides a rebate on the registration of low-emitting or electric vehicles. In total, the central government paid over 192,000 rebates amounting to SGD617.8 million. The program slowed the rate of purchases for SUVs and utility vehicles and saw an increase in EV purchases. Singapore uses the enhanced Vehicular Emissions Scheme (VES) to encourage the purchase of low emission vehicles, which applies rebates or surcharges on vehicle registrations based on the vehicle’s emissions (carbon

dioxide, hydrocarbons, carbon monoxide, nitrogen oxides, and particulate matter). The pollutant with the highest emission value determines the VES rebate or surcharge. Singapore recently increased the rebates and surcharges to encourage the adoption of lower emissions vehicles.

Providing financing options for BEVs is another way economies can encourage adoption. The Australian Capital Territory offers zero interest loans for zero-emissions vehicle purchases. Under the Sustainable Household Scheme, eligible households can receive loans of between AUD2,000 to AUD15,000 to put towards the cost of a zero-emission vehicle. The loan is repayable over and up to ten years. Likewise, Australia offers concessional loans for people on fixed incomes wanting to own a BEV. These loans are also available to finance an e-bike.

Incentives are not the only way to encourage BEV adoption. Disincentives for purchasing ICEVs will effectively increase the price of purchasing them. And in some economies, this type of vehicle will not be available for purchase by a certain year. Australia; Canada; Chile; New Zealand; the Philippines; Singapore; and Chinese Taipei all have proposed bans or initiatives for 100 percent sales of zero-emissions vehicles by a future date. Canada and Chile aim to implement their initiatives by 2035. Singapore aims to have all new vehicle purchases be cleaner energy vehicles by 2030. They plan to achieve this by ceasing the registration of new ICEVs by 2030. Canada's green levy tax will tax ICEVs that are designed primarily for use as passenger vehicles with a weighted average fuel consumption rating of 13 or more liters per 100 km at a rate ranging from CAD1,000 up to CAD4,000.

Expanding the electric vehicle charging network

One of the biggest impediments to BEV adoption is the availability of charging stations. A 2023 study modeling the impact of the barriers on EV adoption found that limited driving range and long charging times are significant barriers to BEV adoption.[lvi] Without an expansive network of chargers, consumers are reluctant to risk driving long distances without knowing if they will be able to charge their vehicle. Understanding this, economies like Canada; New Zealand; Chinese Taipei; the United States are investing in charging infrastructure. For instance, New Zealand announced plans to invest in public charging at community facilities for all towns with 2,000 or more people. The announcement is part of a NZD120 million expansion over four years. Canada is funding CAD680 million in increasing the availability of localized charging and hydrogen refueling stations. While the Unites States Bipartisan Infrastructure Law provides USD7.5 billion in funding to build approximately 20,000 charging spots or around 5,000 stations.[lvii] Lastly, Chinese Taipei is investing TWD30 million into public charging stations. They also require public parking lots to reserve at least two percent of their spaces for EV charging, while private lots are encouraged to allocate at least one percent of theirs.

Figure 11: A BEV charges at a new charging station in Sydney, AU.
Source: Australia Department of Climate Change, Energy, the Environment and Water

The government of New Zealand has other initiatives in place to encourage the uptake of electric vehicles, such as information campaigns and contestable funds to support the adoption of low-emission transportation options.[lviii]

Ridesharing

Ridesharing, the adding passengers to a private trip in which driver and passengers share a destination especially by using Mobility as a service (MaaS), was once considered a method to reducing the

number of personal vehicles using a transportation network resulting in lower GHG emissions. Some economies reported having programs that encourage the use of ridesharing. However, research is mixed on the impact ridesharing has on reducing GHG emissions. In fact, some research indicates that ridesharing may have a higher carbon impact that the trips they replaced depending on the number of occupants using those services and the carbon footprint of substitutes dependent on the urban makeup (i.e. transit, walking).[lix]

Nevertheless, there is still potential for ridesharing to decrease GHG emissions over the long run.[lx] In some Canadian Provinces, car-sharing companies offer subscription-based or membership-based services to use a car for a certain period, ranging from a few hours to a few days via a mobile app. In the Canadian Province of Quebec, Kangaride, a rideshare app, connects drivers and passengers to share travel costs for medium to long distance car trips. In Chinese Taipei, there are a variety of taxi booking mobile applications, to include a more popular application that integrates with a common communication application. The convenience of this requires no downloading of additional applications. But Chinese Taipei's Ministry of Transportation and Communication wants to make ridesharing, and transit, more convenient. They are piloting a public (MaaS) application that offers nine types of transportation services.

CONCLUSIONS

APEC economies may be able to reduce their transportation GHGs by influencing their citizens' travel behavior. Across all modes of transportation there are policy options for directly and indirectly influencing how and what travelers choose for getting around their communities. This report explores the general policies APEC economies are using to influence traveler behavior to help economies better understand and implement their own strategies that may result in the reduction of GHG emissions. This report provides high level takeaways from research conducted through a literature review, an online survey, and virtual discussions with governmental staff across several APEC economies.

The research team has made some preliminary observations based on the research from this study:

- Land use, and the organization of physical space, is important in guiding traveler decisions.
- To influence decisions based on cost, both incentives and disincentives may be needed.
- Eliminating barriers to convenience can help make modal shifts an option.
- Create the infrastructure that allows electric modes to be a convenient option for users.

Land use, and the organization of physical space, is important in guiding traveler decisions.

Land use policies and laws dictate how dense an environment can be and the type of transportation options that are available to people. These policies can make a specific transportation mode more convenient, such as building more housing around transit centers or reducing parking in a given area. Likewise, these policies determine the mix of uses, such as residential, commercial, industrial, or other uses which could provide a variety of community amenities closer to where people live. Allowing for high densities and intensities of development may reduce travel by personal vehicle, which would result in a reduction in GHG emissions and is supported by the literature.

Almost all APEC economies participating in this study noted that they are considering the implementation of land use policies as a method to shape the built environment and influence traveler behavior. Respondents stated that planning should be based on high quality data to help inform decision-making. Land use changes to reduce emissions include the elimination of parking minimums, which makes it more cost effective for developers to build and allows for more variety in housing unit types. Land use planning also encourages densification and intensification within proximity of transit stations and corridors allowing for people to rely on transit or active transportation rather than single occupancy vehicles.

To guide decisions based on cost, both incentives and disincentives may be needed.

Changing traveler behavior may require both incentives, like subsidies, and disincentives, such as fees. to achieve intended results. Generally, people base their modal choices on their value or cost. If economies want to encourage a shift away from ICEVs, because of the associated GHG footprint, then they may need to influence how costly ICEV use is and make alternative modal substitutes cheaper. This is achieved either by offering lower prices for substitutes or influencing the cost of owning an ICEV either directly or indirectly.

All APEC economies responded that they have methods for increasing the cost of ICEV ownership and subsidizing alternative modes of transportation that emit lower GHG emissions. Although there has been a focus on making BEVs an appealing, cost-effective substitute to ICEVs, many economies have also made efforts to make other alternative transportation options cheaper such as transit and active transportation.

Eliminating barriers to convenience can help make modal shifts an option.

Relative costs are not the only barrier preventing travelers from choosing lower GHG emission options. Travelers will consciously and unconsciously calculate the viability of a modal option based on its convenience or level of difficulty to use. Economies can make transit and alternative transportation a more convenient option to traveling over higher emission options such as ICEVs.

Barriers to convenience can involve soft infrastructure, for example the type of payment options available for transit, or hard infrastructure, such as modal access that involves the proximity of a transit center to trip generators. APEC economies reported that they experimented with mobile application payment schemes to make it easier to pay for transit and bike shares. Mobile applications not only make it easier to pay for services but are offered through a traveler's phone which they are familiar with. Changes to the built environment that make certain active modal transportation convenient may also encourage modal shift. Protected and well thought out bicycle networks may help travelers feel more comfortable riding bikes in dense urban environments. Providing a straightforward network of bike lanes with appropriate signage makes it less confusing for new users.

Create the infrastructure that allows electric modes to be an option.

One of the biggest impediments to BEV adoption is the availability of charging stations. A 2023 study modeling the impact of the barriers on EV adoption found that limited driving range and long charging times are significant barriers to BEV adoption.[lxi] Without an expansive network of chargers, consumers are reluctant to risk driving long distances. Understanding this, economies like Canada; New Zealand; Chinese Taipei, and the United States are investing in charging infrastructure.

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Challenges and Future Research

The study team examined the many policies and programs economies used to influence traveler behavior to determine if there are any measurable impacts to GHG emissions. Although there are a plethora of policies and programs across APEC economies with potential to influence traveler behavior, there are challenges in measuring their impact. Most of the policies and strategies used by economies in this research are relatively newly implemented. There has not been enough time to measure their impact. Furthermore, it is difficult to determine direct causal benefits linked to specific policies and inferences on the relationship between strategies that impact on changing traveler behavior with the change in GHG emissions need to be made. Therefore, there is a general lack of data on impacts.

This leads to potential for future research to help APEC economies better understand not only the most influential ways to influence traveler behavior, but also those ways with the greatest impact on reducing GHGs. This research concludes with the following research questions:

Table 2: Questions for future research based on study findings

Policy and Programmatic Decision Making	What research/data/information/factors inform or influence policy and decision making related to designing policy and plans based on traveler behavior/GHG emissions reduction?
	What factors in policy and planning can be attributed to high usership shares of public transportation?
Enforcing Policy	What are the enforcement measures or incentives for local or regional jurisdictions to incorporate density and active transportation targets within key regional and local planning documents?
Measuring Impacts	What are the monitoring mechanisms to determine how a specific program or policy is influencing traveler behavior, and if that change in behavior is impacting GHG emissions?
	What are the trends in active transportation use after bicycle networks are expanded? Is there indication the IVEV use has decreased either to modal shift or road dieting?
	Having changes in the minimum or maximum requirements for building parking spots per unit with a development shown any differences in how many parking spots per unit are actually built?
	How effective are incentives for purchasing BEVs in encouraging mass early adoption? Is there a relative price point for a BEV that makes it more appealing than ICEVs?

APPENDIX

1. Please describe a tool, strategy or policy in use in your economy to influence a change in individual travel behavior (such as shift from single occupancy vehicle to an alternative mode):

2. What province, city, or town in your economy would you consider to be the most bike and pedestrian friendly?

3. What province, city, or town in your economy has the highest ridership of public transportation (train, bus, etc.)?

4. Are there any cities or provinces in your economy that charge drivers a fee or toll to drive (such as Area License Fees in Singapore or congestion pricing found in London)?

5. Are there any cities or provinces in your economy that limit single occupancy vehicle use whether by requiring vehicles to have a minimum number of riders present (i.e., high occupancy lanes) or by restricting vehicles from sections of the city for a period of time (similar to Jakarta's car free day)?

6. Are you aware of housing development policies in your economy that remove parking minimums or create parking maximums?

7. Are there policy efforts, including tax incentives, in your economy that have or currently are encouraging vehicle owners to purchase electric vehicles? Or electric bicycles?

8. Do you know of any widely used mobile applications (Mobility on Demand (MOD) / Mobility-as-a-Service (MaaS) platforms), public or private, that individuals use to manage their personal trips? Some examples may include Kakao, Go-jek, Grab, or the Seoul Metropolitan Government's smart card application.

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