



2024

CITY AND COUNTY OF HONOLULU ENERGY CONSERVATION AND EMISSIONS REDUCTION PLAN FOR HONOLULU TRANSPORTATION SYSTEMS: APPENDIX 1-8

Prepared by the City and County of Honolulu in Cooperation with the O'ahu Metropolitan Planning Organization and the United States Department of Transportation



This report was prepared by the City and County of Honolulu in cooperation with the O‘ahu Metropolitan Planning Organization and the U.S. Department of Transportation. It was prepared with assistance from ICF, the University of Hawai‘i Institute for Sustainability and Resilience, and Walker Consultants.

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Contents

Appendix 1. O‘ahu Climate Action Plan Ground Transportation Sector: An Assessment of Transportation Trends, City Progress, and Next Steps

Appendix 2. Capital Improvement Budget Prioritization Tool

Appendix 3. Transportation Demand Management Framework for City Employees

Appendix 4. Regional Mobility Corridor Scenarios

Appendix 5. Regional Parking Pricing Program Framework

Appendix 6. Public Transportation Fleet Transition Plan

Appendix 7. Capital Fleet Transition Plan, Phase II

Appendix 8. Electric Vehicle Infrastructure Action Plan



CITY AND COUNTY OF HONOLULU

ENERGY CONSERVATION AND EMISSIONS REDUCTION PLAN FOR HONOLULU TRANSPORTATION SYSTEMS

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Transportation*



2024

Executive Summary

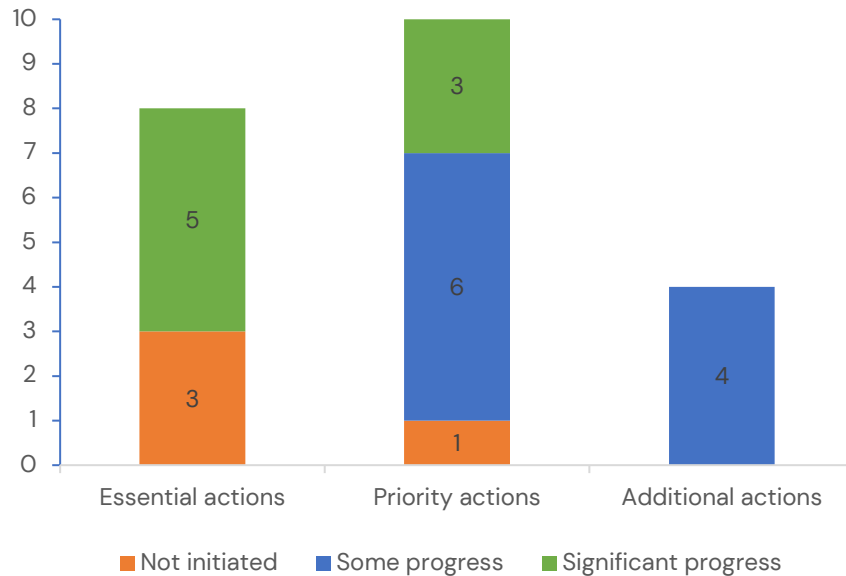
This report serves as a progress update for the City and County of Honolulu’s 2020–2025 Climate Action Plan (CAP) as it relates to the ground transportation sector. This report tracks progress on CAP actions, presents additional transportation data and trends, both current and projected into the future, and identifies opportunities for further advancement to decarbonize O‘ahu’s transportation sector. As a cross-cutting issue relevant to all four strategies, this report also delves into local transportation equity and safety issues.

In the first two years of the 5-year CAP implementation window, the City has made significant progress on eight of the 22 CAP actions and some progress on another ten actions (Figure ES- 1). Four actions have not yet been initiated and no actions have been completed. We identify existing CAP actions as *essential*, *priority*, and *additional* – where essential CAP actions are policies that are foundational for a successful implementation of several other policies and are focused on land use and pricing strategies that disincentivize fossil fuel consumption and single occupancy vehicle (SOV) travel; priority CAP actions focus on increasing the use of public transit and active transportation modes; and additional policies focus on electrification and alternative fuels. There are a total of eight CAP actions identified as essential, of which five have significant progress and three have not been initiated. There are ten priority CAP actions, three with significant progress, six that have just begun in their efforts, and one that has not been initiated.

O‘ahu Climate Action Plan Ground Transportation Sector

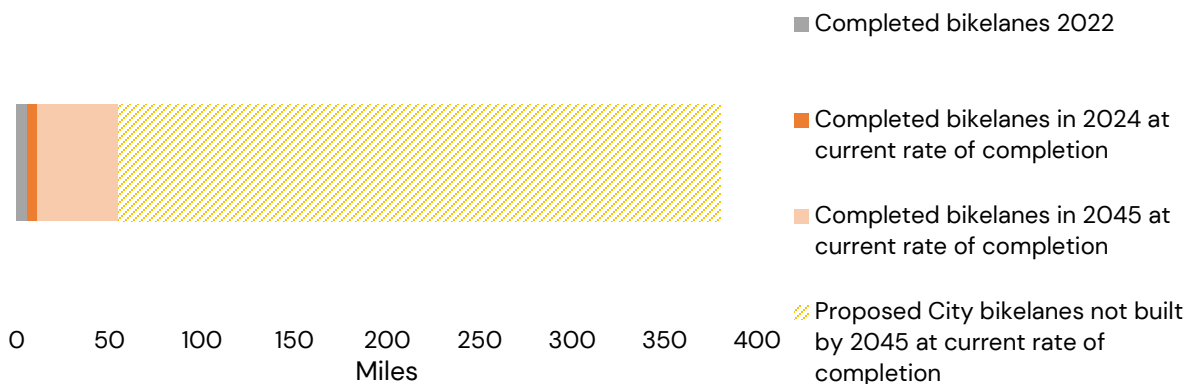
An Assessment of Transportation Trends, City Progress, and Next Steps

Figure ES- 1. Honolulu CAP Implementation



Overall, we find that the speed of progress toward CAP actions suggests that the City is not on track to meet their CAP goals; a key example being the slow implementation of the O‘ahu Bike Master Plan (Figure ES- 2).

Figure ES- 2. City Progress in Implementing the Bike Master Plan



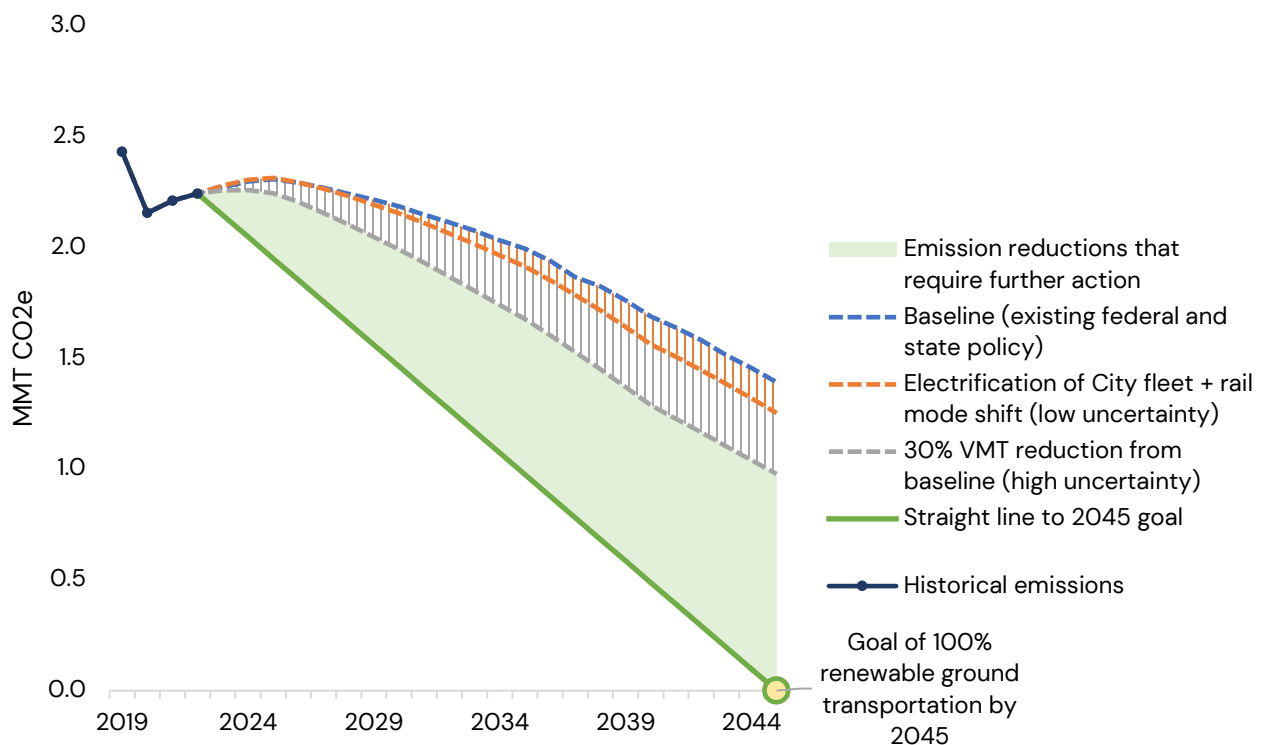
Greenhouse gas (GHG) modeling suggests that there is expected to be a reduction in GHGs from the transportation sector between 2019 and 2045 (Figure ES- 3). GHGs are expected to decrease by 50% in 2045 compared to 2019, based primarily on continued realization of more fuel-efficient vehicles entering the roads from federal Corporate Average Fuel

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Economy Standards, with additional reductions stemming from electrification of the City’s own vehicle fleets and launch of the Honolulu Skyline. We consider the GHG outcomes of a 30% reduction in average Vehicle-Miles Traveled (VMT) per person by 2045 and find that emissions decline by another 10 percentage points to 40% of 2019 levels, but still leaving a large gap to the City’s goal of net zero emissions. As such, considerably more efforts will need to be made, incorporating federal and state policy efforts, for the City to continue to close this gap.

Figure ES- 3 Projected Emissions from O‘ahu’s Ground Transportation Sector



To provide an illustration of the magnitude of mode shift needed to achieve a 30% reduction in VMT (from the modeled baseline), we draw comparisons of modal split between counties with high biking and walking – Multnomah County (containing Portland), Oregon, and San Francisco, California. If a 4% bike mode share and 22% walk mode share can be achieved for O‘ahu (up from 1% and 10%, respectively), transit usage, beyond the projected usage of the Skyline, would have to increase by approximately 300%. This means transit usage would have to increase from its current 9% mode share to 29%. Achieving

large VMT reduction therefore requires a massive investment in TheBus and its services such that it reverses what has been a declining ridership trend.

Feedback received from both internal and external stakeholder meetings find that the greatest challenges to CAP implementation are financial and human resources, institutional structures, and negative public sentiment. Given the modest progress made on existing ambitious CAP actions, we recommend the City focus on moving forward essential and priority CAP actions first, unless there is opportunistic funding specifically around additional CAP actions (that center on electrification rather than VMT reduction). Based on model results and stakeholder feedback, a new CAP focal point should be to plan for and launch efforts to massively upgrade bus transit service, primarily by decreasing travel times through rapid bus lanes, and better coordinating multi-leg trips. To achieve CAP actions, budgeting priorities must be aligned between coordinating and lead departments, as well as increasing the ability to tap into new sources of climate funding.

Lastly, the City has opportunities to improve transportation choices that not only reduce GHGs but support more equitable transportation outcomes. Given that transportation choices are shaped both by income and demographics, it is critically important for options like walking, biking, and public transit to support accessibility, mobility, and safety. For mode choice to align with VMT and GHG reduction, non-SOV modes must be competitive in their holistic cost profiles (including financial, time value and safety) to SOV.

Table of Contents

Executive Summary.....	1
Table of Contents	5
Table of Figures.....	6
Tables.....	8
I. Introduction.....	9
II. Equal Opportunity for Greener Mobility	10
Defining Transportation Equity	11
Transportation Equity on O‘ahu.....	14
Designing Policies to Promote Transportation Equity.....	21
III. Transportation Data and Trends.....	26
O‘ahu’s GHG Emissions and Factors that Determine Emissions.....	26
Transportation Trends and Pandemic Impacts	29
Electrification and Vehicle Technologies	40
IV. Future GHG Emissions within O‘ahu’s Ground Transportation System.....	49
V. Progress on and Next Steps for Transportation Related CAP Strategies	69
VI. Steering Toward the Lowest Emissions Path.....	82
Stakeholder Input – Barriers to Implementation and Ways to Push Forward	82
VII. Recommendations	91
Recommendations for Implementing Existing Climate Actions and a New CAP Action.....	91
Recommendations for Promoting Greater Transportation Equity	94
VIII. References.....	96
IX. Appendix I: External Stakeholder Participation	104
X. Appendix II: Description of Projection Updates.....	106
XI. Acknowledgements	109

Table of Figures

Figure 1. Mode Share and Demographic Characteristics for Honolulu	15
Figure 2. Comparison of Traffic Fatalities and Mode Shares on O‘ahu in 2021	17
Figure 3. Proposed State and County Transportation Expenditures for O‘ahu for the Years 2022–2026 by Project Type	19
Figure 4. Proposed City and County of Honolulu Transportation Expenditures by Project Type and Funding Source	20
Figure 5. Annual Public Costs of the Vehicle Economy in Hawai‘i.....	21
Figure 6. Components of a Transportation Network Equity Analysis	23
Figure 7. 2019 Ground Transportation Emissions Shares by Vehicle Type	27
Figure 8. VMT Shares by Vehicle Type – Percentage of Total VMT 2019	28
Figure 9. Trips Under 50 Miles by All Modes on O‘ahu by Distance as Compared to 2019 Levels	31
Figure 10. Long term Trends in Annual VMT per Capita and Annual Fuel Use per Vehicle	32
Figure 11. Honolulu VMT in the Month of June 2020, 2021, and 2022 as Percentage of June 2019 Values	33
Figure 12. Price per Gallon for Regular Gasoline on O‘ahu, the State, and Nationally	34
Figure 13. O‘ahu Mode Share 2015–2021	35
Figure 14. Percentage of Monthly TheBus Passenger Trips Taken Relative to Pre-pandemic Levels	37
Figure 15. Honolulu Annual Bikeshare Ridership and New Member Enrollments.....	38
Figure 16. Traffic Fatalities on O‘ahu per Hundred Thousand Residents.....	39
Figure 17. U.S. EV Vehicle Sales Forecasts.....	41
Figure 18. Hawai‘i EV, PHEV, and HEV Vehicle Registrations.....	42
Figure 19. Cumulative Number of Public Chargers Installed on O‘ahu by Year and Charger Level.....	44
Figure 20. Location of Public EV Chargers on O‘ahu by Type	45

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Figure 21. O‘ahu’s Transportation Baseline Emissions by Vehicle Type.....	50
Figure 22. Summary of O‘ahu GHG Emissions Pathways Based on Existing Trends, Policies, and CAP objectives.....	52
Figure 23. Difference in GHG Emissions between the “Electrification of City fleet + rail mode shift” and “30% VMT reduction from baseline” from “Baseline” by Vehicle Type	53
Figure 24. Emissions from light-duty vehicles under different assumptions about EV penetration.....	54
Figure 25. Emissions from EV Electricity Demand with Different Ratios of Renewable Energy Electricity Generation.....	55
Figure 26. Estimated Per Mile Cost Increase (%) Related to a 30% Reduction in VMT.....	57
Figure 27. Comparison of O‘ahu Non-SOV Commute Mode Shares to Other U.S. Counties	62
Figure 28. Honolulu CAP Implementation Status by Priority Level.....	78
Figure 29. Current and Expected Progress on Completing Proposed City Projects in the 2019 Bike Master Plan.....	80
Figure 30. Suggested Procedural Solutions to Expediate Implementation of CAP Actions – City and External Stakeholders.....	87
Figure 31. Suggested New Actions and priorities to Expedite CAP Strategies – City and External Stakeholders	89

Tables

Table 1. Concepts in Transportation Equity.....12

Table 2. Questions for Examination of Transportation Equity 22

Table 3. Impact of Different Types of Pricing Strategies.....60

Table 4. Comparison of O‘ahu’s Commute Mode Share to Other Counties 64

Table 5. Examples of Mode Shares to Achieve 10%, 20%, and 30% VMT Reduction..... 67

Table 6. Description of Priority Levels for GHG Reduction Actions.....69

Table 7. Progress on and Prioritization of CAP Transportation Strategies and Actions..... 71

Table 8. O‘ahu Bike Plan– Implementation Costs and Targets for Remaining Projects 81

Table 9. List of Existing CAP Actions Assessed at Stakeholder Meetings 82

Table 10. Barriers to Implementation of Actions Identified in City Stakeholder Workshops.. 83

Table 11. Barriers to Implementation of Actions Identified in External Stakeholder Workshops
..... 84

I. Introduction

On June 2, 2021, the City and County of Honolulu (“the City”) adopted its first Climate Action Plan (CAP) by Resolution of the City Council (21-105). Signifying its continued commitment to decarbonization of O‘ahu’s economy and systems, and in support of the State’s net negative emissions target by 2045, the CAP laid out nine major strategies and 47 actions for immediate and near-term implementation (from 2020 to 2025). Of these, Strategies 1 through 4 cover transportation-related sources of GHG emissions and offer a total of 22 specific actions for the City to undertake.

This report provides an update to transportation-related strategies and actions, organized in the CAP as:

- 1) Encourage Density and Mixed Land Use in Strategic Areas,
- 2) Enable and Provide Multiple Modes of Green Transportation,
- 3) Encourage Mode Shift through Parking Efficiency, and
- 4) Electrify the City Fleet and Support High-Efficiency Vehicles.

This report tracks progress on CAP actions, presents additional transportation data and trends both current and projected through the year 2045. As a cross-cutting issue relevant to all four strategies, this report also delves into equity and safety issues for O‘ahu’s transportation sector. Though the CAP was released relatively recently, incorporating more recent data and trends is important because the CAP was produced during the COVID-19 pandemic and must be updated every five years. At the time of analysis, tremendous uncertainty existed in terms of potential lasting impacts of the pandemic on transportation systems and trends, and this report provides an opportunity to reflect on these impacts and recovery of transportation systems. As such, this report looks at 2020–2022 transportation data and incorporates it into updated GHG projections through 2045 for light duty and heavy-duty vehicles for O‘ahu. As an update to CAP models, this report also operationalizes light duty (motorcycles, cars, and light trucks) and heavy-duty vehicle (heavy trucks, buses, and other heavy vehicles) turnover models to project GHG emissions into the future based on forecasts of future vehicle miles traveled (VMT), vehicle efficiency improvements, and electrification of transportation. Lastly, this report presents stakeholder input on the barriers and solutions to moving forward existing CAP actions and, together with the GHG analysis, provides recommendations on further advancement to decarbonize O‘ahu’s transportation sector.

II. Equal Opportunity for Greener Mobility

Key Takeaways

GHG mitigation and transportation equity overlap in many ways that can create opportunities for win-win solutions. There has been progress in O‘ahu’s transportation plans in terms of promoting more equal distribution of resources; however, ensuring equal transportation access requires going beyond Title VI requirements and performing deeper analysis of the distribution of private and social costs and benefits. Externalities, including but not limited to climate change impacts, other pollution, and traffic injuries, as well as land use value should be considered when distributing resources to various transport modes across the island. Such an analysis would likely reveal more inequalities in the status quo of resource distribution, which is heavily focused on SOVs, given that negative externalities for bikes, walking, and transit are very small compared to automobiles.

The magnitude and urgency of the need to transition to low-GHG transport systems necessitates massive investments in transportation systems and infrastructure across the world as well as much better utilization of the existing infrastructure. Achieving a low-GHG transportation sector requires re-thinking the long-standing pillars of mobility, accessibility, and safety to also consider GHG emissions outcomes. The speed and scale of this transition opens opportunities to better incorporate equity considerations into transportation systems, and care should be taken to understand the impacts of transportation interventions, particularly to disadvantaged groups and underserved communities.

Defining Transportation Equity

Who are ‘Underserved Communities?’

The US DOT defines ‘underserved communities’ as “a population sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified by (...) the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.”

The socio-economic ripple effects of long-standing and systematic unequal access to mobility can be far reaching. Peoples’ ability to access social, economic, and cultural opportunities depends on their ability to reach destinations where such opportunities occur either physically or digitally. As such, transportation equity is as much about how far certain groups need to move to reach opportunities (land use patterns) as it is about access to means of transportation that can reach such destinations (quality and range of the transportation network) (El-Geneidy & Levinson, 2006). Transportation equity was officially established as an important planning consideration under Title VI of the Civil Rights Act of 1964, and most contemporary transportation planning documents consider transportation equity to some degree (Guo et al., 2020). Nonetheless, considerably more progress is necessary both generally and in the context of transitioning to low-GHG transport systems.

No singular definition exists for the concept of transportation equity, nor one prescription for how to achieve an equitable transportation system. Rather, transportation equity is rooted in an ethical framework shaped by ideas of fairness, equity, and justice. Litman (2022b) unpacks the concept of equity into *horizontal* and *vertical* equity, as detailed in Table 1 below. Horizontal equity refers to the idea that individuals and/or groups should receive equal treatment, in terms of the distribution of either resources or opportunities. Vertical equity takes into consideration the relative ability to carry burden, recognizing that people have different circumstances and thus should have a different allocation of resources and opportunities that wholly or partially compensate for those differences.

Table 1. Concepts in Transportation Equity

Horizontal equity	<i>Fair distribution of resources:</i> public resources should be allocated in such a way that people generally get what they pay for and pay for what they get.
	<i>Distribution of external costs:</i> the different costs that various modes of travel impose on others, such as pollution, congestion, and safety concerns, should be minimized and compensated for, and the burden be paid by users.
Vertical equity	<i>Inclusivity:</i> to what degree transportation systems serve different mobility needs such as those by youth, seniors, and people with disabilities.
	<i>Social justice:</i> to what degree transportation systems serve disadvantaged and underserved groups and mitigate or eliminate structural injustices.
	<i>Affordability:</i> to what degree transportation systems promote equal access as it relates to income. Regressive transportation policies are those that favor high-income people. Progressive transportation policies are those that favor low-income people. To fairly assess cost burden, it is common to assess the financial impact of transportation as a percentage of income.

Source: (Litman, 2022b).

Horizontal equity is concerned with the unfair distribution of benefits and costs of transportation policies that often mirror systemic inequality seen elsewhere in society (Sanchez et al., 2003). Historically, groups that face discrimination and unequal opportunities in other aspects of society have also been underserved in spending on and design of transportation systems and have typically also had limited access to housing in areas with high economic opportunity. Studies have, for example, identified a higher relative prevalence of pedestrian accidents among low income and minority groups (Kravetz & Noland, 2012). The reason for this statistic is probably manifold. Low-income and minority groups have a higher prevalence of walking as it has little to no capital costs. But a national study also found that low-income communities are less likely to have pedestrian safety infrastructure such as sidewalks, streetlights, and traffic calming features (Gibbs, 2012). Further, worsening the impacts, low-income and minority communities are often receiving a disproportionate number of pedestrian citations (Mahdawi, 2020; Rosen, 2012; Sanders et al., 2017; Schmitt, 2020).The health impacts from automobile pollution also tend to fall

disproportionately on certain communities and groups, including children, older adults, people with pre-existing cardiopulmonary disease, and people living in low socioeconomic communities (US EPA, 2014). Lastly, automobile pollution is experienced relatively more by groups that tend to have low or no vehicle ownership, as they would be more likely to be walking, biking, and taking public transit and thus have more exposure to street-level pollution.

The history of “Jaywalking”?

In “The Dawn of the Motor Age” published in 2008, Peter Norton, a historian and expert in the history of “jaywalking” in America, tells the history of pedestrian traffic violation laws in America. He refers to early legislation proposed by automakers to shift blame onto pedestrians for rapidly increasing injuries and fatalities faced by pedestrians with the incursion of vehicles into cities. Before the 1920s city streets were used as public space where pedestrians could roam freely (though horse carriage accidents happened), and laws generally put the responsibility on the heavier vehicle when pedestrian accidents occurred (Norton, 2008). “Jaywalking” laws underline how public streets have become car centric, and some mean they contribute to drivers being less concerned with pedestrian safety. The mere fact that low-income and minority neighborhoods are substantially more prone to pedestrian fatalities due to poorer safety infrastructure, makes “jaywalking” an inequitable policy. Minority and poor neighborhoods receive a disproportional number of jaywalking tickets, in some locations to such a degree that it’s unlikely that racial and socioeconomic profiling does not play a role (Mahdawi, 2020; Rosen, 2012; Sanders et al., 2017; Schmitt, 2020). January 2023 California Governor Gavin Newsom signed the “Freedom to Walk Act,” (AB 2147), decriminalizing “jaywalking” in the state, thereby joining Kansas City and Virginia.

Vertical transportation equity is concerned with creating more inclusive transport systems, i.e., giving all people and groups access to mobility (or, at a minimum, sufficient access to healthcare, employment, education, and basic shopping) by adapting transportation systems to improve accessibility for people of all abilities and socioeconomic status (Guo et al., 2020; Litman, 2022b). Seniors, youth, and people with disabilities often lack independence in terms of mobility and must rely on relatives or expensive taxis/shuttles for transport assistance if they live in a community with poor public transport options. Low-income people often lack mobility options or are disproportionately burdened with high

transport costs. Women often face unique challenges and transportation needs, particularly as it relates to safety concerns (Hail & McQuaid, 2021). Offering a diverse set of transport options and focusing on low-cost options with attention to non-motorized modes can increase vertical equity in transportation particularly as it relates to socioeconomic disparities (Litman, 2022b). Attention must be given to the prevalence of inequity also within such modes. Research shows that active transportation options are often distributed unequally and lack particular attention to needs of minority groups and women. Bicycling in the U.S., for example, tends to be dominated by white males (Lee & Jones., 2017). Day (2006) found that middle-class suburban neighborhoods were more often the target group of active transportation planning campaigns. The same often goes for bike-sharing and car-sharing services, which tend to be in the private sector with attention to profit rather than equity, often leading to concentration of transportation-sharing services in middle-class and affluent communities (Guo et al., 2020). Complete Streets initiatives focus on planning streetscapes that enable safe access for multiple types of transportation types as well as users with a range of ages and abilities.

Transport Equity Opportunities in Climate Action

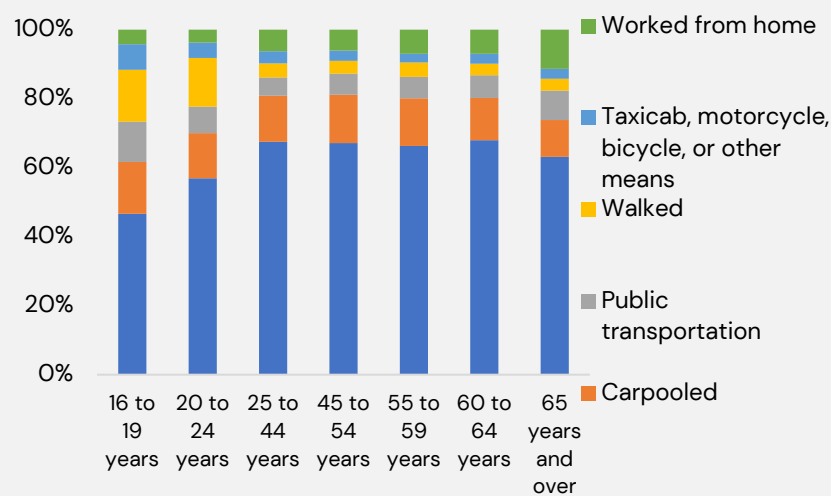
Low-income people and some otherwise disadvantaged groups emit fewer GHG emissions than the general population because they are less likely to own a car, more likely to car-share, use transit, bike, or walk. At the same time, low-income and disadvantaged groups tend to be disproportionately burdened with non-user automobile costs, and other negative externalities including health effects from pollution and traffic accidents. A key driver of these disproportionate burdens is the lack of pedestrian and bike safety measures in underserved communities. Many GHG reduction policies, particularly those that shift public spending away from subsidizing private vehicles toward public transit and non-motorized mobility, offer an opportunity for synergistic policy effects that produce a fairer distribution of direct costs and negative impacts. Other GHG policies, such as subsidizing car EV ownership, are important to reducing emissions but have also been found to perpetuate inequitable outcomes and thus cannot be the sole intervention.

Transportation Equity on O‘ahu

On O‘ahu, mode choices of the commuter population depend on their residential location, as well as demographics. Mode choice can be due to differences in transportation needs, preferences, and access to various forms of transportation among different groups. Figure 1

below shows commuter mode shares – driving alone, carpooling, and use of public transportation – among different social and economic groups. To the degree that funding and resources are disproportionally allocated to various modes relative to their commuting mode share, it also affects the distribution of transportation benefits among social and economic groups. Differences in mode choice across social groups are at least partially due to differences in income between these groups. The average household in Honolulu spent 12.4% (\$7,580) of its budget on transportation in 2020–21, statistically significantly lower than the national average of 16.2%. An estimated 94% of these expenditures for the average Honolulu household went to buying and maintaining private vehicles (US Bureau of Labor Statistics, 2021).

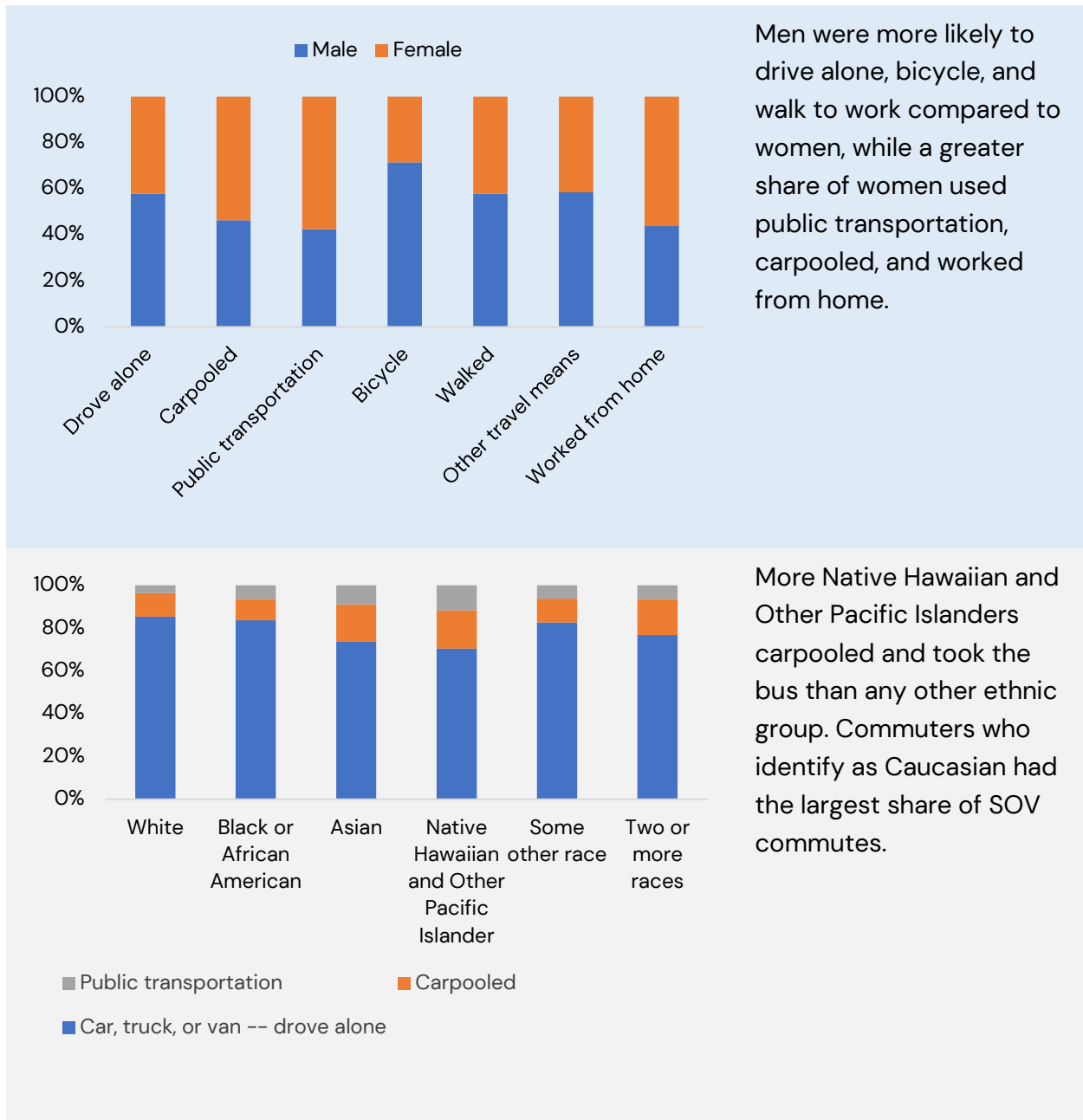
Figure 1. Mode Share and Demographic Characteristics for Honolulu



In 2021 young adults and teenagers had the smallest share of people commuting by SOV and the largest share of people using non-car modes. The SOV mode share was similar between people aged 25 to 64, while people over 65 years had a greater rate of working from home and using public transportation.

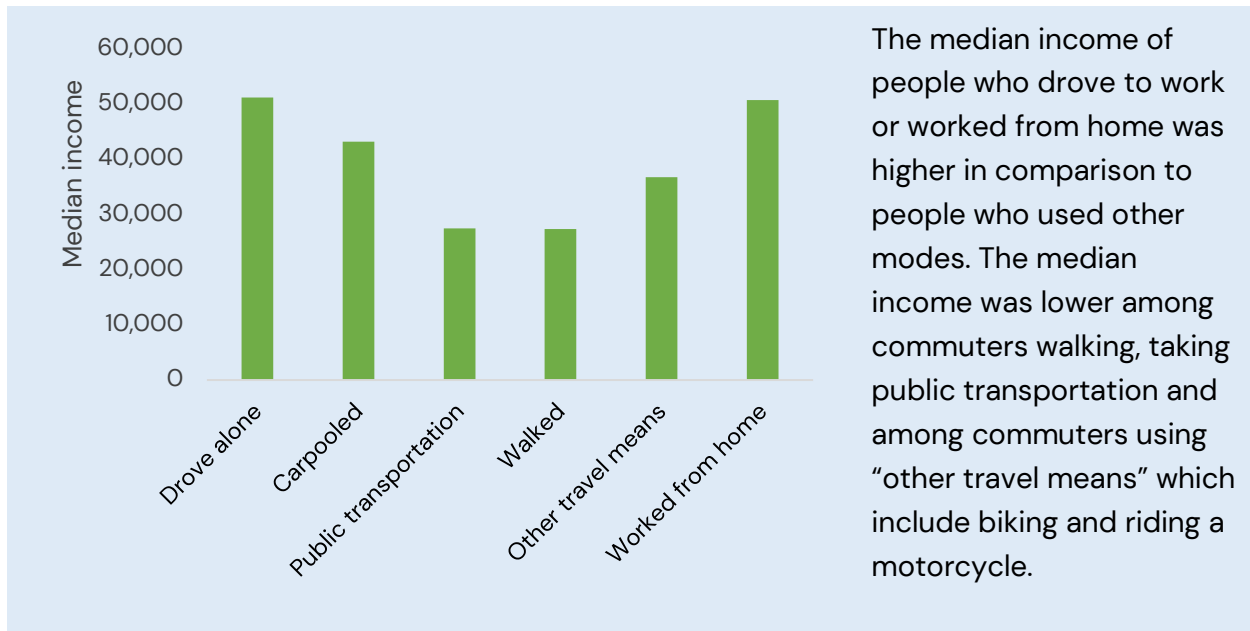
O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps



O‘ahu Climate Action Plan Ground Transportation Sector

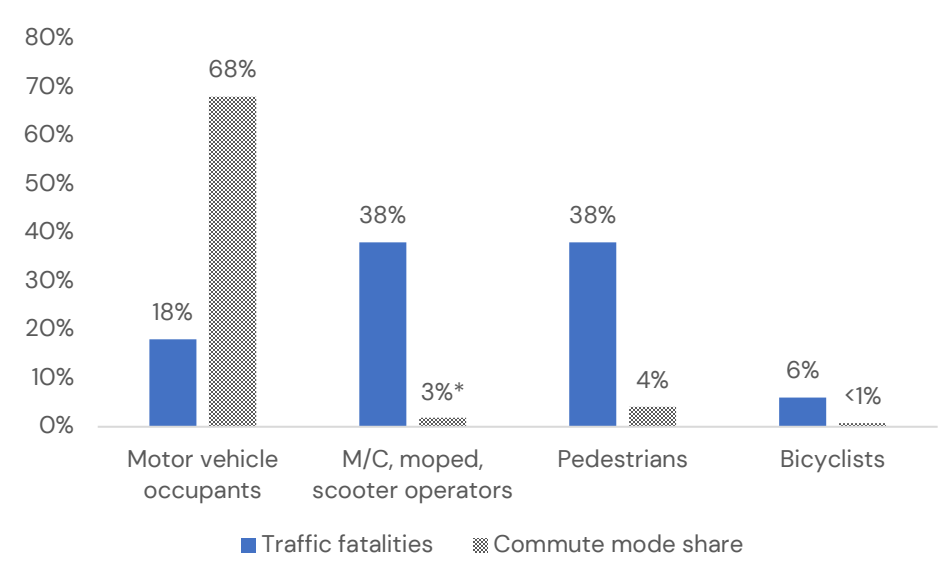
An assessment of Transportation Trends, City Progress, and Next Steps



Source: U.S. Census Bureau (2022a)

Note: Public transportation does not include publicly provided taxicabs.

Figure 2. Comparison of Traffic Fatalities and Mode Shares on O‘ahu in 2021



Source: HDOT (2022) and U.S. Census Bureau (2022b)

Note: Commuter mode shares do not add to 100% as public transit and other means of commute are not included in the graphic. The share of traffic fatalities is normalized across the four categories in the figure so these shares sum to 100%.

The majority of crashes involve only motor vehicles; however, pedestrians, bicyclists, and motorcyclists are overrepresented relative to their mode share, particularly in serious and fatal injuries. Figure 2 compares fatal crashes involving various modes to commuter mode shares. Motorcyclists (including scooter, moped and motorcycle riders) made up 38% of fatal traffic crashes in 2021, more than 17 times the commuter mode share for motorcyclists.¹ Pedestrians made up only 5% of commuters in 2021, however, 38% of people killed in crashes were pedestrians. Bicyclists make up less than 1% of commuters in 2021, yet 6% of people killed in crashes were bicyclists. On O‘ahu, the elderly, residents in areas with high percentages of minority populations, and people in poverty experience relatively higher rates of pedestrian fatalities (DTS, 2022). The elderly are particularly vulnerable as pedestrians and bicyclists. People 65 years and older made up 41% of people killed in crashes while walking and 24% of people killed while bicycling between 2015–2020 despite comprising less than 10% and 12% of the walking and biking population respectively (U.S. Census Bureau, 2022a; City and County of Honolulu, n.d.). A study that looked at traffic fatalities among Native Hawaiians between 2007 and 2016 found that young Native Hawaiians were disproportionately at risk of traffic fatalities in comparison to people of the same age in the general population (Prevedouros et al., 2019).² On the other hand, the study found that there were significantly fewer traffic fatalities among Native Hawaiians 50 years and older relative to the same age group in the general population (Prevedouros et al., 2019).

A key component of supporting both more equitable forms of transport while reducing GHG emissions is to invest more in active transportation networks such that it supports the mobility of otherwise underserved communities. In this way, the concept of horizontal equity within transport can also be extended to thinking about investment in transportation modes. Automobiles tend to receive more government funding despite imposing higher external societal costs than other modes. Figure 3 displays distribution of total planned

¹The mode share in the American Community Survey for motorcyclists are bundled with taxicabs and other small commuter modes, thus the mode share for motorcyclists alone is likely to be smaller than 2%.

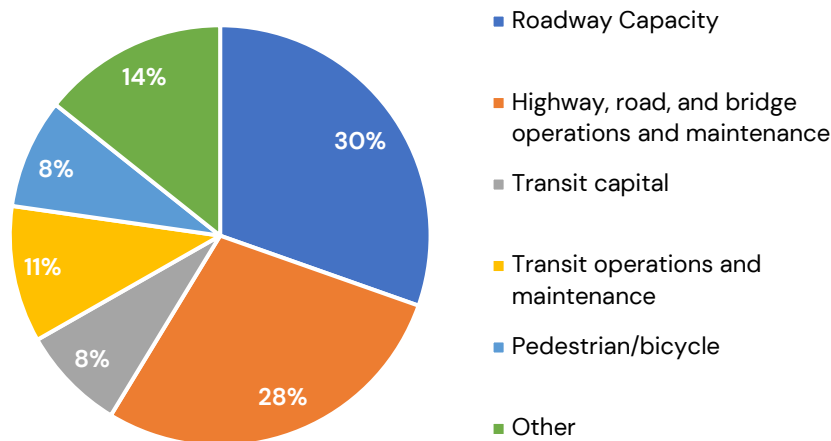
² Though many fatalities were linked to both speeding and alcohol-related fatalities, there is also potentially a built-environment component to these outcomes, as areas that have received less investment in roads and safety features could also lend themselves to unsafe speed conditions. In addition, improper usage of restraints was found to contribute to Native Hawaiian and Pacific Islander traffic fatalities, prompting need for outreach.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

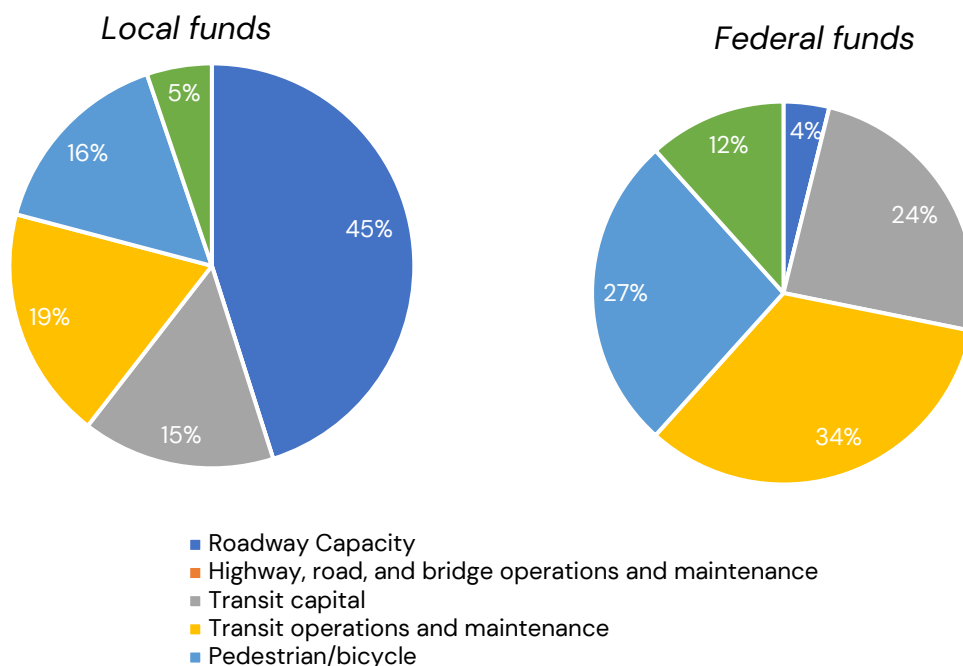
expenditures of funds in the O‘ahu Transportation Improvement Program for the years 2022–2025, while Figure 4 shows the distribution of the portion of these funds that is administered by the City and County of Honolulu. Overall, 58% of transportation expenditures on O‘ahu in this period are dedicated to projects that directly benefit motor vehicles, as compared to 19% to transit, and 8% to pedestrian and bicycle projects combined (O‘ahu MPO, 2021b). For projects administered by the City and County of Honolulu, the plan dedicates 45% of *local* funds to roadway capacity projects compared to 34% on transit and 16% on bike and pedestrian projects. The City plans to spend 5% of federal funds on roads in the same timeframe (O‘ahu MPO, 2021b). As such, the share of transportation funding that is dedicated to car-centric projects is less than the current automobile commuter mode-share. On the other hand, car-centric infrastructure makes up most of the transportation infrastructure on a per mile basis in most U.S. cities. Therefore, increasing the portion of bike, pedestrian, and transit centric infrastructure naturally requires relatively more capital investment than maintaining already built roads.

Figure 3. Proposed State and County Transportation Expenditures for O‘ahu for the Years 2022–2026 by Project Type



Source: Adapted from O‘ahu Transportation Improvement Program 2022–2025 (OMPO, 2021)

Figure 4. Proposed City and County of Honolulu Transportation Expenditures by Project Type and Funding Source



Source: Adapted from O‘ahu Transportation Improvement Program 2022–2025 (O‘ahu MPO, 2021)

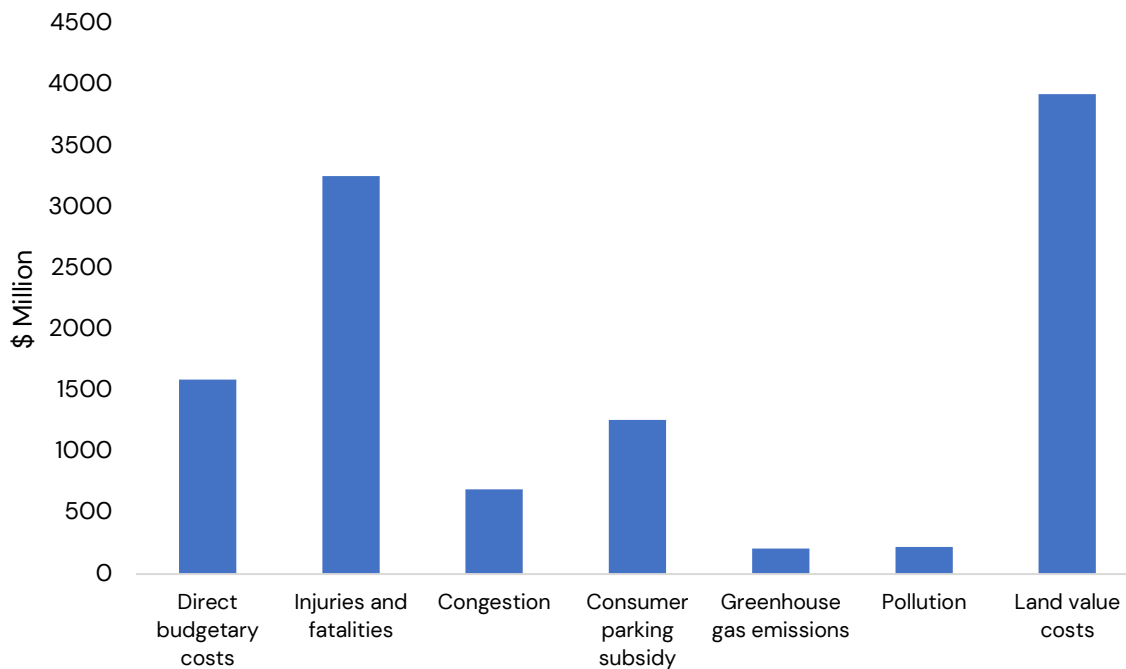
The local transportation expenditures described above only account for direct government expenditures on infrastructure and not for negative externalities (the costs imposed on non-users or society as a whole) from driving, public transit, and car-infrastructure. Ulupono (2021) found that Hawai‘i’s motorized vehicle economy amounts to expenditures of over \$20 billion annually and that less than half of these costs are borne directly by vehicle owners. The majority of Hawai‘i’s vehicle economy is funded by the public via non-vehicle related taxes, and these expenditures tend to exacerbate rather than mediate external costs such as ground level pollution, congestion, and GHGs. The distribution of the cost of automobiles borne by the general public is shown in Figure 5. Biking and walking also have some external costs related to government spending and traffic-related crashes but very little compared to automobiles; they also have positive external benefits such as improved health. One report estimated that external costs from automobiles can be as much as 34 and 140 times that of biking and walking respectively (Litman, 2021). Moreover, Ulupono (2021) estimated that annual per household costs of vehicle ownership amounts to

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

\$24,400, making it an equity and affordability imperative to support choices for convenient, safe, and affordable transportation alternatives to the car (Ulupono, 2021).

Figure 5. Annual Public Costs of the Vehicle Economy in Hawai‘i



Source: Ulupono (2021).

Designing Policies to Promote Transportation Equity

The City already has in place a system of checks and balances to promote an equitable distribution of funding for bike and pedestrian projects. Both the O‘ahu Pedestrian Plan (2022) and the Honolulu Bike Plan update (2019) define Environmental Justice Communities in accordance with Title VI of the Environmental Justice Act and perform spatial analysis to assess whether project funding is at least proportional to the share of population in these areas. For example, an equity analysis conducted for the O‘ahu Regional Transportation Plan uncovered that the gap in resource allocation to Title VI and Environmental Justice communities is narrowing, from \$1,728 less per capita in the previous plan to \$258 less per capita in the current plan (O‘ahu MPO, 2021a). Despite the improvement, a gap nonetheless remains and prompts increased attention to resource allocation within project planning. The O‘ahu Pedestrian Plan highlights critical prioritization areas as they relate to safety concerns and documents how elderly as well as environmental justice communities are disproportionately subject to traffic injuries and fatalities in general terms (Honolulu DTS,

2022). Progressing to concrete and actionable steps should include developing equity project prioritization criteria associated with allocation of resources. This will require a more in-depth analysis of the current pedestrian-, bike-, and transit network overlayed spatially with socio-economic data. Developing such controls earlier in the planning process can both ensure equal distribution of resources (horizontal equity) and promote more equal outcomes (vertical equity). Because transportation equity is a multi-faceted spatial issue, a first-step in addressing transportation inequity is to analyze existing procedures, systems, and investments to identify equity prioritizations. Performing such an equity survey of the transportation systems allows for the design of equity policies and procedures that address systematic inequalities in transportation policy. Table 2 lists research questions that are meant to uncover systematic horizontal and vertical inequities in transportation planning.

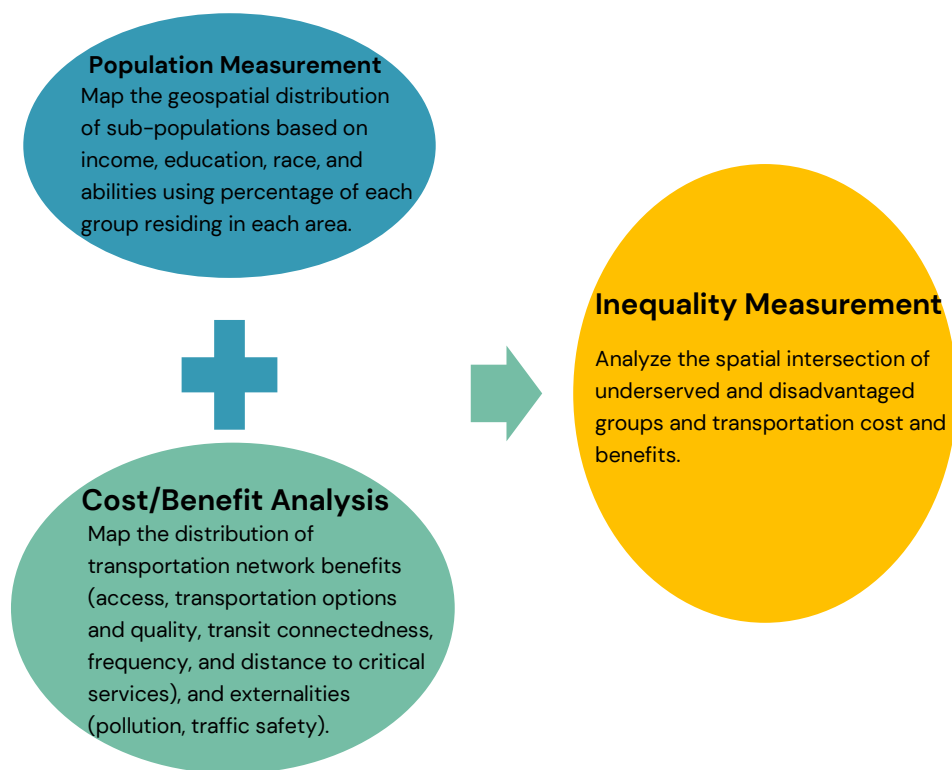
Table 2. Questions for Examination of Transportation Equity

Horizontal Equity		Vertical Equity		
"Fair Share"	Sharing and Mitigating External Costs	Inclusivity	Affordability	Social Justice
What demand exists for various modes and accessibility options? What are the costs of serving those options? Are user costs and subsidies justified and/or proportional to demand?	What external costs do various travelers impose and bear (e.g., pollution exposure)? What are the net external costs imposed or borne by various groups? How can external transport costs be mitigated?	How well does planning respond to non-auto travel demands? What is the mobility disparity between motorists and non-motorists? What is needed to better serve mobility impaired travelers?	What are the user costs of various accessibility options? To what degree does planning respond to demand for more affordable modes? How can transit become more affordable?	What structural inequities exist in transportation planning? What is their legacy of inequity? What policies and programs can reduce current and correct for the legacy inequities?

Source: Adapted from Litman 2020b

Guo et al. (2020) proposes a three-step overlay analysis to uncover spatial prevalence of inequities, as shown in Figure 6. The approach couples detailed spatial population data and a spatial cost-benefit analysis with the intent of uncovering the spatial intersection of disadvantaged and underserved groups, as well as transportation costs and benefits. The approach suggests assessing not only the quantity of transportation benefits provided to each spatial entity but also the quality such as connectedness to services and other modes and the quality of bike and pedestrian infrastructure (Guo et al., 2020).

Figure 6. Components of a Transportation Network Equity Analysis



Source: Adapted from Guo et al. (2020)

Because inequalities tend to compound (e.g., discrimination leads to lower income levels which lead to poorer access to transportation), cross-cutting solutions are likely to have the furthest reach. Certain policies are more likely to address all forms of equity while others may have both positive and negative impacts on other aspects of equity (Litman, 2020b). For example, subsidizing car-ownership for low-income people does achieve greater access for this group, but this policy increases the cost burden for others that for various reasons do not own a car and increases external costs such as pollution and

congestion, which can add to societal impacts as well as those specific to vulnerable groups. Efficient road and parking pricing reduce externalities associated with congestion and pollution effects but also lowers access as they raise the cost of car-ownership. Thus, interventions within transportation systems are often required to occur as a package of actions, each addressing issues relating to efficiency, effectiveness, and equity.

Finally, though transportation systems should enhance access to social and economic opportunities equally among residents, these systems are insufficient on their own. Research shows that land-use and housing policies are more powerful tools in enhancing economic equality and access to opportunities (Tomasiello et al., 2020) and that housing and transportation must be addressed in concert to evaluate equity implications and guide policies toward bringing better access to opportunities for lower-income households (Welch, 2013). Welch (2013) found that among several federal prescriptions designed to increase access to housing and transit for low-income and disadvantaged groups, some led to higher transit access while others led to poorer access compared to the general population. Because of the heterogeneous impact of affordable housing policies, land-use policies (such as those proposed in CAP Strategy 1) should be considered in a local context as well as in concert with transportation policies when performing an equity analysis and designing solutions. The City is already doing this to some degree with its Transit Oriented Development plans and guidelines in the Land Use Ordinance. Continuing to promote affordable housing and land use strategies in consort with CAP actions, also outside of TOD zones, will be imperative to ensure effective GHG reduction outcomes that also minimize adverse economic impact on lower-income households.

Smart Growth for Whom? – Equity Implications of Density and Mixed-Use

Density, mixed-use zoning, infill development, compact and “15-minute” cities, are all “smart growth” concepts that are tightly woven into modern urban sustainability – and GHG reduction planning. The idea is that through zoning, physical design, and taxes, the state can direct development in a more environmentally beneficial direction – generally toward less sprawl. The benefits of density and mixed-use are well documented; how to achieve this outcome, and with what tradeoffs, are areas of considerable study. There is ample evidence that compact and mixed-use urban environments can lead to a reduction in car dependency and improved mobility for a broader variety of transportation users and thus also social benefits (Hankey & Marshall, 2010; Lee & Lee, 2020; Leibowicz, 2017; Marshall, 2008; Ng, 2009). Denser development have been linked to greater levels of social upward mobility due to improved access to job opportunities (Ewing et al., 2016). Simply put, shorter distances between necessary and recreational destinations give more opportunities and enable less travel and travel with less energy intensive modes. And no doubt, limiting outward sprawl limits the degree of which urban development displaces rural ecosystems and agricultural land. Nonetheless, another body of literature warns about increased housing prices and alienation of working-class families from urban areas that have been shaped around density and mixed-use policies (Ahlfeldt & Pietrostefani, 2019; Hoxie et al., 2023; Moos et al., 2018; Palm et al., 2014). For example, in Vancouver, Canada – a North American City that implemented “smart growth” regulation in an era when most North American cities were developing around the new found freedom associated with the automobile – Quastel et al. (2013) find that urban areas that had undergone densification and transit oriented development were significantly more likely to have experienced gentrification over the decades. The authors do not fault density and transit policies for rising housing cost per-say but rather the unlucky combination of such spatial policies with an eroding political concern for social fairness in the housing market. This body of literature warns us that “smart growth” policies are not social policies in and of itself. Density policies can also lead to congestion and loss of urban greenery if it is not accompanied by parking reform, supply of active and public transit options, and protection of green space. Increased density remains an essential component of the City and County of Honolulu’s strategy toward creating a low-emissions and equitable transport sector, but also prompts complementary housing oriented policies and programs (see <https://www.honolulu.gov/tod/zoning-policies/related-items/affordable-housing.html>).

III. Transportation Data and Trends

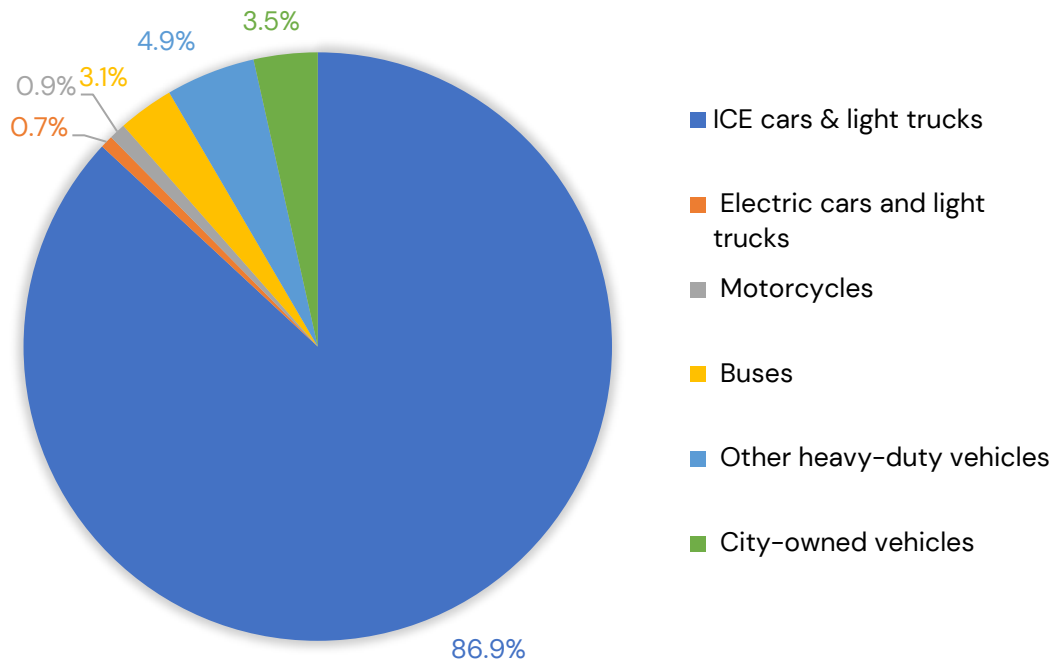
O‘ahu’s GHG Emissions and Factors that Determine Emissions

Key Takeaways

Gasoline cars and trucks are responsible for most ground transportation GHG emissions and the largest share of VMT on O‘ahu. Dramatically reducing SOV trips should be a key target for GHG reduction in the ground transportation sector. Pre-pandemic data suggest that commuters on O‘ahu were trending toward more single occupancy and overall vehicle usage. The near-term data suggest that work-from-home increased substantially though it remains unclear how durable this effect might be or to what extent it affects household VMT. Transit usage remains substantially below pre-COVID ridership, which adds to a longer-term trend of ridership decline. There was a recent boost in EV adoption, but the overall share of EVs on the road is only 1%.

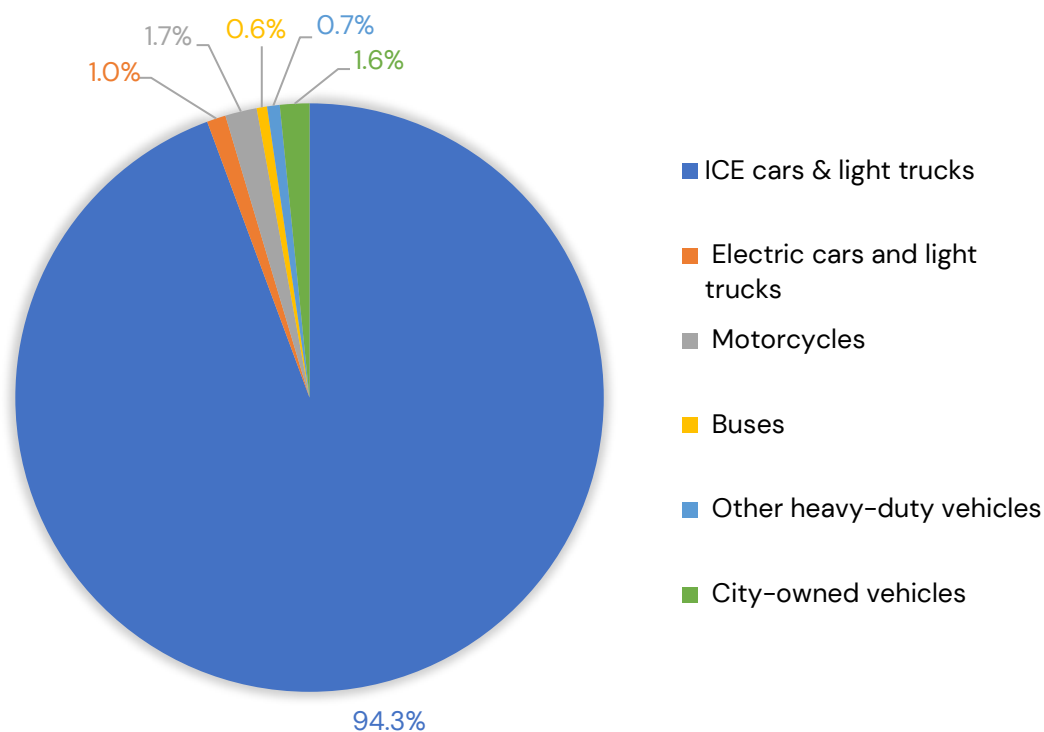
Gasoline powered cars and light trucks make up the vast majority of ground transportation GHG emissions and VMT on O‘ahu, as shown in Figure 7 and Figure 8.

Figure 7. 2019 Ground Transportation Emissions Shares by Vehicle Type



Source: Emissions from Hawai‘i GHG Inventory Report (2023) distributed to vehicle type based on data from AFDC (2022), DBEDT (2020), FHWA (2022, 2022b), HSEO (2020), City and County of Honolulu (2020)

Figure 8. VMT Shares by Vehicle Type – Percentage of Total VMT 2019



Note: “City-owned vehicles” include all types of vehicles including buses, cars, motorcycles, and other heavy-duty vehicles. All other categories exclude City-owned vehicles.

Source: Calculated using annual VMT per vehicle data from FHWA (2022) and number of registered vehicles from Alternative Fuels Data Center (AFDC, 2022), DBEDT (2020), HSEO (2020), City and County of Honolulu (2020).

A total of 87% of ground transportation GHG emissions for O‘ahu and 94% of VMT are from gasoline- and diesel-powered internal combustion engine (ICE) cars and light duty trucks. There were 770,000 registered motor vehicles on O‘ahu in 2021, approximately 740,000 of which were light duty passenger cars and trucks (DBEDT, 2021). There were a total of 14,000 electric vehicles (EVs) registered on O‘ahu in 2021, comprising about 2% of the light duty vehicle fleet (DBEDT, 2022a). The charging of EVs emit GHGs associated with combustion of fossil fuels for electricity generation. Indirect emissions from EVs amounted to about 0.7% of transportation emissions in 2019. There are approximately 11,000 cars and light

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

trucks that run on diesel, and 26,000 motorcycles. Approximately 5% of vehicles on the road are new each year and a similar, though slightly lower, number are retired from usage.³

City owned vehicles account for 1.6% of total ground transportation VMT, and 3.5% of GHG emissions. This is because a sizable portion of annual VMT within the City fleet comes from City buses and other heavy-duty vehicles that use more fuel per mile than lighter vehicles and on average travel much greater distances than LDVs. However, because vehicles like buses tend to transport a greater number of people, their per capita GHG emissions per mile traveled tend to be substantially lower than transport via passenger cars and trucks. The second largest source of GHG emissions, non-city heavy duty vehicles and buses, make up almost 8% of emissions and less than 1.5% of VMT. Motorcycles comprise 1.7% of annual VMT and 1% of GHG emissions.

Transportation Trends and Pandemic Impacts

Key Takeaways

As of February 2022, people on O‘ahu still made fewer trips compared to pre-pandemic levels. Mode shares remained stable between 2015 and 2019, with SOV commutes increasing slightly and bus and carpooling decreasing slightly. Mode share changed substantially during the pandemic: the share of people working from home tripled in 2021. Surveys indicate that this number may remain higher than pre-pandemic levels though prior research suggests that this increase will not necessarily decrease overall VMT. While VMT has generally been increasing on O‘ahu, it fell during the pandemic but is nearly back to pre-pandemic levels as of June 2022. TheBus ridership was severely impacted by the pandemic and remains lower than pre-pandemic levels.

The rapid onset of the global COVID-19 pandemic in 2020 drastically changed the mobility landscape for people all over the world. O‘ahu was impacted by a series of stay-at-home orders, coupled with the shuttering of many in-person work and school activities. Questions

³ In 2021, there were an additional 58,000 new cars and light trucks registered statewide. Taking the defacto population share of O‘ahu relative to statewide (66%), this is 5% of total registered vehicles. A similar number of vehicles were retired in 2021, as net registrations increased by fewer than 700 vehicles (DBEDT, 2021).

remain as to the durability of some of these new work-from-home arrangements on transportation systems, as well as to changes in public transit ridership. While it is still too early to conclude whether the pandemic has caused long-term changes in transportation systems for O‘ahu, there is certainly more hindsight than at the time of writing the CAP. This sub-section looks at short-term impacts in key transportation trends with a focus on pandemic-related drivers.

Mode Shares and Travel Behavior

At the height of the pandemic, cities worldwide saw a drop in trips of as much as 90% compared to pre-pandemic levels (IEA, 2020).⁴ Figure 9 illustrates the movement of people on O‘ahu during the pandemic period and through February 2022 for trips up to 50 miles both in comparison to 2019 levels (BTS, 2022).⁵ Because the data only track movement, we do not know by which mode trips were made; however, the natural distance limitations created by Hawai‘i’s island geography allows us to assume that most short to medium trips (under 50 miles) occur on O‘ahu by ground (though a small portion of this may be boat traffic and trips by air to Moloka‘i). In general, people have made fewer trips throughout the pandemic than they did in 2019 though there have been periods of increased travel, particularly for trips between 25–50 miles. People on O‘ahu traveled between 30–50% less in the first couple of months after Hawai‘i put in place the first COVID-19 restrictions and as of January 2022 still make fewer trips of all lengths than before the pandemic. In January 2022, people on O‘ahu made 390,000 fewer trips between <1–50 miles than in January 2019 (BTS, 2022). Sustained lower levels of movement generally correspond to sustained higher levels of people staying at home (black dotted line in Figure 9 – though we find the data puzzling and perhaps erroneous in that a large proportion of people stayed at home in

⁴ Based on data collected by the Citymapper Mobility Index.

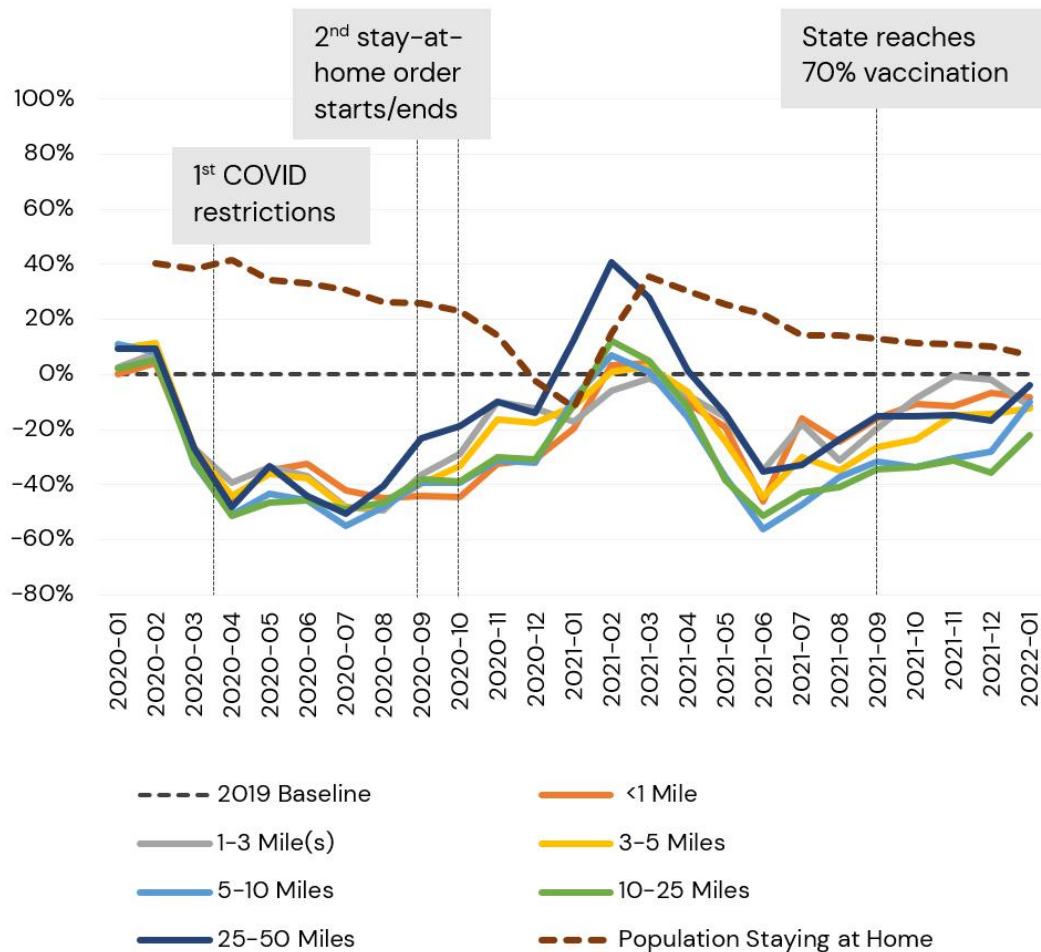
⁵ Based on anonymized mobile device data from multiple sources analyzed by the Maryland Transportation Institute and Center for Advanced Transportation Technology Laboratory at the University of Maryland for BTS. Trips are defined as movements that include a stay of longer than 10 minutes at an anonymized location away from home. Home locations are imputed on a weekly basis. A movement with multiple stays of longer than 10 minutes before returning home is counted as multiple trips. Trips capture travel by all modes of transportation. Including but not limited to walking, biking, driving, and transit.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

winter 2020 relative to winter 2019, though this was pre-COVID). The distribution of trips by length has remained largely unchanged since 2019 (BTS, 2022).

Figure 9. Trips Under 50 Miles by All Modes on O‘ahu by Distance as Compared to 2019 Levels

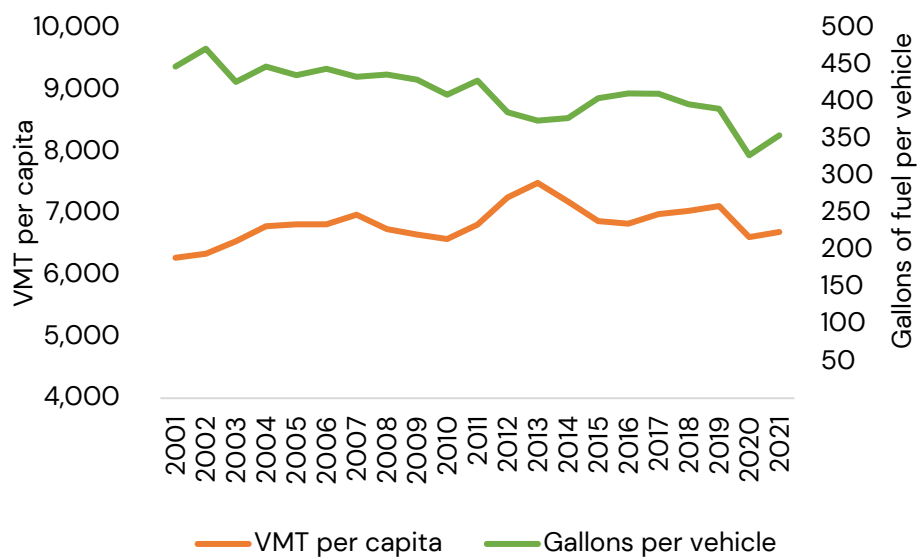


Source: BTS (2022)

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

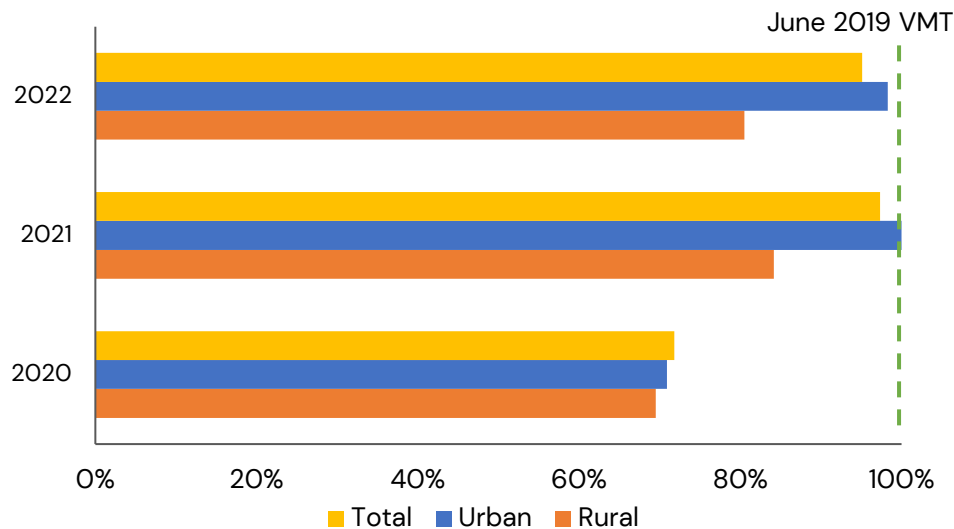
Figure 10. Long term Trends in Annual VMT per Capita and Annual Fuel Use per Vehicle



Source: DBEDT (2022c)

Figure 10 shows that per capita annual VMT has had an upward trend the past two decades (about 13% between 2001 and 2019). At the same time increasing fuel efficiency has led fuel consumption per vehicle to decrease (about 20% from 2001 to 2019).

Figure 11. Honolulu VMT in the Month of June 2020, 2021, and 2022 as Percentage of June 2019 Values

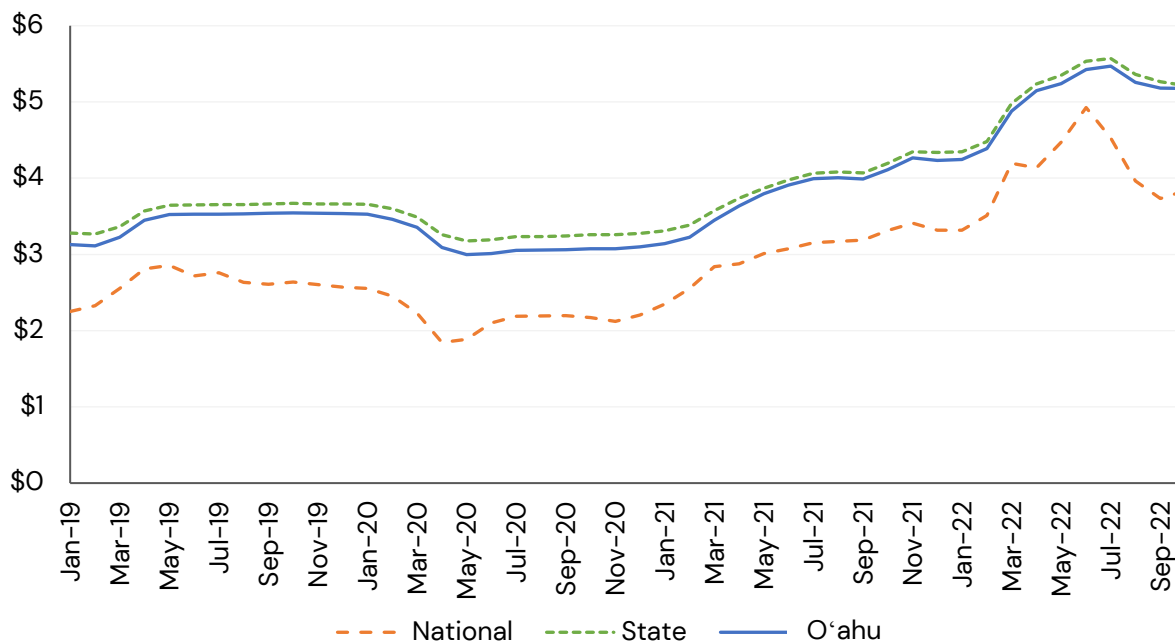


Source: DBEDT (2022c)

As Figure 11 above tells us, the decrease in overall VMT seen during the height of the pandemic and associated GHG reductions were largely temporary (DBEDT, 2022c). Though VMT in rural areas remains lower than it was in 2019, urban VMT makes up the bulk of VMT and has rebounded to pre-pandemic levels. It is hard to say whether rural VMT will remain lower than before the pandemic. To the degree the decrease is due to sustained increase in telecommuting by rural residents, it may result in sustained lower levels of VMT, but such a shift could also lead to more driving for other purposes as many people combine their commute trips with other errands.

Gasoline prices have increased by more than 50% from \$3.70/gallon in January 2020 to \$5.20/gallon in September 2022 (DBEDT, 2022a). O‘ahu’s gasoline prices typically lie slightly below the state average and substantially above the national average as shown in Figure 12. Consumers can respond to higher gasoline prices in a number of ways. Short-term responses tend to center on driving less while long-term responses can extend to investment in more fuel-efficient or EVs.

Figure 12. Price per Gallon for Regular Gasoline on O‘ahu, the State, and Nationally

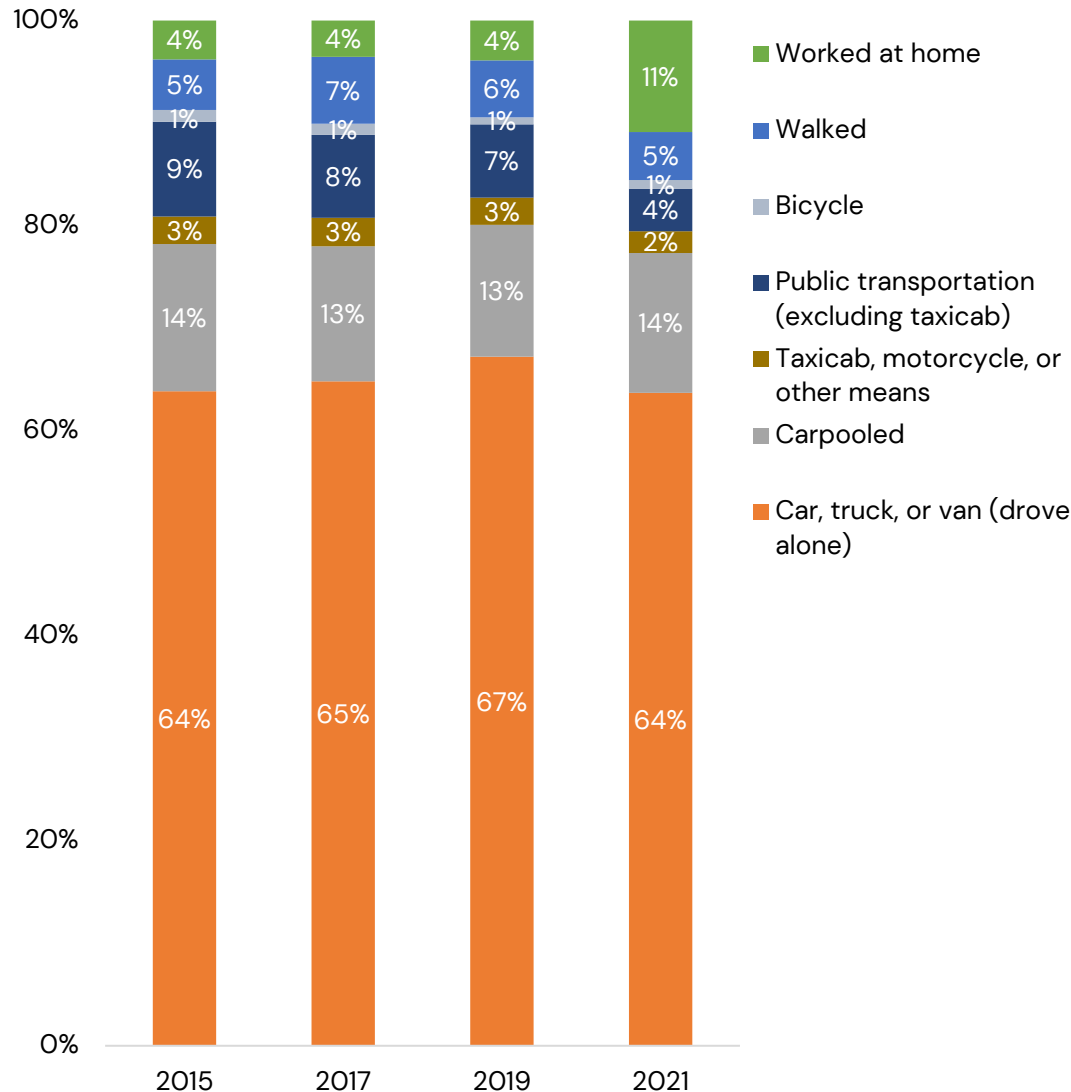


Looking at data from 2015 reveals that commuter mode shares on O‘ahu have remained relatively stable— though with a slight trend toward increasing usage of SOV trips and away from carpooling and public transportation. Figure 13 below shows O‘ahu’s commuter mode shares for 2015, 2017, 2019, and 2021.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Figure 13. O‘ahu Mode Share 2015–2021

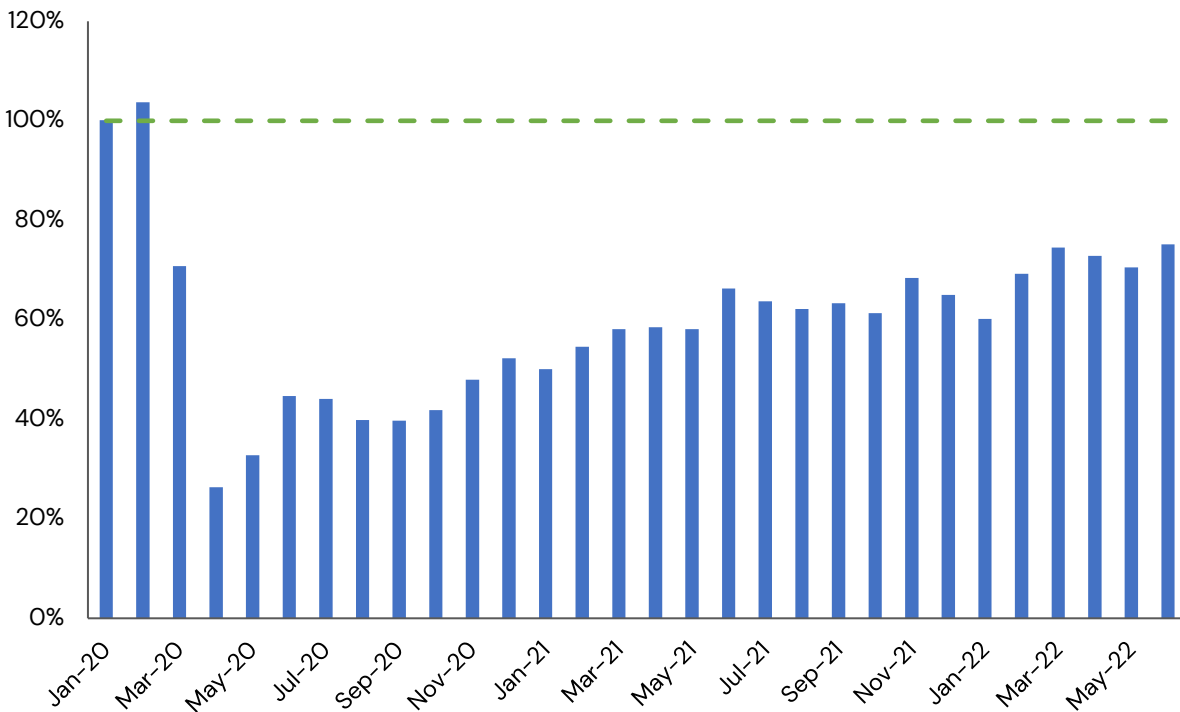


The share of commuters that use public transportation has declined by about 0.8 percentage point a year from 2015 to 2019. During the pandemic, as evidenced in 2021, there was a further shift away from public transportation and a significant increase in people working from home.

In 2021, the State Department of Business and Economic Development and Tourism (DBEDT) issued a survey to thousands of Hawai‘i-based firms and received responses from 861 firms in O‘ahu. The study found that about half of employees in firms with a teleworking policy were working outside the office at least some of the time (DBEDT, 2022b). The study

also found that most of the firms that had instituted a teleworking policy during the pandemic had made hardware and software investments to accommodate remote work and were planning to continue offering a telework option after pandemic concerns lessened (DBEDT, 2022b). Correspondingly, a survey conducted by the Honolulu Department of Transportation Services stated that a substantial portion of City and State employees who drove to work prior to the pandemic would prefer to telecommute in the future (DTS, 2021). While it is commonly assumed that an increase in telecommuting will decrease GHG emissions because the direct effect of working from home is the reduction of that specific commute, some studies have found that, overall, telecommuting has little effect on reducing GHGs and can even result in increased GHGs due to a substantial rebound effect (Holden & Linnerud, 2011; Zhu, 2014). Because commute trips are a fraction of overall trips (20% of total trips for O‘ahu), prior studies suggest that policies aiming to reduce commute travel can increase leisure travel, as well as increase the average miles travelled per commute trip though fewer trips are taken. Zhu & Mason (2014) suggest that policies aiming at increasing telecommuting must be looked at holistically if they are to be a part of a GHG reduction strategy though they acknowledge there are other potential societal benefits from working from home.

Figure 14. Percentage of Monthly TheBus Passenger Trips Taken Relative to Pre-pandemic Levels

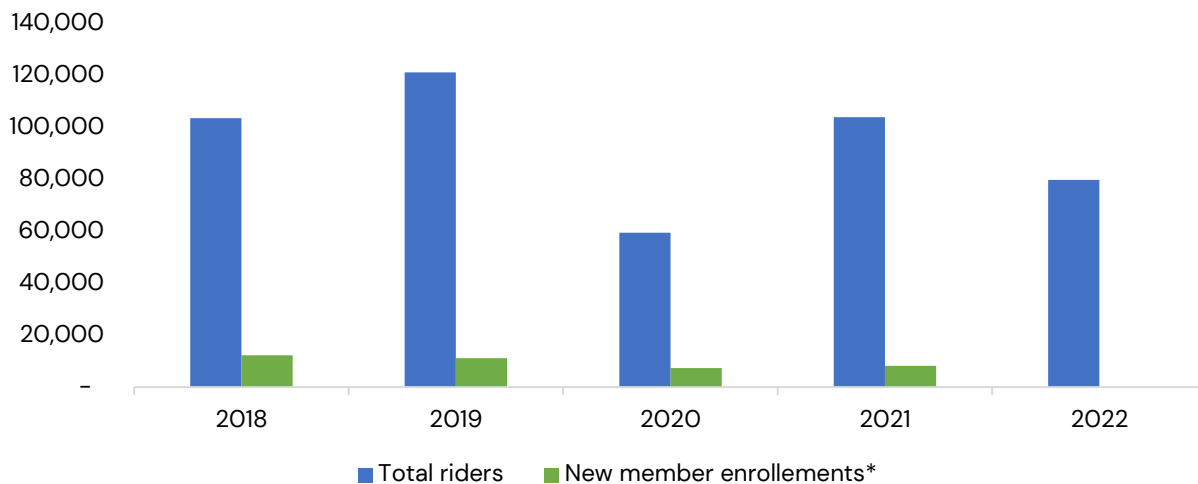


Source: Federal Transit Administration (2022)

Over the past decade, TheBus has experienced a downward trend in ridership in Honolulu. Like other places in the country, a drastic decline in transit ridership occurred during the pandemic and relative to other mid-sized metropolitan areas in the US, transit ridership in Honolulu has recovered at a slower rate (Arvin & Siegal, 2022). As Figure 14 shows, by June 2022, bus ridership was still at less than 80% of pre-pandemic levels (Federal Transit Administration, 2022) despite service returning to almost full capacity. Lower bus ridership during the pandemic partially reflected lower mobility in general as well as other mobility modes being deemed safer in the context of the pandemic—enclosed spaces were often avoided as a safety precaution. In January 2022, ridership was at 60% in comparison to the same month of 2020. About 30,000 passengers either stayed at home or found other modes of transportation. The continuation of lower transit ridership in Honolulu suggests that at least a portion of these passengers likely transitioned to other modes of travel.

As Figure 15 shows, ridership in Honolulu’s bikeshare system, Biki, increased by 30% between 2018 and 2019 then dropped by 40% between 2019 and 2020. This steep decline in ridership mirrors the drop in short trips shown in Figure 9 associated with a steep decline in tourism and restricted mobility among residents during the COVID-19 pandemic. As of 2022, there were 35% fewer riders than in 2019. New membership enrollments have also declined though data do not exist for 2022.

Figure 15. Honolulu Annual Bikeshare Ridership and New Member Enrollments



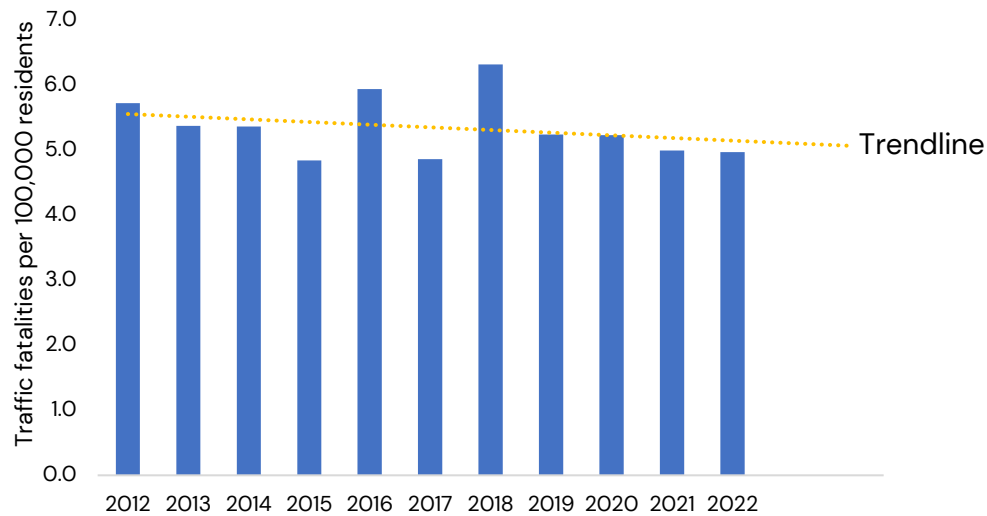
*No data were collected on the number of new member enrollments in 2022.

Source: Data collected and shared with CCSR by Biki

Traffic safety is an important part of recruiting and maintaining bike and pedestrian users. Though movement by any mode declined during the pandemic, traffic fatalities nationally increased. Hawai‘i, however, bucked this trend. Statewide per capita traffic fatalities dropped in 2020 (DOE, 2022a), and per capita traffic fatalities on O‘ahu remained approximately the same as in 2019 and 2020 and declined slightly in 2021 and 2022 (HIDOT, 2022b).⁶ Figure 16 shows per capita traffic fatalities fluctuating but trending downward since 2012 as illustrated by the yellow dashed line.

⁶ Population estimates from DBEDT Data Book for years 2012–2021. 2022 population is based on assumption that the population will grow by 0.5% annually as projected in DBEDTS long term economic forecast.

Figure 16. Traffic Fatalities on O‘ahu per Hundred Thousand Residents



Source: Hawai‘i Department of Transportation (HIDOT), 2022

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

Electrification and Vehicle Technologies

Key Takeaways

Projections of EV sales nationally vary greatly and depend on several federal policies, including Corporate Average Fuel Economy (CAFE) standards and subsidies for EVs. Localized EV adoption depends on a number of factors, including price competitiveness relative to ICEs, typical driving patterns, the availability of charging networks, and other local EV support policies. State and county-level EV support policies, beyond the facilitation of charging infrastructure, are found to have low-cost-effectiveness in terms of promoting additional EV sales. Other innovations in travel technology, such as ridesharing and autonomous vehicles (AVs) offer important mobility and safety features – but require interventions akin to those dissuading single occupancy vehicle trips more generally if they are to contribute to GHG reduction.

Modern EVs came to market in 2010, and sales have steadily increased across the world, nationally, and in Hawai‘i. There were 20,000 EVs on the road in Hawai‘i in 2022, 16,000 of which were registered on O‘ahu. Though there has been a recent increase in EV adoption, sales trends have largely fallen short of expectations and early government goals. The growing prevalence of EVs is occurring in concert with other emerging technologies such as semi- and fully automated vehicles, and car- and ride-sharing technologies. This sub-section looks at how O‘ahu’s transportation network and how its users are integrating new technologies.

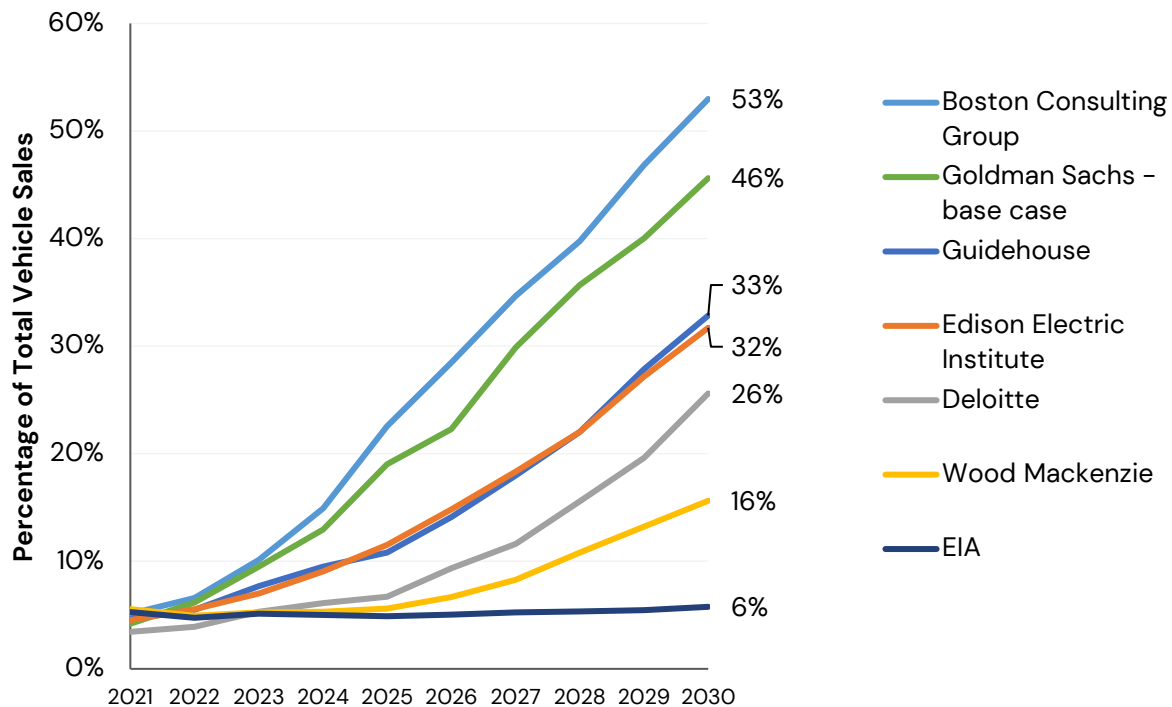
Trends in EV Adoption

EVs are a critically important technology to efforts to decarbonize the transport sector. If EVs are powered by electricity generated from renewable sources, they can achieve zero GHG emissions in their operation. However, there is wide variation in the outlook for EV adoption across the world and within the U.S. Figure 17 below shows a range of EV sales forecasts released in recent years from major consulting and research groups, demonstrating the wide variation in predictions regarding future electrification of the private vehicle fleet.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Figure 17. U.S. EV Vehicle Sales Forecasts

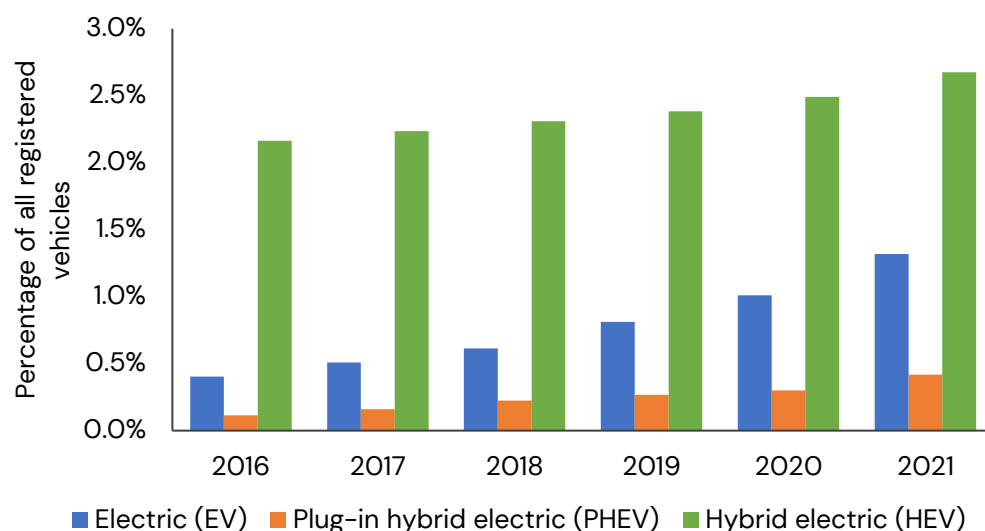


Source: Adapted from Satterfield & Scheffter, 2022

At the lower end of predictions around EV adoption growth is the U.S. Energy Information Administration (EIA, 2022). The EIA assumes very little growth in EV sales, forecasting only 6% of new cars sold in 2030 will be electric. On the high end of the spectrum, Boston Consulting Group forecasts that over half of vehicles sold in the US will be EVs by 2030. There are a few reasons to believe that the EIA forecast is overly pessimistic. Firstly, though the price tag for EVs has historically been higher than ICEVs and many manufacturers raised EV prices during COVID-19 due to supply shortages, supply has since normalized and a few manufacturers have released EV models in 2023 that are price competitive to ICEVs (see for example <https://www.nytimes.com/2023/02/10/business/electric-vehicles-price-cost.html>). Further, EVs tend to have lower operating costs with lower lifetime fuel and maintenance costs, which offer substantial life-time savings (Harto, 2020). Moreover, range anxiety is becoming less of an issue with consumers as models with longer ranges become available (especially in Hawai‘i where distances are relatively short). Some EV models now have comparable range to many ICEVs and have similar or better acceleration and top speed making them competitive to ICEVs.

Hawai‘i reached 10% EV vehicle sales in the first quarter of 2022 though there was built-up demand due to pandemic related vehicle delivery delays, which likely pushed up this number (Hawai‘i Automobile Dealers Association, 2022). Figure 18 shows the percentage of vehicles in Hawai‘i that are battery electric vehicles (BEV) and plug-in hybrid EVs (PHEV). For context, to show a much longer-standing technology, hybrid electric vehicles (HEV) are also shown. BEV registrations in the past 5 years have more than doubled (U.S. DOE, 2022b).

Figure 18. Hawai‘i EV, PHEV, and HEV Vehicle Registrations



Source: (U.S. DOE, 2022b)

Widespread adoption of EVs depends on a number of factors, including technological advancement in driving range and shortening charging time, lowering upfront costs and the role of policy, and the robustness of charging infrastructure networks (Coffman et al., 2017).

The most influential policy in determining EV adoption across the US is the federal Corporate Average Fuel Economy (CAFE) standard. CAFE is governed by the U.S. Department of Transportation and determines the fuel efficiency of new vehicles on the road (separated by cars and trucks). The fuel efficiency of new vehicles is determined based on a national average per vehicle manufacturer, where there is also a system of tradeable credits between manufacturers. The final rule for 2024–2026 light duty vehicles will raise the industry-wide fleet average to approximately 49 miles per gallon by 2026 (NHTSA, 2022). As such, CAFE does not determine specific types of vehicles that will be sold in any particular state or region.

O‘ahu Climate Action Plan Ground Transportation Sector

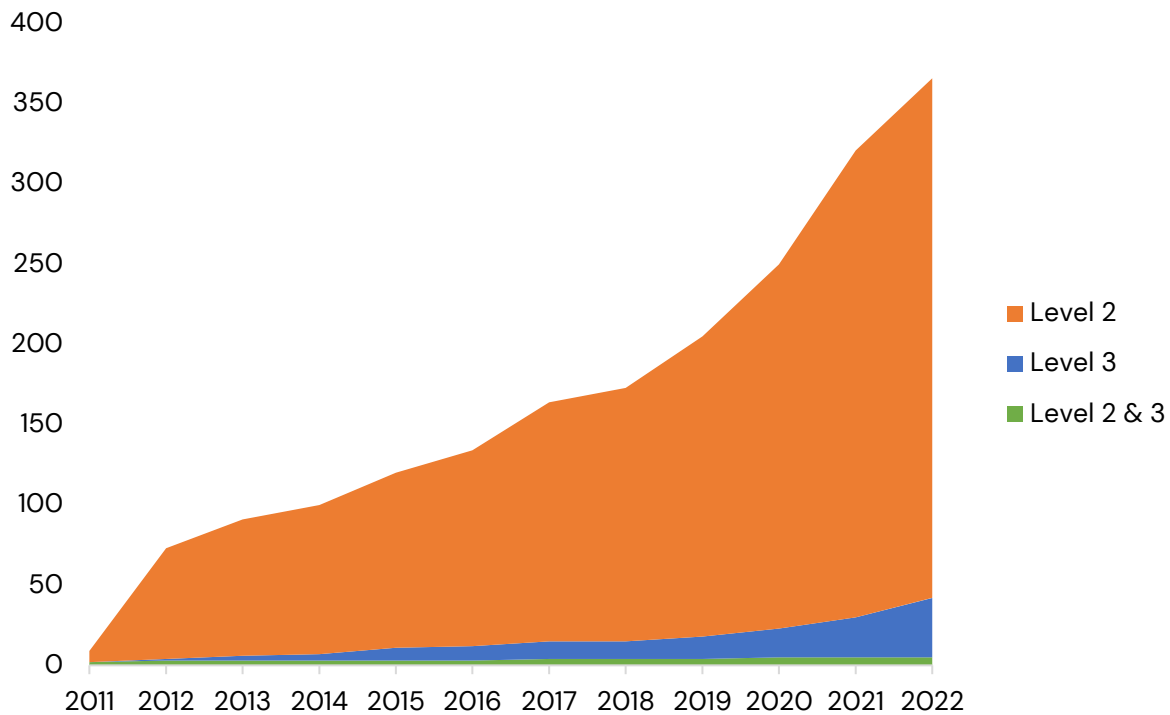
An assessment of Transportation Trends, City Progress, and Next Steps

Up until 2022, federal policy awarded an up to \$7,500 tax credit to EV sales, which varied based on battery size.⁷ The replacement EV tax credit embedded in the newly adopted Inflation Reduction Act (§Public Law 117-169) only awards the credit to purchases of vehicles with final assembly in the U.S, rendering most current models on the market ineligible. However, the intent of the incentive is to prompt more US manufacturing, and there is uncertainty in terms of how this will play out.

Available EV models are also becoming more robust from a technological standpoint, particularly with longer driving ranges. Longer ranges are critical to reducing range anxiety as well as lowering the burden of both charging infrastructure provision and charging time (Coffman et al., 2017). The availability of charging networks is important to supporting the rollout of EVs though studies are unclear regarding the direction of causality of charging stations related to EVs on the road (meaning which leads to the other: charging stations leading to EV adoption, or EV adoption leading to charging stations). Research has also found that EV drivers prefer/tend to use home chargers over public chargers (Axsen et al., 2020). Nonetheless, there is still an important role for public charging stations to lower “range anxiety” and provide alternatives for people without access to home charging. Over the past decade, EV chargers have become vastly more available on O‘ahu. Figure 19 shows the number of public chargers installed in each year over the past decade, and Figure 20 shows the location of public chargers by type.

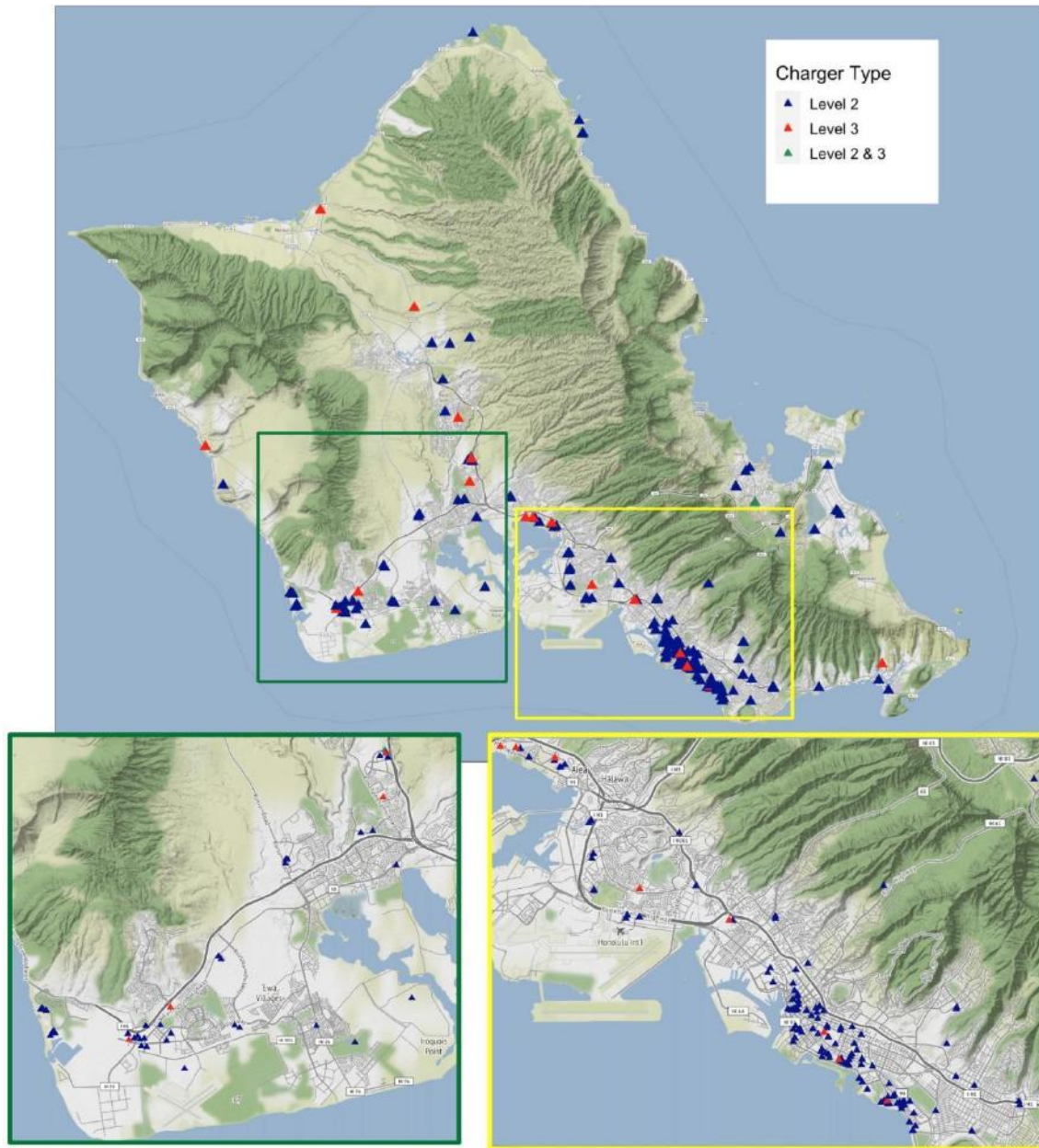
⁷ The credit begins to phase out for a manufacturer’s vehicles when at least 200,000 qualifying vehicles have been sold for use in the United States (determined on a cumulative basis for sales after December 31, 2009) (Internal Revenue Service, 2022).

Figure 19. Cumulative Number of Public Chargers Installed on O‘ahu by Year and Charger Level



Source: (Alternative Fuels Data Center, 2022)

Figure 20. Location of Public EV Chargers on O‘ahu by Type



Source: Alternative Fuels Data Center (2022)

The total number of publicly available chargers on O‘ahu increased from 24 in 2011 to 495 in 2022 (these numbers exclude chargers installed at private residences). A third of these were added in the past two years. Though a handful of level 3 chargers (DC fast chargers), which have much shorter charge times, have been added to O‘ahu’s EV infrastructure in

recent years, most chargers on O‘ahu are of the level 2 type. The difference in average charging time from 0 to 80% between a level 2 and level 3 charger is substantial: level 2 charger takes 4.5 hours compared to 30 minutes on a level 3 charger. Level 2 chargers are therefore more suited to private residences, workplaces, and other places where people tend to spend a significant amount of time, while level 3 chargers are better suited for on-the-go charging stations. HECO is undertaking efforts to increase the availability of fast charging stations across O‘ahu (HECO, 2022b).

Despite Hawai‘i’s continued reliance on oil burning for electricity generation, EVs offer a substantially lower GHG vehicle alternative than internal combustion engine vehicles and are also better than the average hybrid (AFDC, 2022). The dependence of the electricity system on oil generation, however, also means that the operating costs of EVs are also tied to the price of fossil fuels. As more renewable energy powers the grid, though, this relationship lessens, and the relative operating cost of an EV declines under high fuel prices (Coffman et al., 2015). With the beginning of decoupling oil price increases in both electricity and transport, increasing gasoline prices would push more people to purchase both more fuel-efficient vehicles as well as EVs.

In terms of O‘ahu’s future uptake of EVs, it is likely that EV registrations will continue to rise in relationship to federal CAFE standards. Because of relatively shorter driving distances, Hawai‘i tends to have more EVs per capita than the national average, but it will take a substantial increase in federal CAFE (or other related policies) to dramatically increase EV adoption across the State. It is possible to relatively increase regional EV adoption, as evidenced by state and municipal policies to prompt EV adoption in their jurisdictions, but studies find that these policies can come at high cost. Two 50-state studies find that the cost of state and local policies to promote EV adoption are potentially high relative to additional EVs on the road (Jenn et al., 2018; Wee et al., 2018). Wee et al. (2018) find that a \$1,000 subsidy (either in direct consumer payments or indirect such as high occupancy vehicle lane access) increases state-level EV adoption by 5–11%. This translates to a cost between \$10,000 and \$30,000 per additional vehicle on the road (Wee et al., 2018). Jenn et al. (2018) find even lower estimated effects, meaning higher costs per additional vehicle. The high cost is due to the large portion of subsidies going to households which would have purchased an EV regardless, even in the absence of the subsidy. Perhaps in response to relatively modest policy effects, states across the U.S. have more recently been pulling back their EV support policies, and there is a prevalence of adopting annual fees assessed against EVs, which serve as a disincentive to EV adoption (Hayashida et al., 2021). The State of Hawai‘i has adopted an annual EV registration surcharge (deposited in the State Highway

Fund). Though it is only \$50 annually, an EV fee is part of what has been an uneven policy approach toward EVs over the last decade (Hayashida et al., 2021; Kun, 2022). For example, Hawai‘i had a short-lived purchase subsidy for EVs when they were first released to market, as well as offered free parking incentives; however, both policies have since been rescinded or allowed to sunset. The State imposes an annual fee presumably to have EVs pay their “fair share” of road maintenance that is otherwise paid by the state’s gasoline tax. Rather than funding the provision of roads through fuel taxes and fees, a more coherent approach that is being piloted and considered by the State Department of Transportation is funding via a VMT tax, which would dually serve to disincentivize VMT.

Lastly, a small but potentially important component of the electrification of transportation is in greater electrification of micromobility services. The State of Hawai‘i in 2022 passed an e-bike and electric moped rebate program, offering up to \$500, to adults eligible for certain low-income assistance programs who do not own a four-wheeled vehicle or are currently a student (HIDOT, 2022a). This is a potentially important program to enable greater equity of transportation options for lower income adults, and the program should be evaluated in the future based on both the number of claims but also the available demographic information of participants.

Trends in Ridesharing and Automation

Ridesharing technologies are increasingly common in urban areas across the U.S. and world. In one line of thinking, the prevalence of ridesharing could potentially reduce GHG emissions if, for example, ridesharing enables a person to forego car ownership, switch trips to active transportation or public transit and take ridesharing sparingly when vehicular travel is prompted. Rideshare programs have also been found to be a complement to public transit because it can solve the “last mile problem” (Hall et al., 2018). In contrast, ridesharing could potentially increase GHG emissions by increasing the number of drivers circling for passengers, as well as the general prevalence of vehicular trips due to increased convenience – in particular, single occupancy trips. Leard and Xing (2020) found that this outcome is true on average across the U.S. Using the National Household Travel Survey, Leard & Xing (2020) found that while most rideshare trips displace other vehicular travel, a substantial portion of rideshare trips displaced active transportation and public transit trips. The net effect is that rideshare has increased vehicular VMT and GHGs.

Connected and automated vehicles (CAV) are another transportation innovation that is, in some forms, becoming widespread across transport systems. CAVs describe a spectrum of vehicle automation from driver-controlled vehicles with modest driving assistance (which is

now quite common as a safety feature) to full automation where the vehicle can perform all driving functions (which is still in development phases and not deployed en masse). On the one hand, CAVs can increase energy efficiency due to the possibility for more efficient driving and more precise processing. On the other hand, however, simulated future scenarios have uncovered opposite effects due to the possibility of increased speeds with CAVs (Vahidi & Sciarretta, 2018). Whether fully automated vehicles (AVs) will result in net energy savings or increases will largely depend on whether automation incentivizes people to shift to private vehicle use versus other modes and to what degree it results in an increase in ridesharing (Vahidi & Sciarretta, 2018). Research and development within vehicle automation is also occurring for low-speed shuttles and could be a viable option for last-mile transportation connections (U.S. DOT, 2020). Beyond potential energy savings, AVs also have the potential to decrease commute times, increase access to mobility, and reduce traffic injuries and fatalities (U.S. DOT, 2020). Though AV technology is well on its way and on the roads already today, it is not a given that it will take over as the dominant technology anytime soon. As an example, for comparison, automobile production began on a mass scale in 1908 but it was not until the 1960s that most potential drivers owned a car. If AVs follow historical trends in emerging transportation technologies, then we may expect fully automated AVs to dominate vehicle sales in two to three decades. Without substantially faster technology development than previous technologies, considerable efforts to increase public acceptance of AVs and a rapid increase in vehicle turnover (meaning scrapping non-CAVs that are otherwise fully functional), it is unlikely that CAVs would dominate by midcentury (Litman, 2022a). Moreover, for either ridesharing or AVs to contribute to reducing GHGs within the transport sector requires additional intervening policy aimed at curbing GHG emissions, quite similar to what is required for fossil fuel-based personal vehicles currently.

IV. Future GHG Emissions within O‘ahu’s Ground Transportation System

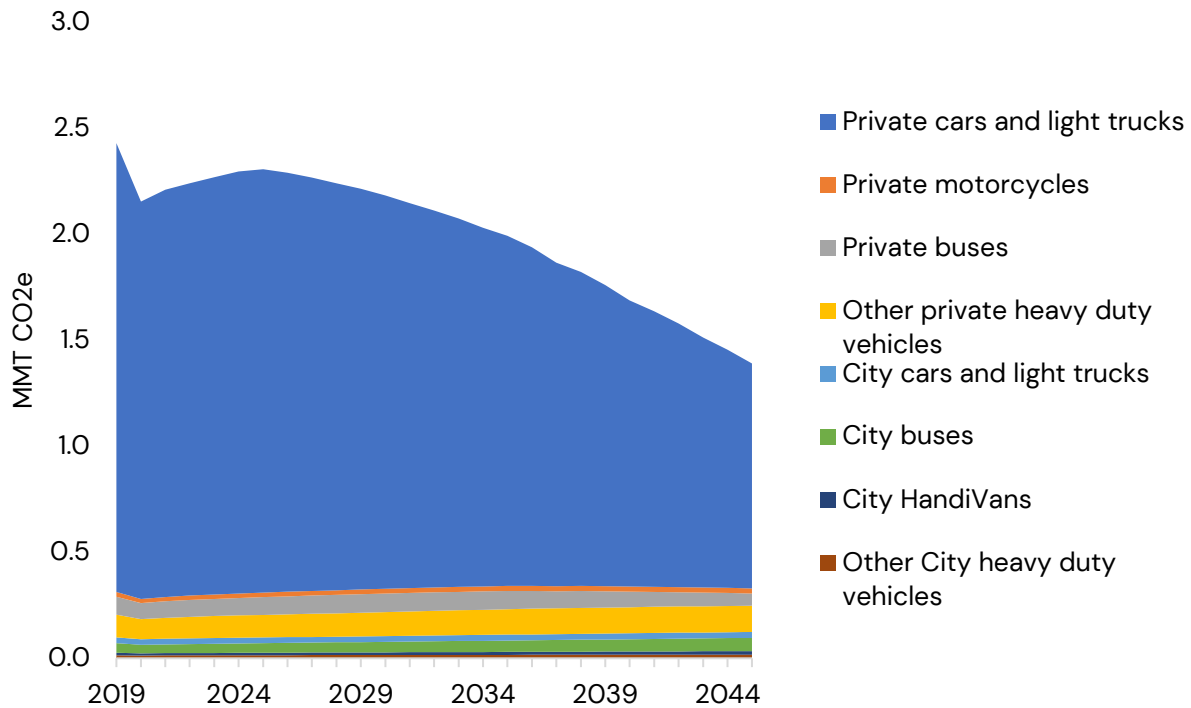
Key Takeaways

Current City efforts and plans will substantially reduce GHG emissions; however, reaching the City’s transportation decarbonization goal of net zero by 2045 will require a level of VMT reduction and electrification of the car fleet that is currently out of policy reach. The greatest potential for GHG reductions within the City’s jurisdiction lies in reducing VMT by drastically increasing access to alternative modes of transportation and decreasing distance to services and activities in key areas. Current efforts are positive but modest in the context of the decarbonization goal. A dramatic shift in EV adoption relies greatly on federal policy, currently via CAFE standards. State and County efforts can support GHG reduction via EVs through enabling and promoting renewable energy for electricity generation and charging infrastructure.

This section builds on tools developed to assess GHG emissions within the ground transportation sector used within the initial CAP. Using light duty and heavy-duty vehicle fleet turnover models (integrating federal CAFE standards for LDVs), as well as assumptions about the adoption of renewable energy for electricity, we project GHG emissions attributed to O‘ahu’s ground transportation sector through the year 2045. The updated modeling assumptions are described in Appendix II.

Figure 21 below provides our baseline estimate for future GHG emissions under existing federal and state policies, broken down by vehicle type.

Figure 21. O‘ahu’s Transportation Baseline Emissions by Vehicle Type



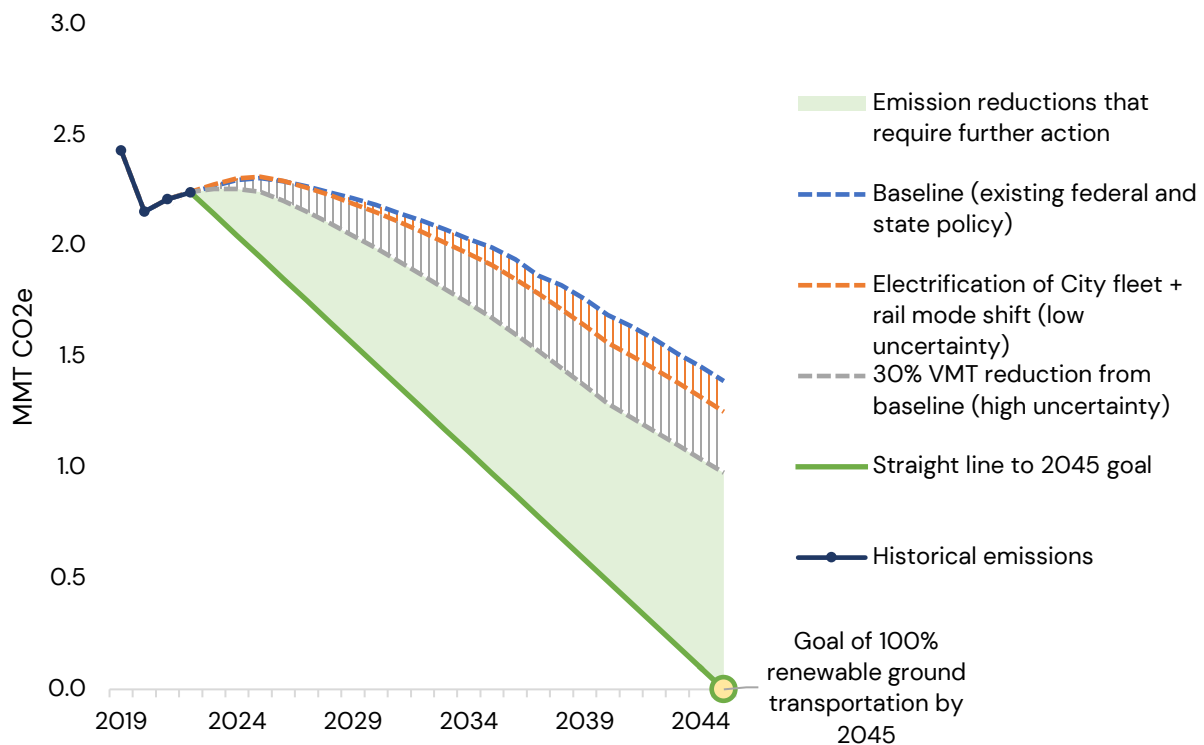
Private cars and light trucks comprise the vast majority of GHG emissions, and they are also expected to experience the greatest reductions in GHG emissions. The reduction in baseline GHG emissions largely stems from our assumption that light duty vehicle CAFE standards currently established stay in place through 2045 – of course a more aggressive CAFE would dramatically change this trajectory as it is the most impactful long-term policy currently in place to influence the fuel efficiency, and therefore GHG emissions, of vehicles. The model shows that, as more fuel-efficient vehicles and EVs enter O‘ahu’s roadways, and older vehicles are retired, emissions decline. The baseline also accounts for the GHG emissions that are generated within the electric sector. The baseline penetration of EVs into the light duty vehicle fleet is based on the Hawaiian Electric Company’s July 2nd 2020 response to the Public Utility Commission’s “backbone study.” Similarly, GHG emissions associated with the electric sector are determined by the Hawaiian Electric Company’s Integrated Grid Plan’s “land constrained scenario” (Hawaiian Electric, 2021). As discussed above, EV adoption across the U.S. is largely determined by federal CAFE and is influenced by government support policies – both for adoption and usage, including the robustness of

charging networks.⁸ This baseline assumes that 52% of light-duty vehicles on the road will be electric by 2045.

Reducing emissions beyond the baseline will require a mix of federal, state, and municipal policies aimed at reducing VMT and increasing electrification of transportation. Figure 22 shows 1) additional GHG reduction due to electrification of the City fleet and introduction of the Honolulu rail transit system (the Skyline), 2) GHG emissions associated with a 30% VMT reduction (from the baseline) and 3) additional GHG emissions reductions still necessary to hit the City’s goal of 100% renewable ground transportation by 2045. Electrification of the City fleet and expected rail ridership is estimated to reduce O‘ahu’s ground transportation emissions by 0.14 MMTCO₂e from 2025 to 2045, cumulatively this will result in 1.56 MMTCO₂e less emitted to the atmosphere in the 20-year period, and emissions will be 10% lower in 2045 than it would have been without intervention. If VMT can be reduced by 30% by 2045 (discussed below), an additional 0.21 MMTCO₂e will be abated, resulting in 4.46 MMTCO₂e less emitted to the atmosphere over the 20-year period, and emissions will be 30% lower in 2045 than they would have been without intervention. To reach zero by 2045, however, requires an additional 0.98 MMTCO₂e reduction in 2045. Assuming a linear path to decarbonization, this means that an additional 14 MMTCO₂e must be abated over the 20-year period or an average of 0.67 MMTCO₂e every year.

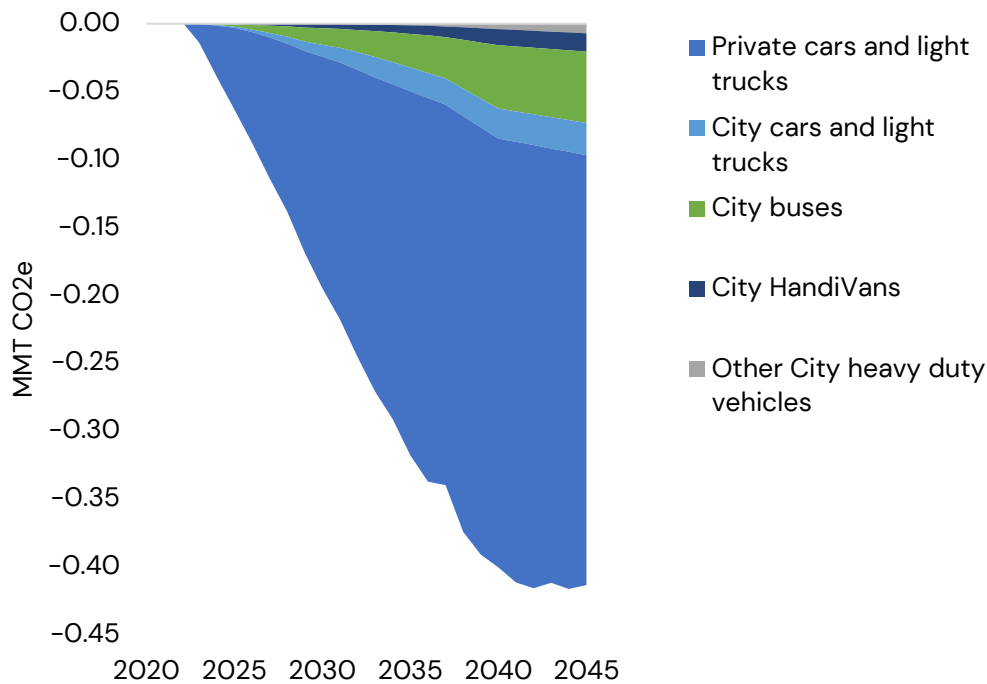
⁸ A state carbon tax has been shown to be an effective way to reduce emissions in the transport sector and prompt both VMT reduction and adoption of EVs (Coffman et al., 2020), though as long as federal CAFE standards exist as currently structured, as a national average, there is a high risk of transport emissions leaking to other states.

Figure 22. Summary of O‘ahu GHG Emissions Pathways Based on Existing Trends, Policies, and CAP objectives



As an update to what is presented in the CAP, the orange dotted line shown in Figure 22 represents major City commitments within the CAP to electrify their fleets, including the City bus. It also includes the introduction of the Honolulu Rail Transit system, where ridership has been adjusted downward from its initial Environmental Impact Statement (and subsequently what was represented in the initial CAP) due to the now truncated rail line. Because these activities are underway, we classify these GHG emissions reductions as having *low uncertainty*. The various VMT reduction strategies detailed in the CAP entail greater uncertainty, however, because many variables affect the impact of each measure. The grey dotted line thus illustrates additional emissions reductions from a 30% reduction in VMT (from the baseline, in addition to the VMT reduction estimate for rail) – where approaches to VMT reduction are discussed below. Figure 23 below shows our estimate in the difference in emissions including both the *Electrification of City fleet + rail mode shift* and the *30% VMT reduction from baseline* scenarios, broken down by type of vehicle.

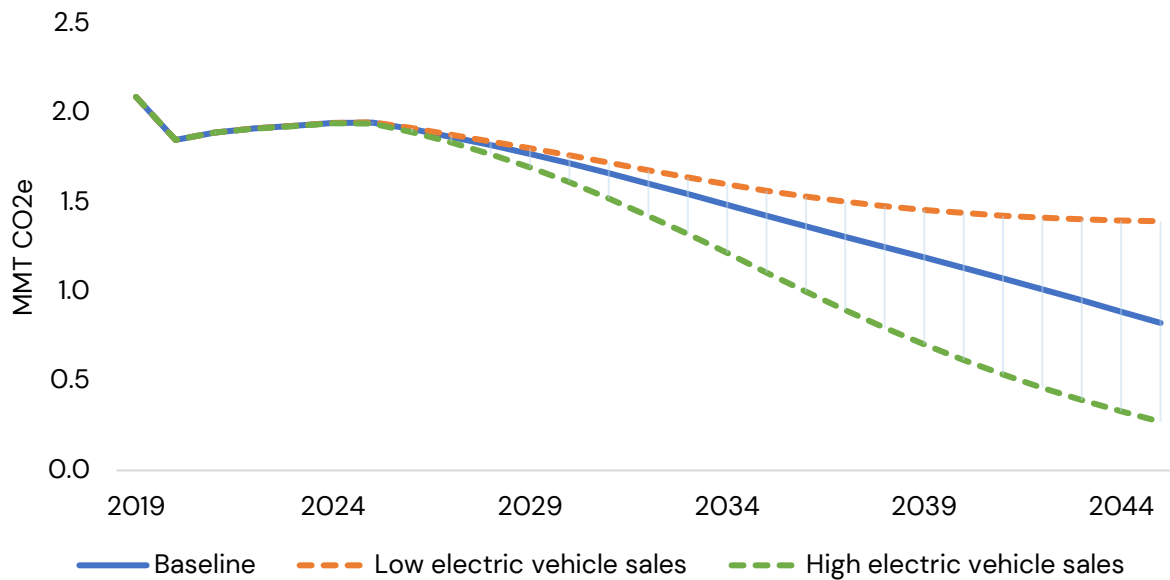
Figure 23. Difference in GHG Emissions between the “Electrification of City fleet + rail mode shift” and “30% VMT reduction from baseline” from “Baseline” by Vehicle Type



Federal and State Actions Needed to Reach Decarbonization Goal

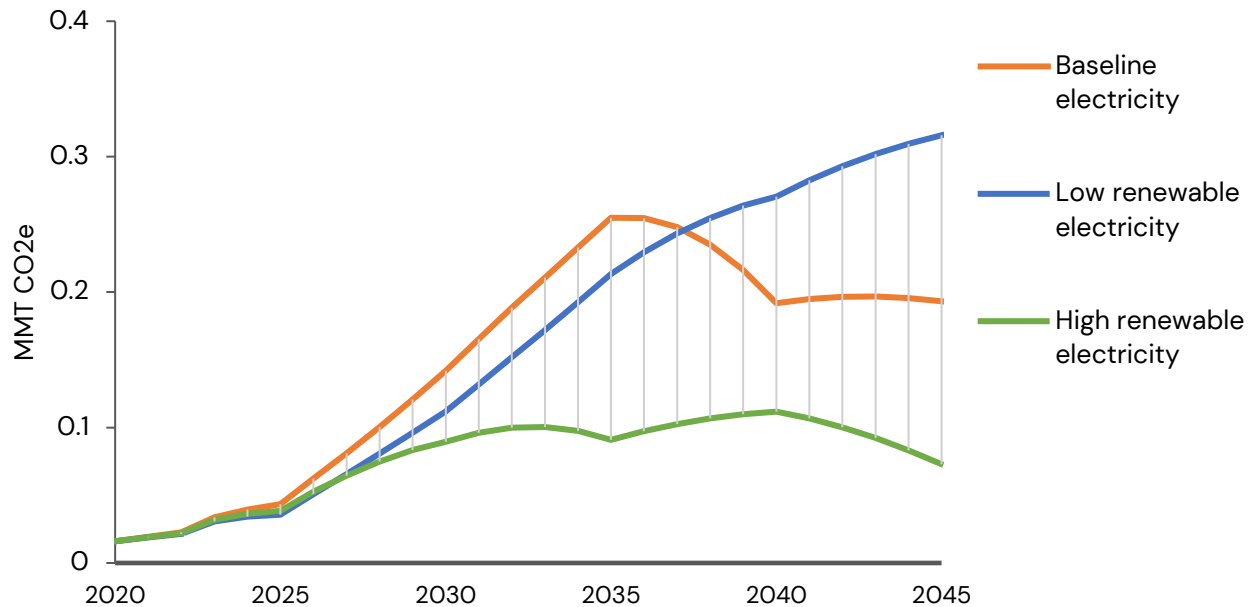
Electrification of transportation, much beyond what we estimate to be the current trend in the baseline, is critical to reducing GHG emissions from the ground transportation sector. Figure 24 below shows a scenario when all new light duty vehicle sales are EVs by 2035 (see *High electric vehicle sales* scenario), total emissions from light duty vehicles are cut in half from the baseline, accounting for expected renewable energy for electricity generation. Alternatively, if EV sales follow the *Low electric vehicle sales* scenario, which represents the Energy Information Administration’s 2022 national forecast (EIA, 2022), then total emissions from all light duty vehicles would be about 50% higher than in the baseline. Thus, further EV technology development and deployment across the US significantly affects how quickly Honolulu’s transportation sector can decarbonize.

Figure 24. Emissions from light-duty vehicles under different assumptions about EV penetration



Whereas the kinds of cars and trucks on the road are largely a reflection of federal vehicle policy, the extent to which EVs reduce GHG emissions is very much in the authority of state and local government – where the State sets the Renewable Portfolio Standard for electricity generation and the county governments play important parts in land use and zoning (see CAP Strategy 7). To illustrate this point, Figure 25 shows indirect GHG emissions from EVs (i.e., electric sector emissions) as a result of the electrification of the City’s fleet under varying assumptions about renewable energy for electricity generation in comparison to our baseline.

Figure 25. Emissions from EV Electricity Demand with Different Ratios of Renewable Energy Electricity Generation



Higher shares of generation from renewable sources of electricity means lower GHG emissions associated with electrification of transportation. Hawaiian Electric, the only electric company serving O‘ahu, will according to their Integrated Grid Plan focus heavily on grid-scale solar as well as grid-exported distributed solar systems to convert their electricity generation to renewable sources by 2045. In addition, the utility has plans to develop land and offshore wind farms and to convert existing fossil units to biofuel (Hawaiian Electric, 2023). Under the “High Renewable Electricity” scenario, the penetration of renewable generation increases at a rate fast enough to stabilize emissions from about 2030 with an eventual decline as the electricity sector is nearly fully decarbonized by 2045. In the baseline, the penetration of renewables accelerates after 2035 causing a drop in emissions and a stabilization in the last years as the share of electric EVs. In the “Low Renewable Electricity” scenario, the penetration of EVs outpaces the decline in the average emissions rate from the electric sector, leading to an increasing emissions level over time.⁹

⁹ The baseline and high electricity scenarios are based on HECO’s “land constrained” and “baseline” renewable deployment scenarios in the IGP *Grid Needs Assessment Report* respectively (Hawaiian Electric, 2022a). The low renewable energy scenario assumes that the baseline renewable energy

In addition to supporting renewable energy deployment, the City can, as discussed above, support the deployment of EVs via codes. The City’s energy code is a good example of this, where parking stalls built for new residential and commercial construction have to meet “EV ready” requirements (City and County of Honolulu, 2021). In regard to retrofitting existing parking stalls, State law requires one level 2 EV charger be available per 100 parking spaces within public parking areas and a reduction in barriers to installing EV charging in multi-family dwelling units (HRS Sections 291-71 & 196-7.5). There are also available tax credits for EV charger installations.

VMT Reduction Strategies

VMT reductions can be achieved through a combination of reducing the number of trips, reducing trip length, increasing carpooling and transit usage, and increasing alternative transportation such as walking and biking (including e-bikes, motorized scooters, and other emerging micro mobility options). Decreasing VMT depends on several factors that ultimately contribute to the economic choice for mobility. Functionally, travel by personal vehicle is often the relatively lowest cost (e.g., monetary cost, time, and convenience) to consumers (i.e., drivers and passengers) and thus why it is the prevalent mode choice – in Honolulu and in many places across the world. Cost does not just refer to monetary expenses but includes time expended, safety concerns, and comfort rating, among other things. The spatial density of a city has been shown to be important to reducing barriers to forms of transportation other than vehicle travel – as proximity tends to relatively decrease the cost of alternative modes such as walking and biking (Deetjen et al., 2018). Strategic approaches to parking prices and other interventions that otherwise deter private car usage can also induce people to switch from single occupancy, personal vehicles to other modes of transportation. Because mobility is an economic and social priority, i.e., people need to be able to access their destinations, strategies to reduce VMT should embrace both “carrots” (i.e., incentives) and “sticks” (i.e., disincentives), and be complemented by a plethora of reasonable alternative transportation choices.

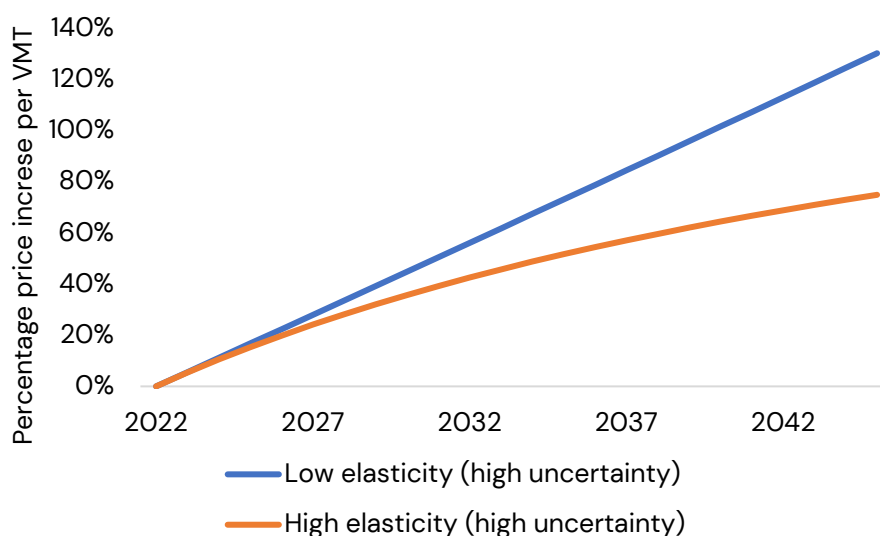
Three pricing policies to reduce private vehicle usage are a VMT tax, a gasoline tax, and parking fees.¹⁰ To illustrate the effects of a VMT tax, we apply elasticity values summarized

deployment will be delayed according to historic delays in renewable energy deployment compared to planned deployment as stated in the company’s PSIP (Hawaiian Electric, 2016).

¹⁰ A congestion fee can also help, but this policy’s primary goal is to shift the time of travel.

in prior studies on the sensitivity of VMT to changes in VMT cost. Figure 26 below shows the implied relative increase in cost of VMT needed to achieve a 30% VMT reduction from baseline levels in 2045 on O‘ahu. Few empirical analyses estimating elasticities exist, and what has been done is both several years old and for other jurisdictions. Therefore, we provide two estimates on the needed increase in VMT costs, each of which is based on a different estimate of the elasticity of VMT with respect to the price of VMT. The elasticity estimates are based on studies summarized by Litman (2022c). Overall, Litman (2022c) finds that VMT elasticities are inelastic, meaning that a 1% increase in the cost of VMT results in a less than 1% decrease in VMT. Since Hawai‘i has limited options for many people and because Honolulu is currently car-centric, the analysis is therefore based on the more inelastic range presented by Litman (2022c). That is, VMT should be relatively price insensitive and thus, reductions will require a larger than unitary increase in cost.

Figure 26. Estimated Per Mile Cost Increase (%) Related to a 30% Reduction in VMT



Source: Litman (2022c)

Using a baseline cost estimate of Honolulu 2021 VMT of \$0.25/mile,¹¹ the relative cost of VMT would have to increase by an estimated \$0.18 to \$0.32/mile or 75% to 130%, based on

¹¹ The cost of VMT is taken to be the sum of the average per mile fuel and maintenance costs. The AAA estimates 2021 maintenance costs to be \$0.096/mile. The average price

prior studies’ elasticity parameters. The idea of *relative cost* means that a cost increase could either be conceived as applying to VMT itself, or in the reduction of the costs of alternative transportation options that would serve as a substitute to VMT. A state-level carbon tax, for example, has been shown to be an effective way to reduce GHG emissions in the transport sector by prompting both VMT reduction in gasoline powered vehicles and adoption of EVs (Coffman et al., 2022).¹² Similarly, a gasoline tax would prompt a reduction in VMT from gasoline powered vehicles and greater adoption of EVs. Because the gasoline tax is not an economy-wide mechanism, however, EVs and electricity prices would be untouched by this policy. Though from a GHG perspective, this may not actually be efficient in the short-term, until there is more renewable energy for electricity generation. Moreover, fuel taxes have been found to be regressive in developed countries (Bento et al., 2005; Teixidó & Verde, 2017; Tiezzi, 2005) depending on how fuel tax revenues are recycled (Bento et al., 2005). As discussed above, the State Department of Transportation has been assessing the feasibility of a VMT fee.¹³ Though it is a better policy tool for financing road maintenance than an annual EV fee, a non-discriminating VMT tax is the poorest of these three instruments at addressing GHG emissions because it indirectly addresses consumption of fossil fuels. That is, a VMT tax generally provides no incentive for consumers to switch to lower emitting vehicles. Therefore, if regulators want to use a VMT tax to reduce emissions, the VMT tax rate for a vehicle should be highly correlated with its

for gasoline on O‘ahu in 2021 was \$3.80/gal and the average fuel efficiency of cars and light trucks is estimated to be a bit more than 25 mpg, leading to a \$0.15/mile fuel cost. Thus, the total VMT cost is \$0.25/mile.

¹² Though as long as federal CAFE standards exist as currently structured, as a national average, there is a high risk of transport GHG emissions leaking to other states – thus the importance of a cohesive federal approach.

¹³ For a VMT tax, the literature suggests that the elasticity of VMT with respect to the price of VMT is between about -0.2 and -0.25 in the short-run based on Litman’s review of numerous studies (Litman 2022c). Long-run values are more uncertain given the lack of studies. Litman updates some of the studies conducted in the 1990s to the 2000s and 2010s. Taking these studies as long-run elasticities suggests a value of -0.4 (Litman 2020). VMT and gasoline taxes have been shown to be regressive, unless the government uses the funds to compensate low- and middle-income households in some manner Bento et al., 2009).

emission rate. Like with fuel taxes, increasing the cost of driving in the absence of good substitutes tends to put a relatively greater financial burden on low-income households. The City can, at least partially, mitigate this unequal tax burden by redistributing the revenues either directly or indirectly to lower income neighborhoods. Examples of indirect redistribution of revenues are improving access to public transit or reducing other tax-burdens for low-income households. However, direct payments are more efficient in that they allow households to mitigate the financial burden from a VMT tax in a way that best suits their needs and the City can better assure that households that are disproportionately affected receive the benefits.

How do People Respond to Transportation Costs?

When making decisions about mobility, people tend to weigh various costs including time and monetary expenditures, comfort, safety, and reliability. These different forms of cost affect where people choose to live and work, how often and how far people drive, to which destinations, and how they choose to get there. Each decision entails an “opportunity cost,” i.e., the benefits related to other possible choices one could have made instead. For example, driving tends to have high monetary cost, low time and comfort costs, and relatively low safety costs compared to active modes. The opportunity cost of driving over walking is the health benefits one gains from physical activity and low monetary cost. When one chooses driving over public transit one gives up the chance to do other things while traveling (such as reading the news or napping) as well as low monetary cost.

When the cost of driving increases, people tend to drive less either by lowering their overall mileage or shifting to other modes. Others may deem the opportunity cost of not driving too large and choose to accept the cost of driving or switch to a more fuel-efficient vehicle if the cost of fossil fuels is a substantial portion of total cost. The cost of driving may increase due to an increase in direct costs (e.g., parking, gasoline prices, insurance cost, or tolls), lower speed limits, a worsening of congestion, or other factors that make driving less comfortable or efficient. For example, any resources put toward expanding road capacity with no restrictions on the expanded capacity will reduce the cost of driving and induce more driving. Because there is latent demand for driving, expanding capacity often leads to more throughput of vehicles but not necessarily a reduction in congestion. If road capacity were expanded for higher occupancy travel or public transit, then costs for non-SOV travel would decline relative to SOV travel. The price elasticity of demand for driving determines how sensitive people are to cost

changes, where a higher elasticity means that people are more sensitive to changes in price. This sensitivity is affected by demographic and economic factors, the type of trip, as well as the quality, cost, and availability of alternatives (e.g., people are more likely to respond to VMT price changes by shifting to public transportation if the service is frequent, comfortable, and affordable). For people to tilt their daily transportation decisions away from the private vehicle, driving must be relatively more costly than other modes. Conversely, alternative modes must be relatively less costly than driving – considering not just “out-of-pocket” costs like transit fares but also the effective costs associated travel time, reliability, comfort, safety, etc.

Table 3. Impact of Different Types of Pricing Strategies

Type of Impacts	Vehicle Fees	Fuel Price	Fixed Toll	Congestion Pricing	Parking Fee	Transit Fares
Number of vehicles owned	x				x	x
Vehicle type	x	x				
Route change			x	x	x	
Time change (peak, off-peak shifts)				x	x	
Mode shift		x	x	x	x	x
Destination change		x	x	x	x	x
Number of trips		x	x	x	x	
Land use changes (location decisions such as where to live and work)			x		x	x

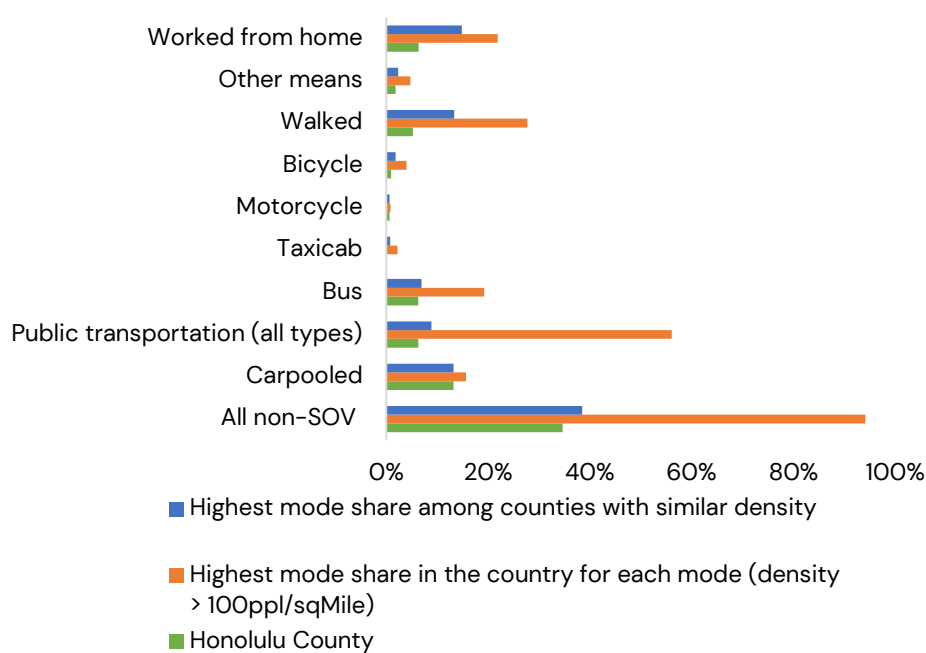
Source: Litman (2022c). "How prices and other factors affect travel behavior"

As another illustration, if instead the City pursued an increase in parking fees to incentivize people to use their cars less, the literature suggests that on average parking fees would need to increase by between 80% and 160% to bring about a 30% reduction in VMT from baseline levels by 2045. Though the City should not prompt a reduction in VMT solely through parking pricing interventions, this order of magnitude gives insight into the levels of change that must occur to prompt large-scale mode shift.

Setting a Mode Share Target

To help focus the efforts of VMT reduction strategies, the City has expressed interest in setting a mode share target. One approach to determining boundaries of mode share goals is to look at other jurisdictions. First, to give a sense of how O‘ahu does in comparison to other counties across the U.S., Figure 27 below shows O‘ahu’s mode share (green bars) in comparison to 1) the best performing mode share within that travel type, among all U.S. counties that have a population density greater than 100 people per square mile (orange bars) and 2) the best performing mode share within that travel type, among counties of similar density to O‘ahu (blue bars). O‘ahu's density is 1,640 people per square mile (ppl/sqMile), and the green bars consider counties with +/- 5% in density.

Figure 27. Comparison of O‘ahu Non-SOV Commute Mode Shares to Other U.S. Counties



Source: U.S. Census Bureau (2022a), U.S. Census Bureau (2010)

Note: Similar density is defined as $\pm 5\%$ of the population density in Honolulu County

In comparison to other counties, O‘ahu (green bars) has a relatively low bicycle mode share. O‘ahu’s mode share is about half of the best performing county of similar density (shown in blue – Williamsburg City, Virginia) and a quarter of the best performing county overall (shown in orange – Multnomah County, which is predominantly the City Portland).

Biking in Portland

Portland’s mode split for bicycling was highest in 2014, at 7% and has since declined to 5% (a percentage point higher than Multnomah County as a whole). The City of Portland, as of May 2020, has 203 miles of bikelane. Of those, 50 miles are protected or buffered bike lanes, 157 are conventional bike lanes, 111 are shared roadways, and 86 are trails. Their bike plan for 2030 (as of their 2019 update) emphasizes the importance of slowing traffic speeds in neighborhoods to increase active transportation safety and prioritizes protected and buffered bike lanes moving forward (City of Portland, 2020). Upon build-out of the plan, there will be 499 miles of separated bike lanes. Portland in 2010 set a mode share target of 25% for bicycling by 2030 (and 10% for walking) – these targets seem unlikely to be met given recent data.

Nonetheless, Portland’s existing efforts at increasing biking mode share, where it is currently highest in the country, offers an interesting example for O‘ahu. Multnomah County is moderately more dense than O‘ahu, by 12% over the county as a whole, as well as has an existing light rail system. Multnomah County’s current commute modal split is additionally 5% walking, 9% transit (bus and rail), 16% worked from home and 8% carpool. Thus Multnomah County perhaps offers a reasonable model for commute mode shift goals for O‘ahu.

O‘ahu has a lower walking mode share in comparison to the best performing county of similar density – Williamsburg City, Virginia; however, it is not a particularly good comparable given the historic nature of the city is intended for walking tours in the city center. Interestingly, Lexington, Virginia has the highest mode share for walking in the country – also likely due to its orientation of historic sites and walking tours. Beyond counties that are rather anomalous, like these two examples in Virginia, or those that are college towns, O‘ahu tends to have a high walking mode share relative to other counties of similar density.

Amongst all counties, O‘ahu performs quite well in terms of its carpooling and bus transit mode share. The county with the highest carpooling mode share, Elkhart County, Indiana, has a rate of 16%. Hawai‘i County is next, at 13%, which is the same as O‘ahu. In terms of bus transit, O‘ahu’s bus mode share (6%) is less than one percentage point from the best performing county of similar density, Allegheny County, Pennsylvania (including the City of Pittsburgh). Unsurprisingly, and not a particularly good comparison, the best performing county in the U.S. in terms of bus transit is Richmond County, New York, which is Staten Island (19%). New York, New York is the best performing county in terms of non-SOV mode

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

share overall, with the Bronx, New York as the best in public transportation of all types. These data are also summarized in Table 4 below.

Table 4. Comparison of O‘ahu’s Commute Mode Share to Other Counties

	City & of Honolulu	Highest non-SOV mode-share distribution (New York County)	County with highest mode share in the county for each mode	Highest mode share in the country for each mode (density > 100ppl/sqMile)	County with highest mode share among counties with similar density	Highest mode share among counties with similar density
All non-SOV	35%	94%	New York County, New York	94%	San Mateo County, California	39%
Car, truck, or van	79%	8%	Arroyo Municipio, Puerto Rico	98%	Gurabo Municipio, Puerto Rico	89%
Drove alone	65%	6%	Guayanilla Municipio, Puerto Rico	95%	Dorado Municipio, Puerto Rico	81%
Carpooled	13%	2%	Elkhart County, Indiana	16%	Honolulu, Hawai‘i	13%
Public transportation (all types)	6%	51%	Bronx County, New York	56%	Contra Costa County, California	9%
Bus	6%	6%	Richmond County, New York	19%	Allegheny County, Pennsylvania	7%
Taxicab	0%	2%	New York County, New York	2%	Lynchburg city, Virginia	1%
Motorcycle	1%	0%	San Francisco County, California	1%	Honolulu, Hawai‘i	1%
Bicycle	1%	2%	Multnomah County, Oregon	4%	Williamsburg city, Virginia	2%
Walked	5%	19%	Lexington city, Virginia	28%	Williamsburg city, Virginia	13%

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Other means	2%	1%	Peñuelas Municipio, Puerto Rico	5%	Gurabo Municipio, Puerto Rico	2%
Worked from home	6%	17%	Marin County, California	22%	San Mateo County, California	15%

While these illustrations are interesting and give some sense of boundaries and possibilities for O‘ahu’s mode share target, we also caution the extent to which localized conditions matter. From our analysis of other county mode shares, it is apparent that O‘ahu can reduce trips through strategically investing and incentivizing active transportation trips and perhaps working from home (though, as discussed above, it is unlikely that this reduces overall VMT – though there are other benefits). Since more than half of trips on O‘ahu are under three miles, there could be greater shift potential to walking, biking, or other short-range modes such as e-bikes and scooters. According to the National Household Travel Survey, 15% of trips under ten miles in 2020 were completed using active transportation (FHWA, 2022). It is safe to assume that active transportation made up an even larger portion of trips under three miles. Given the high share of carpooling, this is likely an unfruitful growth area to reduce commute-based VMT.

To further investigate the relationships between mode share and overall VMT, a further linkage must be made between commute mode share and overall VMT – for which limited data exist for O‘ahu. The O‘ahu Regional Transportation Plan (ORTP) 2021 update includes in its analysis data on mode shares for all trip types, published in the City & County of Honolulu (2021). The prior ORTP (O‘ahu MPO, 2011) presents mode share for all trip types in more detail. By combining these data, as well as making assumptions about the relative average distance of types of trips,¹⁴ we are able to estimate the level of mode shift required to achieve a 10%, 20% and 30% reductions in annual VMT relative to the baseline.

¹⁴ To make this calculation, we normalize mode share data to a car trip (i.e., the unit of VMT). We assume the relative distance of types of trips based on SANDAG (ICF, 2019). Other published trip distance data from California MPOs were reviewed, such as in San Francisco; however, due to San Francisco’s much more dense design, it was determined that San Diego was a better fit. We assume that there is no overall VMT reduction from an increase in the commute mode share worked from home, given study findings of the strong rebound effects. From there we estimate a VMT parameter that reflects O‘ahu’s current all trip mode share. We change these shares per example counties to estimate a new VMT parameter and compare it in percentage terms. We assume that there are no rebound effects from emptier roads, which is unlikely. Policy interventions related to “road diets” are important to ensure that latent demand for driving is not a determining factor of rebound of VMT.

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

Specifically, we find that if O‘ahu’s total modal split was akin to Multnomah County, Oregon’s commute mode split, we would reduce annual VMT by 10% relative to the baseline. If O‘ahu’s modal split achieved San Francisco’s modal split (for all trips – 22% walk, 2% bike, 22% transit, and 54% car; SFMTA, 2019), it would reduce O‘ahu’s VMT by almost 20% relative to the baseline. (We note that San Francisco has a population density over ten times greater than O‘ahu and thus trip lengths are considerably shorter, with walking and biking trips being much better substitute for driving trips. O‘ahu would have to substantially alter its land use to achieve such an outcome.) Taking the best of Multnomah County and San Francisco (bicycling and walking mode share, respectively), and assuming that O‘ahu could achieve those, means that transit trips would have to increase to 29% to achieve the full 30% VMT reduction relative to the baseline.¹⁵ It is important to note that our baseline assumes an 11% growth in VMT between 2019 and 2045. As such, realized VMT relative to 2019 levels will be considerably smaller. Our estimates are summarized in Table 5 below.

¹⁵ For comparison, ORTP (2021) estimates that daily VMT will decline by 5% by 2045 relative to no action, where action includes planned bike and pedestrian projects, the rail project and rail-bus realignment improvements. Thus, actions have to go far beyond current planned projects to have VMT reduction substantially contribute to decarbonization goals.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Table 5. Examples of Mode Shares to Achieve 10%, 20%, and 30% VMT Reduction

	City and County of Honolulu 2021	10% VMT reduction	20% VMT reduction	30% VMT reduction
Example reference case	NA	Multnomah County	San Francisco County	Multnomah and San Francisco Counties composite and high bus ridership
Car (including carpooling)	80%	70%	54%	45%
Non-SOV mode share	20%	30%	46%	55%
Transit	9%	15%	22%	29%
Bike	1%	4%	2%	4%
Walk	10%	10%	22%	22%
Estimated VMT Reduction from 2019 levels for O‘ahu	NA	0%	-11%	-22%
Estimated VMT Reduction from Baseline for O‘ahu	NA	-10%	-20%	-30%

In jurisdictions with extremely low vehicle usage, public transportation is the mode type that absorbs the most trips. As illustrated in our estimate of mode share and VMT reduction, additional investments in public transport are needed for the City to substantially reduce VMT. These investments exceed those included in the ridership projections estimated for the Honolulu rail project, as this is already accounted for in our projections of GHG emissions and VMT through the year 2045. To illustrate this point, we estimate the level of expansion of bus service necessary to absorb the additional 20% reduction in VMT; there would need to be between 800 and 1700 new buses put into service (where the range represents assumptions about bus capacity and size).¹⁶

¹⁶ The lower estimate assumes that all new buses are 60 feet and higher occupancy of 45 people per bus. The higher estimate assumes the current mix of buses is maintained and ridership is between the low and high occupancy estimates.

Incentivizing this substitution of bus transit trips, as well as all modes as discussed above, requires a series of interventions that ultimately encompass the relative cost of travel. Increasing quality of service would, for example, engage positive externality effects that would prompt further bus ridership and should be met with further increasing quality of service (O’Sullivan, 2018). In contrast, bus ridership trends presented above would suggest a negative feedback loop, where service provision is often cut in cities facing declining ridership, which prompts further declines in ridership. Critical investments in reducing transit time, for example through rapid bus lanes, as well as connection time, including the “last mile” issue, are important to reversing this cycle (O’Sullivan, 2018).

In sum, whatever set of policies the City chooses to enact or mode share goals the City adopts, the resulting reduction in VMT will ultimately depend on the relative access to and cost of driving a personal vehicle to other modes of transportation. The number of people who choose to forego their personal vehicle to satisfy their travel needs will depend on how convenient (flexible, frequency of service, and reliable), safe, and low cost the City can make alternative modes of transportation and increases to the cost of personal vehicle trips the City can impose such as gasoline, VMT, and/or congestion taxes as well as increasing parking costs. Because O‘ahu does not systematically collect mode share trips beyond commute modes, other than within ORTP updates every decade, progress will have to be tracked via a combination of commute mode share reported by the U.S. census and annual VMT data reported by the State.

V. Progress on and Next Steps for Transportation Related CAP Strategies

The CAP identified four strategies and 22 actions for the City to facilitate a transition to a lower GHG transport economy. Table 7 analyzes the progress of the City’s efforts toward each action, and Figure 28 summarizes the City’s progress. As a starting point, each action is assigned a status: *not initiated*, *some progress*, *significant progress*, or *completed*, based on information provided by lead City departments. Building upon the CAP, the actions presented in Table 7 are further categorized into three levels: *essential*, *priority*, and *additional*, as defined in Table 6 below. This categorization is based on Deetjen et al. (2018), who reviewed three dozen CAPs in major U.S. cities. *Essential* actions are those that interact with and are important for the success of multiple other-climate actions. Actions that encourage dense development and discourage driving, for example through parking efficiency, are considered *essential*. Policies that encourage multimodal transportation and other VMT reduction strategies should be a *priority*. VMT reduction strategies also have important co-benefits related to, among others, health, and equity (Litman, 2022d). Clean vehicle strategies, like prompting EV adoption, are categorized as the lowest priority, *additional*, due to few county level policy levers, relatively low cost-effectiveness, and the likelihood of driving rebound effects – meaning that more fuel-efficient vehicles tend to drive farther because of the relatively lower cost of VMT (Deetjen et al., 2018). *Additional* actions do not address VMT.

Table 6. Description of Priority Levels for GHG Reduction Actions

Priority Level	Order of Implementation	Type of Policies
<i>Essential actions</i> Actions that are foundational for a successful implementation of several other policies	Should be implemented prior to or simultaneous to <i>priority</i> actions as they improve the effectiveness of most other GHG reduction actions.	Land use and pricing policies that disincentivize fossil fuel consumption and SOV travel as well as actions that coordinate implementation and

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

		integration of multiple transportation modes.
Priority actions Actions that provide incentives to shift means of travel away from SOVs	Should be implemented in conjunction with <i>essential</i> actions.	Resource allocation to projects that expand infrastructure for or access to alternative transportation modes.
Additional actions Actions that focus on electrification and alternative fuels	Relatively low cost-effectiveness. Should not be prioritized at the expense of <i>essential</i> and <i>priority</i> actions.	Policies that incentivize a shift to alternative fuels.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Table 7. Progress on and Prioritization of CAP Transportation Strategies and Actions

Color Code	Status
	Not initiated
	Some progress
	Significant progress
	Completed

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
1.1	DPP	Adopt policies that support greater housing affordability located near transit and in areas in proximity to job centres and key destinations.	City Council have adopted all 8 TOD plans: https://www.honolulu.gov/tod/neighborhoods.html The City should continue to dedicate resources to enable and facilitate affordable housing projects in TOD zones and other strategic areas and update the Affordable Housing Strategy Implementation Status report.
1.2	DPP	Revise land use and zoning regulations to allow for mixed-use development across O‘ahu to support “complete communities”.	The City’s Land Use Ordinance has been amended to specify for mixed use in TOD areas. The City should continue to revise to allow for more complete communities across the island, unless specific environmental, safety, or health concerns prohibits mixed-use.

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
2.9	DTS	Hire a mobility manager.	Mobility manager was hired in 2022, however, this position is no longer filled. Mobility manager should be engaging in streamlining implementation of active and public transportation projects such as the bike and pedestrian plans, integration of the HOLO card, innovative efforts to increase transit service and ridership, as well as enabling the usage of public space for mobility purposes (for example, encompassing 3.5, 3.3, 1.3, 2.1, 2.3, 2.5, 2.6 and 2.10).
3.1	DPP	Eliminate current minimum off-street parking requirements to allow for flexibility.	Ordinance 20-41 was adopted in 2020 eliminating minimum parking requirements in TOD areas. Next steps are to expand areas where minimum parking requirement is eliminated and perhaps capping new parking in strategic areas.
3.2	DPP	Encourage unbundling parking from multi-dwelling housing units in TOD and other suitable neighbourhoods.	Ordinance 20-41 was adopted in 2020, which allows for but does not require unbundling of parking.
3.3	DTS	Develop curb management systems within TOD and other high-demand areas.	A planner has been hired at DTS with capacity to initiate this action

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
3.4	DTS	Efficiently manage and price public parking at City-owned lots and implement dynamic metering rates.	The City’s efforts on updating concession agreements and parking pricing are generally stalled islandwide. Current efforts aim to return to regular functionality of the system. There is lack of funding to execute efficiency improvements. Leverage Walker report to move forward.
3.5	DTS	Repurpose underutilized public parking in preference to multimodal transportation infrastructure, urban greenery, and public-serving spaces.	DTS has encouraged and permitted parklets through their Parklet Program (since 2016). During the pandemic, Honolulu saw a boost in parklet installations, e.g., “Park Blitz” initiative arranged by Better Block Hawai‘i in collaboration with local businesses, Re-use Hawai‘i, the Ulupono Initiative, and the Kaimuki Business Association, among others. Additional steps are necessary to repurpose spaces for multimodal transportation infrastructure and should be part of the effort of the new mobility manager.
Priority Actions			
CAP Action	Lead	Description	Progress and Next Steps
1.3	DTS	Provide connectivity and streetscape infrastructure in new developments to support complete streets principles	The City’s Complete Streets Program collaborates and coordinates with various City agencies to deliver complete streets projects in accordance with the Complete Streets Manual. Since the CAP release, the City updated its manual to reflect latest national best-practices regarding uncontrolled pedestrian crossings and stop-controlled crosswalks for projects impacting multiple intersections. Continue and ramp up.

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
		working with the private sector.	
2.1	DTS	Implement the O‘ahu Bike Plan and continue to build out protected bikeways with safe connections.	Since the O‘ahu Bike Plan update was completed in December 2019, an additional 5.5 miles of bikeways have been installed out of the 325 miles of proposed City bikeways in the plan. Implementation of the plan must be accelerated if objectives are to be met by 2045, see below. In support of new active transportation mobility, the City should also investigate setting signal timing and lowering speed limits in strategic areas to prioritize bike and ped movement over vehicle movement.
2.2	DTS	Develop a City-focused Transportation Demand Management Program, including updating the telework policy.	The City’s telework policy has been updated and launched on their website. An extensive study was completed surveying State and City employees and managers on O‘ahu and reviewing telework best practices from other locations.
2.3	DTS	Complete the O‘ahu Pedestrian Plan and implement high priority	The plan has been completed in July 2022. While it is too early to assess progress, implementation is important to increasing pedestrian mode share. In support of new active transportation mobility, the City should also investigate setting signal timing and lowering speed limits in strategic areas

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
		pedestrian projects.	in ways that prioritize bike and ped movement over vehicle movement.
2.4	DDC	Plan and plant trees as part of roadway rehabilitation projects.	The newly completed O‘ahu Pedestrian Plan adopts the objective to “Incorporate trees and landscaping as integral components of the pedestrian environment.” Siting conflicts with streetlights have been an issue in the context of road rehabilitation projects. Continued work is necessary to mitigate this interaction.
2.5	DTS	Repurpose general travel and parking lanes for multimodal and active transportation use.	Over the last two years the City has completed several projects that repurpose and/or share car/parking lanes such as the curb extensions on Pauahi Street, instalment of pedestrian refuge islands along California Avenue and North King Street, instalment of 3.2 miles of bike sharrows along Mānoa Road, and addition of new bike lanes and sharrow markings along Nu‘uanu Avenue. As prioritized in the bike plan, efforts should focus on protected bikeways rather than shared lanes – for safety and ultimately determining usage by a wide variety of riders.
2.6	DTS	Implement TDM programs to increase non-vehicular mode share in new multi-family housing and	The City is currently developing a TDM plan and have conducted preliminary studies that will inform the plan.

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
		commercial developments.	
2.7	DTS	Identify candidate projects and develop dedicated bus lanes along high-occupancy transit corridors.	In 2020, the City converted one mile of the rightmost travel lane on King Street through Downtown to a bus-only lane from Dillingham Boulevard to Punchbowl Street. The intent of this project was to gain local experience with creating new red-paint bus-only lanes. This is a strong example of a project from which the City can learn and replicate. The City is currently designing bus-priority lanes along Kūhiō Avenue.
2.8	DTS	Launch integrated transit fare card (Holo).	The usage of the City Holo payment card for multimodal transit was established by ordinance 21-7 adopted in 2020. Currently, it can only be used for TheBus. Extend the Holo card to Biki and other emerging micromobility, as well as rail transit when applicable.
4.5	DTS	Provide private car sharing with high fuel efficiency vehicles priority access parking to enable point-to-point service in high usage areas.	New rules have been adopted that allow for parking reservation for car-sharing with the Department of Transportation Services. The City controls six city owned off street parking facilities where parking stalls can be reserved for car sharing programs. Next steps would be to expand efforts to public-facing vehicles, beyond City operations, however such efforts should not come at the expense of resources dedicated to essential and priority actions.
Additional Actions			
CAP Action	Lead	Description	Progress and Next Steps

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
2.11	DTS	Seek innovative business solutions to deliver VMT reduction services. (Waikiki TMA model.)	Efforts made to give more authority to Waikiki TMA. Model should be expanded to other locations.
4.2	DFM	Develop a plan and implement City passenger vehicle fleet transition to achieve 100% clean fleet goal by 2035.	Draft Plan is nearing completion, pending input from various City agencies.
4.3	DDC	Develop charging protocols for EV buses and other City-owned EVs; facilitate integration of intermittent renewable energy.	Initial locations of chargers identified and there is location PV; however, not integrated with chargers or in relationship to intermittency. Concept will be further studied at the engineering level and at the HECO interconnection level because of the different tariffs and physical connections involved.
4.4	DDC	Expand EV charging infrastructure for the City EV fleet (triple public charging	Prioritization of locations for fleet charging is pending fleet-transition plans from each City department. PV systems are being designed for the Kalihi-Palama Bus Facility, but as of yet there

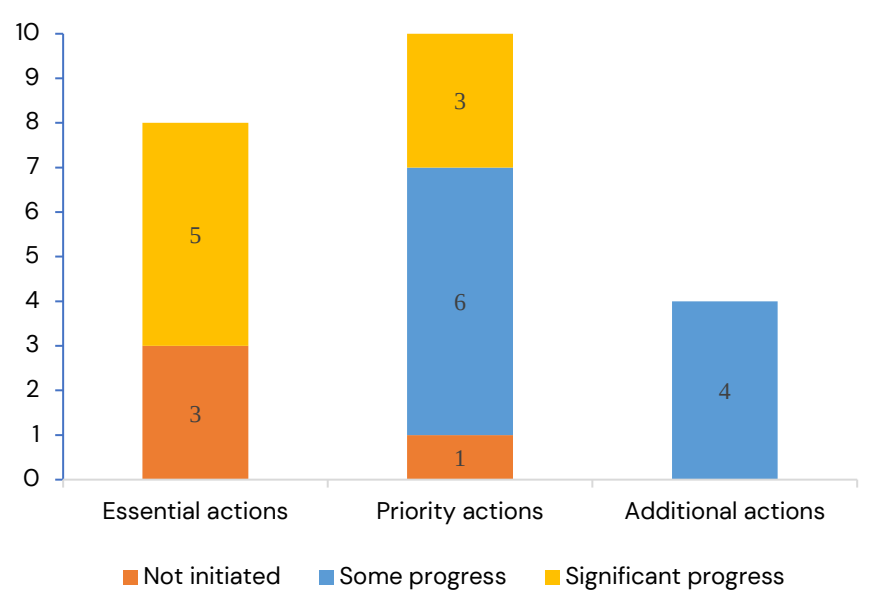
O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

Essential Actions			
CAP Action	Lead	Description	Progress and Next Steps
		capacity on City facilities). Enable cost recovery at City owned public EV chargers.	are no plans to connect these to charging infrastructure.

Figure 28 shows a summary of CAP actions that directly or indirectly address GHG emissions from the transport sector and their status toward completion. With two years into the 5-year CAP implementation window, the City has made significant progress on eight actions and some progress on ten actions. Four actions have not been initiated by respective City departments, and no actions have been completed.

Figure 28. Honolulu CAP Implementation Status by Priority Level



The slow progress in the *additional actions* does not necessarily warrant an increase in resource allocation. Though if funding is available that is earmarked for electrification and if implementing *additional* actions otherwise would not compromise implementation of *essential* and *priority* actions, then an increase in efforts could be warranted. Three *essential* CAP actions have not been initiated; action 3.3 and 3.4 related to curb

O‘ahu Climate Action Plan Ground Transportation Sector

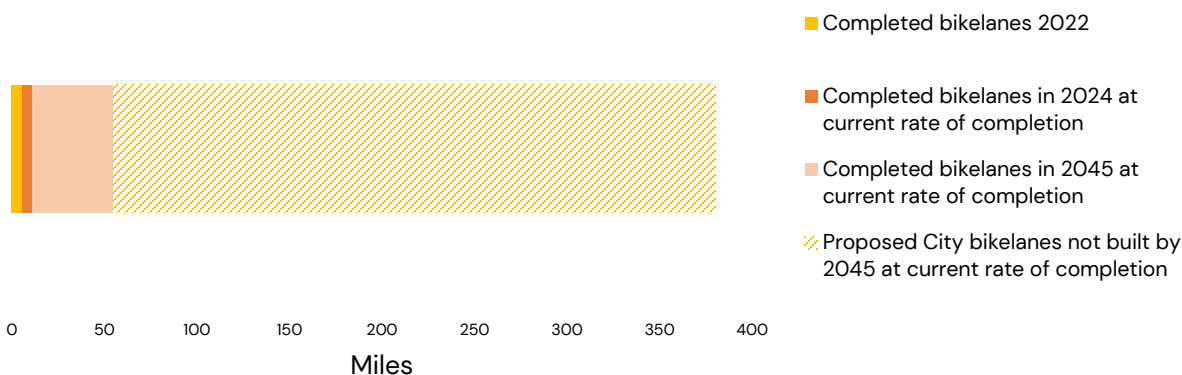
An assessment of Transportation Trends, City Progress, and Next Steps

management and parking pricing, respectively, and action 2.9, which establishes and fills a mobility manager position. Because these actions can impact the effectiveness of mode-shift strategies, these should receive high priority along with the other uncompleted *essential* action. Underpriced parking imposes a high cost to the public (Shoup, 2005), especially if considering the opportunity cost of land used for parking. Important progress was made when the City approved all eight transit oriented development (TOD) plans. In order to transfer these plans into real-life land-use effects, the next steps should be to develop permitting processes that incentivize density and mixed use as well as development of new and upkeep of existing affordable housing. Such land use policies will be necessary to shift a substantial portion of trips to active modes of transportation.

Among *priority actions*, the City has made some progress on six, made significant progress on three actions, and not initiated one. Noteworthy, the City completed and published the O‘ahu Pedestrian Plan, which includes an inventory of existing pedestrian conditions, identifies pedestrian safety issues and *High Pedestrian Injury Locations*, proposes pedestrian programs, and prioritizes safety improvements including missing walkway projects to facilitate walking and multimodal travel consistent with the City and County of Honolulu’s Complete Streets law. Because the plan was recently completed, it is too early to assess its progress in implementation. At its release, the City had several walkway improvements under development including seven corridors, 24 intersections/crossings that have a high prevalence of pedestrian injuries as well as 29 other priority missing walkways.

Within the O‘ahu Bike Master Plan (2019), the City set the goals of doubling bicycling as a mode share (i.e., from 1% to 2%), and completing an additional 325 miles of City bikeways. There are an additional 242 miles of proposed State bikeways – to add to the existing 211 miles of bikeways on O‘ahu. About 66 miles of existing bikeways on O‘ahu are shared traffic lanes, and the current plan puts considerably more emphasis on buffered and protected bike lanes for greater safety and inclusion of bicyclist abilities. Relatively little progress has been made implementing the O‘ahu Bike Master Plan since its completion in December 2019, and there will need to be considerably greater emphasis on implementation to meet the CAP and bike plan objectives. As Figure 29 shows, as of December 2022, 5.5 miles of the 325 miles of proposed bike lanes, or less than 2%, have been completed. The plan sets a target to complete all priority one projects in five years (by 2024), which requires building out an average of 17.6 miles per year. If progress continues at the same rate (about 1.8 miles/year), the City will have completed only 11 miles by 2024, 77 miles less than its target.

Figure 29. Current and Expected Progress on Completing Proposed City Projects in the 2019 Bike Master Plan



Source: Honolulu Department of Transportation Services (pers. comm. October 2022) and City and County of Honolulu Bike Master Plan (2019)

Table 8 below breaks down the bike and pedestrian plan’s objectives for bikeway miles, the capital cost of bike- and walkway miles (adjusted for the Bike Plan from 2019 to 2022 dollars given recent trends in inflation), and the time frame set for City projects. For the Bike Plan, the table shows an adjusted target timeline in which remaining project miles are distributed evenly between 2023 and 2045. Pedestrian plan target years for implementation are based on plan performance goals where 50 miles are completed by 2031 and five miles per year thereafter until all projects are completed in 2050.

Pedestrian projects are substantially more expensive on a \$/mile basis, likely because much of the biking infrastructure is relatively low-cost shared lane and shared roadway infrastructure. To reach completion by 2045 and 2050 respectively an average of 14 miles of bikeways and 5–6 miles of walkways must be built per year. Achieving this requires an estimated 9–10 million \$2022 funding for bikeways and 19.6 million \$2022 for walkways per year adjusted for inflation.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Table 8. O‘ahu Bike Plan– Implementation Costs and Targets for Remaining Projects

Project Type	Bike Plan Projects			Pedestrian Plan Projects
	Priority 1 projects	Priority 2 projects	Priority 3 projects	Priority walkway projects
Average cost/mile (\$2022 million)	0.68	0.61	0.61	3.72
Average annual cost (\$2022 million)	10.9	9.76	9.36	19.6
Estimated total cost of projects (\$2022 million)	60	62	46	539
Unbuilt project miles as of 2022	83	103	134	145
Target year of completion of all projects	2024	2029	2034	50 miles by 2031 and 145 miles by 2050
Annual miles required to reach target	14	14	13	5–6

Sources: O‘ahu Pedestrian Plan (2022) and O‘ahu Bike Master Plan (2019)

Note: Timeline for completion of projects is just an estimate and assumes that priority 1,2, and 3 projects are completed in that order (meaning all priority 1 projects are completed before any priority 2 projects start and so on) and that the average time requirement per mile of bike lane is uniform across all priority levels.

VI. Steering Toward the Lowest Emissions Path

Stakeholder Input – Barriers to Implementation and Ways to Push Forward

Three stakeholder workshops were held to gather input on barriers and solutions to pushing forward existing CAP actions, and brainstorming new CAP actions in anticipation of 2025 and beyond. The first, held on April 14, 2023, included participants internal to the City and key partners such as the representatives from the O‘ahu Metropolitan Planning Organization. The other two, held on August 7 and 8, 2023, had participants external to the City, including representatives of transport-related advocacy groups, climate and justice advocacy groups, academia, and health, children, and elderly advocacy groups. Appendix I includes the full list of participants. The recommendations in this section of the report are drawn from these three meetings.

The first activity within stakeholder meetings was to gather information on barriers and solutions to existing CAP actions that are either “not initiated” or “initiated.” Table 9 lists the actions that were included in the workshop. Table 10 and Table 11 depict categories of barriers identified from stakeholder workshops for actions that had low levels of completion (“not initiated” or “initiated”) and are either an essential or a priority action.

Table 9. List of Existing CAP Actions Assessed at Stakeholder Meetings

CAP Action	Description
2.1	Implement the O‘ahu Bike Plan and continue to build out protected bikeways with safe connections.
2.3	Complete the O‘ahu Pedestrian Plan and implement high priority pedestrian projects.
2.4	Plan and plant trees as part of roadway rehabilitation projects.
2.5	Repurpose general travel and parking lanes for multimodal and active transportation use.

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

2.6	Implement TDM programs to increase non-vehicular mode share in new multi-family housing and commercial developments.
2.7	Identify candidate projects and develop dedicated bus lanes along high-occupancy transit corridors.
3.3	Develop curb management systems within TOD and other high-demand areas.
3.4	Efficiently manage and price public parking at City-owned lots and implement dynamic metering rates.
4.5	Provide private car sharing with high fuel efficiency vehicles priority access parking to enable point-to-point service in high usage areas.

Table 10. Barriers to Implementation of Actions Identified in City Stakeholder Workshops

CAP Action	2.1 – Implement Bike Plan	2.3 – Complete Pedestrian Plan	2.4– Plant trees for roadway rehabilitation projects	2.5 – Repurpose travel lanes for multimodal use	2.6 – Implement TDM programs	2.7 – Develop dedicated bus lanes	3.3 – Develop curb management systems	3.4 – Efficiently price public parking	4.5 – Provide private car sharing priority access parking
Barrier									
Revenue loss				1					
Bureaucratic delay	2	4							
Public sentiment	1	3	1	2		1	1		
Lack of political support	1					1			
Cross-departmental and plan coordination					1	2	1	1	
Inadequate funding	5	5					1		
Inadequate staffing		3	1		3		1	1	1
Gap in expertise								2	
Conflict with or shortcomings of existing infrastructure	1		5	1		1			

Number stakeholders who identified the barrier



Table 11. Barriers to Implementation of Actions Identified in External Stakeholder Workshops

CAP Action	2.1 – Implement Bike Plan	2.3 – Complete Pedestrian Plan	2.4– Plant trees for roadway rehabilitation projects	2.5 – Repurpose travel lanes for multimodal use	2.6 – Implement TDM programs	2.7 – Develop dedicated bus lanes	3.3 – Develop curb management systems	3.4 – Efficiently price public parking	4.5 – Provide private car sharing priority access parking
Barrier									
Public sentiment	2	3		4		1		2	1
Lack of political support		1		2	1				
Cross-departmental and plan coordination	1					1	1		1
Inadequate funding	7	2	3		1				
Inadequate staffing	3	1	6		1		1	1	
Gap in expertise		1	1		1		1		
Conflicts with or shortcomings of existing infrastructure							1	3	1
Climate change			2						

Number stakeholders who identified the barrier



Within the stakeholder meetings, a few patterns emerged in the gathered input. Inadequate staffing and funding were the two most stated barriers to implementation overall. City internal stakeholders saw funding as a particularly important obstacle to implementing the bike plan (2.1) and both funding and staffing as an obstacle to implementing the pedestrian plan (2.3). Meanwhile, most external stakeholders named funding and staffing as pertinent obstacles to implementing the bike plan (2.1) and planting trees in conjunction with road projects (2.4). Another commonly perceived barrier was when CAP actions either come into

conflict with existing infrastructure, traffic, or the built environment, or when existing infrastructure does not have the adequate capacity design to facilitate implementation of a CAP action. This was for example the number one barrier identified by internal stakeholders related to tree planting where impervious surfaces or inadequate infrastructure for watering trees were important concerns. Permitting and design issues related to right-of-way rules are barriers that internal stakeholders face when implementing active transportation or transit related actions and many expressed concerns about public pushback from drivers who lose road or parking space when other modes of transportation are allocated more of the roadway. Some participants noted that negative public sentiment would fade once benefits related to non-personal vehicle modes are demonstrated.

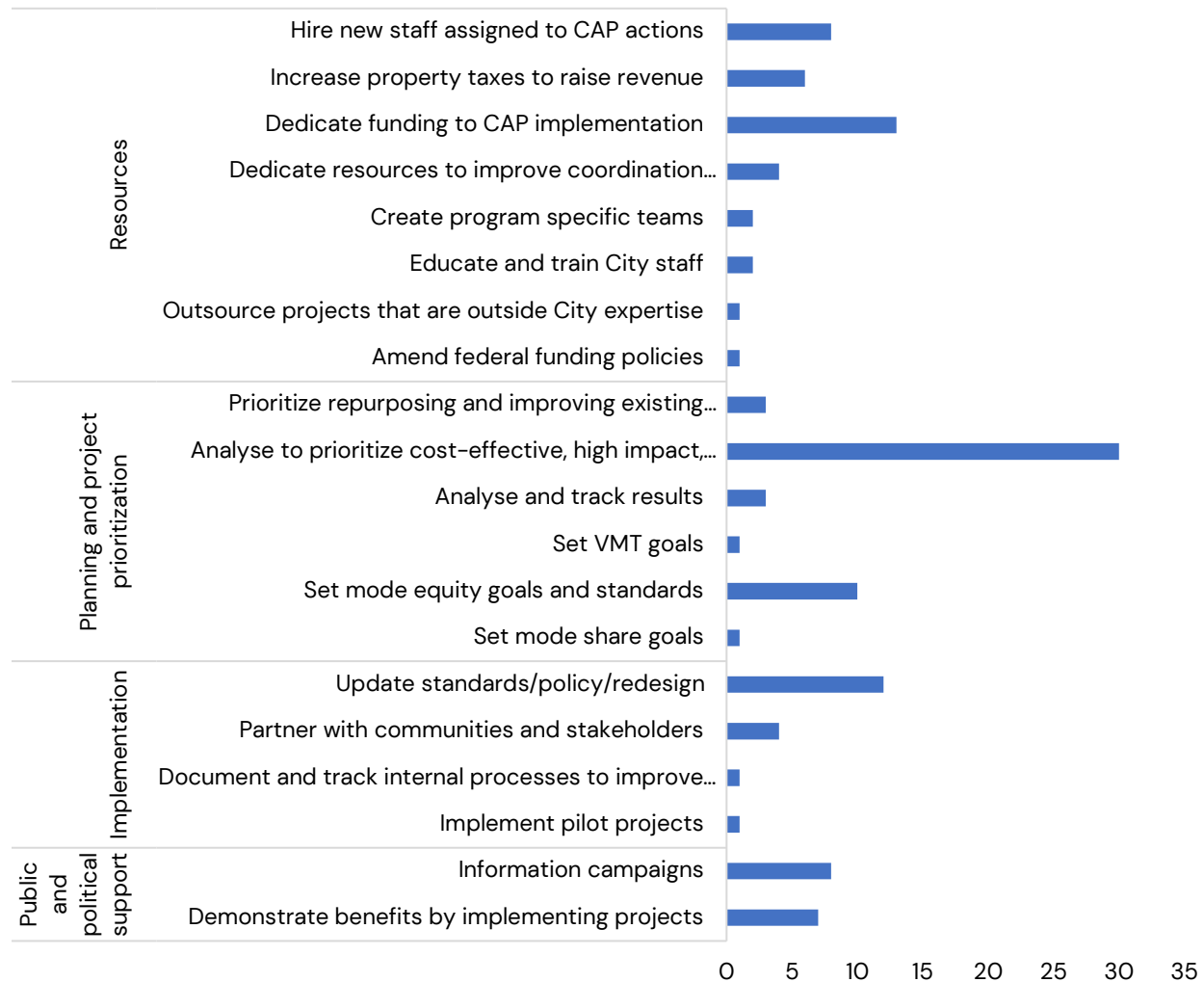
Two barriers were expressed only by internal stakeholders: *bureaucratic delays*, and *loss of revenue*. Most prominent were issues related to *bureaucratic delays* in implementing the bike (2.1) and pedestrian plans (2.3), where inefficiencies in the City’s internal processes were perceived to lead to hold-ups in project implementation. Some participants pointed out the City’s procurement process as a particularly inefficient bottleneck. These projects have also faced challenges associated with aligning project scopes to federal funding requirements. Because the City has little control over federal bureaucratic processes, this issue necessitates additional dedicated staff time to obtain and manage federal funds or pursue other funding sources. One internal stakeholder identified *revenue loss* as a barrier to implementing new pricing mechanisms (3.4) for City owned parking. Though this is essentially a funding issue, it is unique to action 3.4 in that it directly affects the City’s revenue stream. To overcome this barrier the City will have to look at increasing other funding sources. For example, increasing parking rates for remaining parking spots or increasing the gasoline tax could fill this funding gap and at the same time support other transportation CAP actions as it makes SOV travel relatively less attractive. In addition, another barrier that the internal stakeholders identified in relation to 3.4 was a lack of expertise or technology for the City to implement advanced parking pricing mechanisms. A solution might be to invest in work force development or outsource to external vendors. In contrast, the barrier noted by external stakeholders for 3.4 related to negative public sentiment and shortcomings of existing infrastructure.

Barriers related to coordination between the different City departments or levels of government were reflected across several actions and in more general statements relating to all actions. This result is not surprising given the interconnected nature of many of the transportation related CAP actions, particularly related to land-use, parking, transit, and active transportation. All these actions can only be implemented successfully in a

coordinated manner. Transit ridership will depend on the connection to bike and pedestrian infrastructure as well as other last mile options. Biking and pedestrian infrastructure will only grow a high user base if land use ordinances allow for neighborhoods that are safe, shaded, have short distance between various uses, and are connected to public transit. Because space is limited, creating such neighborhoods will require repurposing parking and SOV lanes. Because of the complicated nature of successfully transforming O‘ahu to a less car dependent society, pushing forward on the CAP actions will benefit from regular coordination meetings with key individuals at City departments responsible for CAP implementation. Building procedural elements that focus on identifying overlapping goals of various projects may also lead to cost savings to the degree that resources can be pooled.

Figure 30 lists procedural solutions to barriers in implementing existing CAP actions, as proposed in the City and external stakeholder workshops.

Figure 30. Suggested Procedural Solutions to Expediate Implementation of CAP Actions – City and External Stakeholders



Perhaps because City staff has little control over funding, few solutions focused specifically on *how* to increase funding, although this was the most prominent barrier associated with implementation of CAP actions (see Figure 30). Rather, suggestions focused on dedicating existing funding to CAP implementation. The most common suggestion for how to deal with limited resources was to improve project prioritization by analyzing data to select the highest impact, lowest cost projects. This solution was the most frequently suggested procedural solution. Similarly other suggestions focused on reducing costs by focusing on projects that repurpose or improve existing infrastructure, such as “quick build” bike lanes,

and converting existing car lanes to bus or bike lanes. Repurposing tends to be substantially cheaper and quicker to complete. Moreover, the current built environments often do not allow for space for new infrastructure because SOV infrastructure currently takes up most or all available ground space. Though in discussion there was concern around public and political pushback against taking away SOV infrastructure, there was also a sense that support will be garnered after implementation was completed and benefits become apparent.

The second activity within stakeholder meetings was to gather ideas for new CAP actions, looking to 2025 and beyond. Participants were given the opportunity to brainstorm new actions as well as prioritize them based on placing “sticky dots” next to their preferred actions. Figure 31 displays the suggested new actions and the number of votes each received.

Figure 31. Suggested New Actions and priorities to Expedite CAP Strategies – City and External Stakeholders

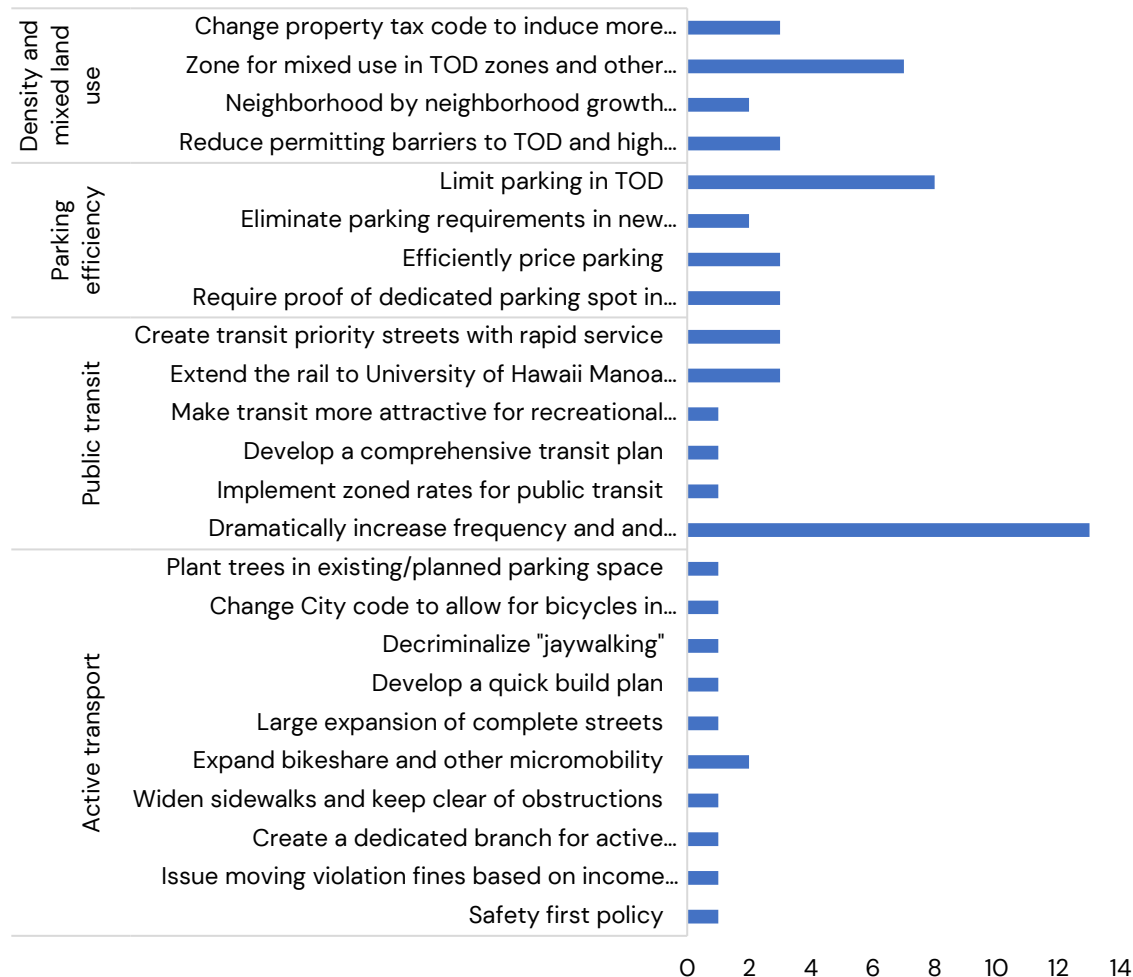


Figure 31 shows that the most suggested new CAP action is to improve transit service, by dramatically expanding reliability and frequency of the bus service as well as creating dedicated bus lanes and room for recreational gear on the bus. Expanding the rail to University of Hawai‘i at Mānoa also garnered some support. Other policy measures that attracted notable support among stakeholders were those focused on limiting space allocated for parking, especially in TOD areas, as well as support for CAP action 3.4 which calls for a more efficient pricing structure for City owned parking. Several suggestions were

O‘ahu Climate Action Plan Ground Transportation Sector

An Assessment of Transportation Trends, City Progress, and Next Steps

focused on encouraging mixed-use and density in TOD areas, supporting the existing CAP action 1.1. No active transportation suggestion stood out as particularly popular among stakeholders, rather there were several specific suggestions that are not included among current CAP actions such as removing “jay walking” as a traffic violation, developing a “quick build” plan, implementing income-based fines system for moving violations, and creating a dedicated active transportation team that can coordinate with other street projects.

VII. Recommendations

Recommendations for Implementing Existing Climate Actions and a New CAP Action

Based on the internal stakeholder meeting, entities responsible for CAP implementation have expressed that perhaps the greatest challenge with implementing established climate actions in a timely manner is the misalignment between required and allocated resources. An assessment of progress on established CAP actions strongly indicates that, rather than establishing many new actions, the City should focus on seeing through the most impactful actions. In addition, massively upgrading the bus transit service is a new CAP action (in line with existing CAP strategies) that came forward within the stakeholder workshops and is strongly supported by the research on GHG reduction opportunities for the City.

The following list contains policy focused recommendations that will advance GHG emissions reductions in the transport sector:

- *Focus on the most effective and pervasive climate strategies first.* As long as there are resource constraints, the City should allocate resources to *essential* and *priority* actions first as described in section V. *Additional* actions should receive the least priority (these are nonetheless GHG reducing and should be pursued based on opportunistic funding availability). The following CAP actions should receive particular attention:
 - Affordable housing development and continued densification and mixed-use development in TOD zones impact the effectiveness of most other actions and thus the City should prioritize permitting processes that encourage the implementation of the eight TOD plans and affordable housing in central locations.
 - Establish a joint mode-share goal of at least 55% non-SOV modes by 2045 to support the 30% VMT reduction goal. Table 5 provides an example of sub-targets for each mode.

- To further support the mode share and VMT goals, the City should prioritize the following efforts:
 - Focus resources on improving bus service and reversing the downward trend in transit use. One way to make transit relatively less costly for the consumer is to convert automobile lanes to rapid bus lanes in strategic corridors (which is an existing CAP action). Overall level of service needs to improve dramatically to turn around the negative ridership trend as well as enable mode shift from SOVs. Travel costs are largely determined by time, so bringing down transit trip time relative to car travel time should be a primary focus. Continuing efforts toward removing parking requirements and repurposing existing street parking to bus and active transport use and repurposing existing city-owned off-street parking to urban greenery should continue. Off-street city-owned parking that is strategically located in connection with planned or existing transit nodes should remain to function as park-and-ride lots.
 - Because implementation of the bike and pedestrian plans suffer from resource inadequacy, the responsible City departments should focus on quick build and repurposing of existing car parking spaces to expand and connect existing active transportation infrastructure in the short term.

Stakeholder workshops uncovered important procedural barriers to implementation. With this as a basis, we suggest four focus areas to empower the City to accelerate climate action progress.

- *Prioritize and coordinate high impact projects.* Relevant departments should develop annual project selection criteria that prioritize high impact projects and underserved communities. Departments should further establish a practice of sharing their project selection to identify opportunities to coordinate and pool funding as well as look for synergies.

- *Align annual budgets with climate action commitments for each department.* The Department of Budget and Fiscal Services should commit to spending a certain amount of its annual budget toward CAP implementation, which can be allocated to each department based on annual project goals while maintaining a focus on the holistic impact of all projects. Some cities have experimented with “climate budgets” to provide clarity and accountability to each department and develop cross-departmental guidelines for assessing GHG impacts of projects. In the short-term funding should go toward the priority areas discussed above
- *Dedicate capacity to seek new sources of climate funding.* The Department of Budget and Fiscal Services should set aside resources to investigate opportunities to secure new funds to support an increase in resource requirements from climate action. Examples of new sources of funding are:
 - Funds reappropriated from projects that increase capacity for personal vehicles. Most funds that are now dedicated to expansion of road capacity for automobiles (see Figure 3) should be funneled toward CAP actions or repurposed to expand road capacity specifically for bus transit and active transportation.
 - Creating a balance-sheet that assesses the overall cost to the public linked to automobile projects which incorporates the externalities discussed in section II is one way to estimate a justifiable shift in spending.
 - Implementing a VMT tax that is a function of the vehicles fuel efficiency and weight and a substantial increase in parking fees. Increasing the cost of driving in the absence of good substitutes tends to put a relatively greater financial burden on low-income households. Therefore, the City should use this additional revenue to improve access to transit and non-motorized mobility in lower-income neighborhoods and in connection with job-centers. With any of these efficiency mechanisms that also raise revenue, care must be taken so as not to unfairly harm lower income households (e.g., use the funds for projects that reduce travel costs for lower income households).

Recommendations for Promoting Greater Transportation Equity

Ensuring equal transportation access requires going beyond Title VI requirements and performing deeper analysis of the distribution of costs and benefits of transportation choices to a broad range of people and communities. Externalities, including but not limited to climate change impacts, pollution, traffic injuries, and land use value should be considered when distributing resources to various transport modes across the island. In conjunction with implementing protocols for ensuring socially equitable funding of transportation projects, the City should prioritize projects that promote mode equity. Mode equity goals received more support from City and external stakeholders than both VMT and mode-share goals. The following recommendations are geared toward addressing transportation and mode equity:

- The City should analyse the existing distribution of externalities from a social and modal equity perspective and develop metrics that can serve as checks and balances for budgeting purposes. A starting point for such an analysis could be the recent report on the vehicle economy for Hawai‘i (Ulupono, 2022) and an equity analysis approach as described in Section II (see for example Figure 6 and Table 2). The approach can build on the equity analysis that is incorporated in, for example, the ORTP, and expand to consider a wider range of costs and benefits (see for example Figure 5) associated with specific projects.
- The City should set the following transport- and mode equity targets:
 1. The average cost (including monetary and time value, as well as relative risk based on accidents relative to mode share) of using public transportation, walking, biking and other micro mobility modes or a combination of the above within TOD areas should be less than using a personal vehicle.
 2. In support of the City’s Vision Zero commitment, the City should set a goal for there to be no greater risk of serious and fatal injuries associated with walking, biking, and other micro mobility modes than

that of using a private vehicle (as measured by accidents relative to mode share).

- The City should continue commitment to the Affordable Housing Strategy in TOD rail areas and expand to TOD bus areas in conjunction with upscaling of TheBus service.
- The City should continue to offer discounted public transportation to resident passengers from specific groups and low-income people. However, the program for low-income households should be amended such that 1) there is no cap on total applicants per funding availability and 2) it is extended to a broader group of people (with a variable rate scale) – suggested up to 80% of Annual Median Income.
- The City should assess the procedural capacity to issue fines for moving and parking violations as a percentage of income. This is for example done in Norway and Finland.
- The City should lead and support changes that result in “pedestrian/biking first” behaviors; for example, by decriminalizing jaywalking.

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IX. Appendix I: External Stakeholder Participation

We thank and acknowledge the stakeholders that joined our workshops. In addition to City and OMPO participants, external stakeholder participants were invited based on their expertise in a variety of areas of transportation planning, as well as complementary sectors such as community health, climate change, and technology.

External Stakeholder Participants:

Todd Boulanger, *Biki*

Roger Chen, Civil & Environmental Engineering, University of Hawai‘i at Mānoa

Travis Counsell, Hawai‘i Bicycling League

Kealoha Fox, Institute for Climate and Peace

Matthew Geyer, Hawai‘i Environmental Change Agents

Trinity Gilliam, Hawai‘i State Energy Office

Leah Laramée, State of Hawai‘i Climate Change Mitigation and Adaptation Commission

Jennifer Lieu, Blue Planet Foundation

Kiana Otsuka, Hawai‘i State Energy Office

Kathleen Rooney, Ulupono Initiative

Julie Yamamoto, *Hui Car Share*

Asia Yeary, Environmental Protection Agency Region 9

Internal Stakeholder Participants:

Office of Climate Change, Sustainability and Resiliency (OCCSR)

Matthew Gonser, Chief Resilience Officer, Executive Director

Benjamin Sullivan, Deputy Chief Resilience Officer, Deputy Director

Rori Kirkpatrick, Climate Action and Mobility Specialist

Department of Transportation Services (DTS)

Jon Nouchi, Deputy Director

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

Daniel Alexander, Complete Streets Planner / Vision
Zero Coordinator

Chris Clark, Chief Planner

Pete Garino, Senior Multimodal Performance Analyst

Max Kalhammer, Infrastructure Planner

Sandra Abelaye, Planner VII

Deanna Brice, Mobility Innovation Manager

Gerald Hieda, Chief Facilities & Equipment Branch

Eileen Mark, Mass Transit Administrator

Meredith Soniat, Assistant Chief Planner

Greg Tsugawa, Planner VI

Jay Egusa, Planner VI

Patrick Preusser, Director of Rapid Transit

Robert Torres, Manager of Revenue Systems

Stuart Ujimori, Parking Controls Developer and Manager

O‘ahu Metropolitan Planning Organization (OMPO)

Mark Garrity, Executive Director

Dallas Ige, Transportation Impact Analyst

X. Appendix II: Description of Projection Updates

Projections of GHG emissions through 2045 for the ground transportation sector are based on vehicle fleet turnover models for light duty vehicles, heavy duty vehicles, and motorcycles. Light duty vehicles include passenger cars, light trucks, minivans, and sports utility vehicles. Heavy duty vehicles include buses and other large service/commercial vehicles. Vehicle turnover models estimate the rate at which older vehicles retire and new ones enter the road. These models were initially created for the CAP, and updated for this report. Updates include: 1) a new calibration year, 2019, for light duty vehicle, motorcycle, and heavy-duty vehicle models, 2) a modified VMT forecast given adjustments to expectations for VMT reduction due to the Honolulu Skyline project, and 3) new EV and renewable energy adoption forecasts. Major changes to GHG emissions result from changing assumptions about VMT and vehicle fuel efficiency – including the adoption of EVs. The three vehicle turnover model are documented within the Technical Appendix of the CAP). The new calibration year of 2019 means that updated fuel use per type are used to update all models. Changes to renewable energy adoption assumptions impact GHG outcomes for both light duty and heavy duty EVs. The majority of changes to model structure and assumptions are made to the light duty vehicle turnover model.

Light Duty Vehicles

The vast majority of ground transportation emissions, estimated at 88%, are from light duty vehicles. As shown in Figure 7, 86% are from internal combustion engines (ICE) and hybrid cars and light trucks, and another 1% from EVs (based on electricity generation). The light duty vehicle turnover model is based on estimated travel demand as represented by VMT. VMT is divided into travel done by non-EVs and EVs, where this is determined based on their proportion of vehicles on the road. The number of EVs on O‘ahu in 2019 was 8,200 (DBEDT, 2020b). Once VMT for non-EV vehicles is isolated and estimated, the fuel efficiency of the 2019 fleet of vehicles on the road is computed by the ratio of non-EV VMT and total gasoline consumed. The total fuel efficiency of O‘ahu’s non-EV vehicle fleet in 2019 is estimated to be 25.2 miles per gallon (mpg).

To estimate future GHG emissions from non-EVs, the 2019 baseline is projected to the year 2045 based on assumptions: 1) of the relative contribution to the overall change in VMT from the change in VMT per vehicle or the change in the number of vehicles, 2) new vehicles enter the fleet based on assumptions on the scrappage rate of vehicles by vintage, 3) about new vehicle characteristics such as fuel efficiency, the mix between cars and light

O‘ahu Climate Action Plan Ground Transportation Sector

An assessment of Transportation Trends, City Progress, and Next Steps

duty trucks/vans/sports utility vehicles, and the rate of additional EV adoption, and 4) about future VMT, accounting for the proposed impact of the amended Honolulu rail transit project. Items 1) and 2) remain the same as the initial CAP, and 3) and 4) are updated for this project.

The fuel efficiency of new light duty vehicles (including both ICE, hybrid and EVs cars and trucks) are based on the U.S. Environmental Protection Agency’s (EPA) corporate average fuel economy (CAFE) standards for cars and light trucks. CAFE standards require light duty cars and trucks to have an EPA rated efficiency of 165 g CO₂e/mile and 240 g CO₂e/mile, respectively, by 2026. Assumptions around fuel efficiency through 2026 remain unchanged from the CAP; however, after 2026, the Department of Transportation’s 2022 Final rule is used, which forecasts 2029 fuel economy to be 62.6 mpg for cars and 42.1 mpg for trucks (U.S. DOT, 2021). This level of CAFE standard is assumed to remain constant from 2030 to 2045. Any change in federal CAFE in the future would dramatically affect baseline conditions for ground transportation GHGs.

In addition to EVs embedded in the fuel efficiency achieved through CAFE, the model assumes additional EV adoption for O‘ahu, beyond the national average. EV adoption is assumed to follow an increasing trend in EV sales based on HECO’s “backbone study” (HECO, 2021). Whereas HECO’s forecast is for cars on the road, we use the turnover model to best approximate this forecast and solve for new vehicle adoption. Starting in 2020 5% of new vehicle sales are assumed to be EVs, rising to 29% in 2030, 63% in 2040 and 85% in 2045. In comparison to other forecasts provided in Figure 17, this is an aggressive forecast for EV adoption.

The last update made to the light duty vehicle turnover model is an adjustment to vehicle travel demand based on current expectations for the Honolulu Skyline. The Honolulu Authority for Rapid Transportation (HART) initially estimated the maximum VMT that could be displaced from passenger cars and trucks, once the rail is fully operational and running at full capacity, to be 566 million miles (HART, 2010). However, given the planned truncated service to the system (HART, 2019), this is adjusted downward. Using HART (2019) estimates for expected passenger trips and making assumptions for peak and off-peak utilization (as in the initial CAP), we reach a new estimate for VMT reduction of 456 million miles by 2045.

Renewable Energy Generation

Lastly, we update the renewable energy scenarios for electricity generation based on Hawaiian Electric’s Integrated Grid Plan (IGP). For the baseline, we assume that HECO follows the “land constrained” scenario within the IGP. Under the “High Renewable Electricity” scenario, we follow the IGP “baseline.” In the “Low Renewable Electricity” we

assume that the baseline renewable energy deployment will be delayed according to historic delays in renewable energy deployment compared to planned deployment as stated in the company’s PSIP (Hawaiian Electric, 2016). Renewable energy uptake for electricity generation is used to estimate GHG emissions for EVs, both light duty and heavy duty.

XI. Acknowledgements

We thank Muhammed Talal Kahn for his research assistance, participants in the three stakeholder workshops for their time and input, and the team at ICF for being a great partner in this work.



CAPITAL IMPROVEMENT BUDGET PRIORITIZATION TOOL

CAPITAL IMPROVEMENT BUDGET PRIORITIZATION TOOL

In this Tool ...

Introduction and Overview	3
Bicycle facility	6
Pedestrian facility	10
Transit service improvements	13
Roadway and Intersection improvements	18
EV charging station development	23
Use cleaner fuel vehicles	26



Introduction and Overview

The primary purpose of the Capital Improvement Budget Prioritization Tool is to facilitate the consideration of greenhouse gas (GHG) reduction potential in the selection of projects for inclusion in the City and County of Honolulu's capital improvement program. The tool was developed by reviewing the existing annual capital program and budget, identifying typical transportation project types, describing how GHG emissions are typically affected by each project type, and identifying key parameters and variables used to calculate GHG emissions at the planning or programming stage. For each project type, this document provides methods to estimate GHG impacts, the potential range of impact, and an example calculation. Also included are brief descriptions of co-benefits to safety, public health, and economic development.

Capital improvement projects can affect GHG emissions in two phases: project construction and project operation. Operations impacts refer to the phase when the transportation project is completed and the improved facility is in use. Operational (or system user) GHG impacts are typically the most significant GHG impacts over the life of a project, whether increasing or reducing GHG emissions. The analysis methods described in this document focus on the operational phase, whereby the GHG impacts are often related to a change in vehicle miles traveled (VMT).

Construction of projects can also have non-trivial impacts on emissions. Construction-related GHG impacts are tied to the intensity and duration of construction activity. These emissions typically result from fuel used in construction equipment as well as the production and transport of construction materials. Projects that do not involve significant use of materials or extended operation of construction equipment (e.g., striping of a bike lane) will result in relatively small construction emissions impacts.

This document was developed by reviewing the Fiscal Year 2024 Six Year Capital Improvement Program for types of transportation projects that could have a quantifiable emissions impact. Transportation projects are sorted into categories or types, and for each project type, the document describes how the project could affect GHG emissions, including both reductions and increases. The project types are:

- Bikeway/bicycle facility
- Pedestrian facility
- Transit service improvements
- Road and intersection improvements
- Electric vehicle charging station development
- Use of cleaner fuel vehicles

This document provides a chapter for each project type. Each chapter describes in detailed terms how emissions impacts related to the project type would typically be calculated at the planning or programming stage, including key parameters and variables that are needed to estimate emissions impacts and that influence the results. An example calculation is also provided. Project type chapters also describe the range of typical GHG emissions impacts, to the extent supported by data. In some cases, this range can be estimated using an emissions impact formula and hypothetical high-end and low-end input

parameters. In other cases, the range may be based on literature. Project type chapters also discuss any potential overlaps or synergies that could occur with implementing multiple transportation projects and project type co-benefits. As supported by data, project cost ranges are also noted.

Transportation Project Types that Could Be Included in the Capital Improvement Budget

Ultimately, information in this document about potential GHG emissions impacts can be incorporated in the capital transportation project budget prioritization process. The City's priority is to deliver capital improvement projects that improve and enhance public safety, achieve sustainability, enhance livability, and expand economic development. The City conducts public meetings on the City's annual Capital Improvement Plan for a three-month period every year during the annual budget bill hearings. This process includes development of the Capital Budgets, which identifies long-lived projects, facilities, and large equipment that the City plans to develop or purchase over the next six years. The Capital Improvement Budget is divided by function: general government, sanitation, public safety, highways and streets, human services, culture-recreation, and utilities and other enterprises. Transportation projects exist in several functions, particularly public safety, highways and streets, and utilities and other enterprises. Several different types of transportation projects exist within the budget; methods for estimating GHG emissions impacts are available for only a subset of these project types. The table below lists different transportation project types found in the Capital Improvement Budget, whether they would have operational GHG impacts, and if operational GHG impacts can be quantified.

Transportation Project Types	Typical System User Impacts	Operational GHG Emissions Quantifiable?
Bikeway/bicycle facility		
Bicycle path or bike lanes	Small VMT and GHG emissions reduction	Yes
Pedestrian facility		
Construction of new sidewalks, including first/last mile connections	Small VMT and GHG emissions reduction	Yes
Pedestrian crossing beacons	Small VMT and GHG emissions reduction	No
Crosswalks	Small VMT and GHG emissions reduction	No
Curb ramps	Small VMT and GHG emissions reduction	No
BRT/Transit Capital Improvement		
High-capacity transit	VMT and GHG emissions reduction	Yes
Multimodal transit fare collection system	Small VMT and GHG emissions reduction	No
Bus stop and station area improvements	Small VMT and GHG emissions reduction	No
Other Types of Improvements		
Intersection improvements	Varies	Yes
Road capacity expansion	Increase in VMT and GHG emissions	Yes
Zero emission vehicle acquisition	GHG emissions reduction	Yes
EV charging station development	GHG emissions reduction	Yes
Cleaner fuel vehicles	GHG emissions reduction	Yes
Complete streets	Varies	No
Intelligent transportation systems	Varies	No
Safety improvements	Varies	No

Project Type Chapters

The remainder of this document is comprised of chapters for each transportation project type for which operations related GHG impacts can be estimated. Each chapter describes the project type, explains how the project type operations can affect GHG emissions (e.g., mode shift or induced vehicle travel), identifies complementary projects, and describes in detailed terms how the project emissions impacts would be typically calculated at the planning or programming stage and the information needed to do so, with an example. Chapters include the range of typical GHG emissions impacts at the project-level, synergies with other project types if constructed in conjunction, potential co-benefits to safety, public health or economic development, and typical project costs.

The use of fossil-fuel powered vehicles is the primary source of GHG emissions within the transportation sector. Automobiles traditionally use gasoline and diesel fuel and release emissions based on the amount of fuel combusted by the engine. Cleaner-fueled and electric powered vehicles can also generate GHG emissions, but at lower rates. Transportation emissions can be reduced by improving the emissions profile of the vehicle fleet or by reducing VMT. Project types in this document could either reduce VMT and encourage mode shifts from single-occupancy vehicles to shared (e.g., transit) or active modes of transportation (e.g., bicycle riding and walking) or increase VMT through induced demand related to roadway capacity increases, as an example. Most of the GHG emission impacts are determined by applying an elasticity value to estimate the amount of VMT that may be increased or reduced through operations of that project type. Some transportation project types are aimed at improving the emissions profile of the vehicle fleet. These project types may promote cleaner fuels and vehicles. The emission reductions from cleaner fuels and vehicles are based on the improved emission factors and on changes to the assumed vehicle fleet mix. Each transportation project type chapter provides key inputs and variables for estimating GHG emissions changes, either increases or reductions and provides estimates calculated on a project basis depending on facility length and other factors cited.



Bicycle Facility

Bicycle facilities expand the bicycle network and include interconnected bicycle lanes (striped or buffered), protected bicycle lanes, multiuse paths, and other facilities that support safe and convenient bicycling. A comprehensive bicycle system should also include wayfinding, crossing and signalization improvements, and amenities designed to support cycling, such as end-of-trip parking. The expansion of bicycle facilities can encourage mode shift and thus reduce automobile travel and associated emissions.

► IMPACT ON GHG EMISSIONS

The impact of bicycle facility expansion on GHG emissions will depend on the extent to which the facility attracts new bicyclists and causes mode shift away from auto travel, as well as the length of trips that are diverted to cycling. The expected range of these GHG reductions, estimated annually and per mile of infrastructure, is as follows:

- On-road bicycle lane (Class II): 14,980–25,229 VMT reduction and 5.3–9.0 metric tons of CO₂ equivalent reductions.
 - Equates to approximately 12,483 – 21,024 VMT and 4.4 – 7.5 metric tons of CO₂-equivalent reduced per mile of infrastructure.
- New off-road bicycle path (Class I): 4,494–8,988 VMT reduction and 1.6–3.2 metric tons of CO₂ equivalent reductions.
 - Equates to approximately 3,745 – 7,490 VMT and 3.6 – 6.3 metric tons of CO₂-equivalent reduced per mile of infrastructure.
- Protected bicycle lane/cycle track (Class IV): 25,229–50,859 VMT reduction and 12.47–18.08 metric tons of CO₂ equivalent reductions.
 - Equates to approximately 21,024 – 42,383 VMT and 10.4 – 15.1 metric tons of CO₂-equivalent reduced per mile of infrastructure.

► IMPLEMENTATION CONSIDERATIONS

Bicycle facility design should consider best practices, ideally providing physical separation between modes through buffered or protected bike lanes (sometimes called cycle tracks) to increase user comfort and safety. Bikeway network development needs to consider filling gaps, including first and last mile connections to transit stations and key destinations. Bikeway facilities can include complete streets principles, which consider safe access and mobility for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. Safety enhancements at intersection crossings, such as pavement markings, signage, medians, and signal detection can benefit safety and user confidence. Wayfinding to destinations, including estimated bicycling travel time can also boost user confidence. Education and encouragement programs, such as community bike rides can help users make use of new facilities.

Methods for measuring the quality, comfort, and safety of the bicycle network such as Bicycle Level of Service or Bicycle Level of Traffic Stress can be used to select bicycle facility types and identify gaps in the system.

► COMPLEMENTARY STRATEGIES

- Bike share programs
- End of trip facilities (bike parking, showers, maintenance hub)
- Transit service expansion
- Mixed use development
- Street connectivity

► CO-BENEFITS

- Bicycle riding is a form of active transportation, and because it is human powered, can improve public health through increased physical activity.
- Bicycle ownership and use can be more affordable than car ownership.
- Bicycle riders often experience a disproportionate number of fatalities and severe injuries when involved in a crash. Bicycle facility expansion can provide safer facilities for the most vulnerable users.
- Bicycle riding can provide a first and last mile connection to transit.

► SYNERGIES WITH OTHER PROJECT TYPES

Expansion of bikeway or bicycle facilities can benefit other transportation project types, specifically pedestrian facilities and BRT/transit capital improvements, by promoting active transportation overall and being part of a transportation system that is less reliant on automobiles. Bikeway or bicycle facilities can provide first and last mile connections to transit.

► COST CONSIDERATIONS

Nationally, the estimated cost of constructing a bike lane is approximately \$5,000 to \$50,000 per mile, depending on the condition of the pavement, the extent of removing and repainting of lane lines, the need to adjust signalization, and other factors. The best time to create bicycle lanes is during regular street reconstruction, street resurfacing or at the time of original construction.¹

The estimated cost of constructing a 10-foot wide, multiuse path in an urban setting using asphalt is \$798,000 per mile or using concrete is \$879,000 per mile.²

► GHG IMPACT ESTIMATION METHODOLOGY

Annual Auto Vehicle Miles Traveled Displaced	
$A_{VMT} = D \times ADT \times (M + C) \times GFA \times L$	
Where,	<u>Units</u>

¹ FHWA Safer Journey Countermeasures (retrieved from [link](#))

² INDOT cost calculator (2019; retrieved from https://www.in.gov/indot/files/INDOT_TrailsCostCalculator_Memo.pdf)

A_{VMT}	Annual Auto Vehicle Miles Traveled Displaced	Miles per year
D	Annual days of use of new facility; default is 365 days	Days per year
ADT	Average two-way daily traffic on road parallel to facility	Vehicle Trips per day
M	Mode Shift Factor (see table below)	Unitless
C	Credit for key destinations near facility (see table below)	Unitless
GFA	Growth Factor Adjustment; 1 for new Class II bike lanes, 1.54 for new Class I bike paths or Class IV cycle tracks, and 0.54 for conversion from Class II bike lanes to Class IV cycle tracks	Unitless
L	Average length of auto trip replaced by bicycle trip; default is 1.2 miles	Miles

Mode Shift Factor

Average Daily Traffic (vehicle trips per day)	One-way Facility Length (miles)	Mode Shift Factor (M)
1 to 12,000	≤ 1	0.0019
1 to 12,000	1.01 to 2	0.0029
1 to 12,000	> 2	0.0038
12,001 to 24,000	≤ 1	0.0014
12,001 to 24,000	1.01 to 2	0.0020
12,001 to 24,000	> 2	0.0027
24,001 to 30,000	≤ 1	0.0010
24,001 to 30,000	1.01 to 2	0.0014
24,001 to 30,000	> 2	0.0019

Credit for Key Destinations Near Facility

Number of Key Destinations	Credit Within 1/2 Mile of Facility (C)	Credit Within 1/4 Mile of Facility (C)
0 to 2	0	0
3	0.0005	0.001
4 to 6	0.001	0.002
7 or more	0.0015	0.003

Annual GHG Emission Reductions

$$E = A_{VMT} \times EF$$

Where,

		<u>Units</u>
E	Annual GHG Emission Reductions	Grams CO ₂ -equivalent (CO ₂ e)
A_{VMT}	Annual Auto Vehicle Miles Traveled Displaced	Miles per year
EF	Emission Factor; default is 355.48 grams CO ₂ -equivalent per mile	Grams CO ₂ e per mile

► **EXAMPLE GHG IMPACT CALCULATION**

A new Class II bicycle lane is constructed on a street that carries an average two-way daily traffic of 18,000 vehicles. The new bicycle lane is 1.2 miles long and has 5 key destinations within a half-mile buffer of the facility.

EXAMPLE: Annual Auto Vehicle Miles Traveled Displaced by New Class II Bike Lane

$$A_{VMT} = 365 \times 18,000 \times (0.002 + 0.001) \times 1.0 \times 1.2 = 23,252 \text{ miles per year}$$

EXAMPLE: Annual GHG Emission Reductions

$$E = 23,252 \text{ miles per year} \times 355.48 \text{ grams CO}_2\text{e per mile} = 8,407.8 \text{ kilograms}$$

$$E = 8.41 \text{ metric tons CO}_2\text{-equivalent}$$



Pedestrian Facility

Pedestrian facility projects contribute to a complete, Americans with Disability (ADA) accessible pedestrian network, made up of sidewalks, crossing facilities, multiuse paths and even pedestrian-only walkways that encourages people to walk instead of drive. Expanded or improved pedestrian facilities can improve pedestrian safety, walkability, and accessibility to key destinations, such as jobs, education, healthcare, food, and other goods and services.

► IMPACT ON GHG EMISSIONS

Pedestrian facilities would result in a reduction of VMT and GHG emissions through mode shift to walking. GHG reductions typically increase with facility length and with the number of key destinations connected by the facility. The expected range of these GHG reductions, estimated annually and per mile of infrastructure, is as follows:

- Pedestrian passageway over several lanes of heavy traffic (grade separated): 2,497–4,993 VMT reduction and 0.89–1.77 metric tons of CO₂ equivalent reductions.
 - Equates to approximately 2,080 – 4,160 VMT reduced per mile of infrastructure and 0.74 – 1.5 metric tons of CO₂-equivalent reduced per mile of infrastructure.
- Sidewalks: 34,164–49,538 VMT reduction and 12.1–17.6 metric tons of CO₂ equivalent reductions.
 - Equates to approximately 28,470 – 41,281 VMT and 10.3 – 14.6 metric tons of CO₂-equivalent reduced per mile of infrastructure.

► IMPLEMENTATION CONSIDERATIONS

The GHG reduction of this project type is based on estimated VMT reduction associated with expansion of sidewalk coverage, which includes not only the building of new sidewalks but also improving degraded or substandard sidewalks (e.g., damaged from street tree roots). Implementation considerations for pedestrian facilities include:

- Provide accessible sidewalks and maintained sidewalks on both sides of the streets in urban areas, particularly to key destinations such as school zones, senior centers, and near transit.
- Enhance pedestrian crossings crossing conditions so crosswalks are well marked, high visibility, illuminated, and with leading pedestrian intervals at signalized intersections. Consider pedestrian hybrid beacons, mid-block crossings, pedestrian refuge islands (particularly on multi-lane facilities), and pedestrian-only connections.
- Consider traffic calming techniques such as speed bumps or tables to slow speeds and better enable crossing of streets.
- Develop contiguous sidewalk coverage and limit out-of-direction travel for pedestrians to the extent possible
- Consider streetscape improvements and pedestrian amenities, such as street trees to create a canopy, landscaping, seats for people to rest, wayfinding signage, and illumination through pedestrian-scale lighting.
- For areas with higher potential for pedestrian activity, consider wider sidewalks, which are shown to be a factor influencing walking propensity.

- In rural areas, consider a path or a wide striped fog lane as an alternative to typical curb and gutter sidewalks.

► COMPLEMENTARY STRATEGIES

- Mixed Use Development
- Higher Density Development
- Street Connectivity Improvement
- Bikeway Network Expansion
- Transit Service Expansion

► CO-BENEFITS

- Walking is a form of active transportation, and because it is human powered, can contribute to public health through increased physical activity.
- Walking can be more affordable than car ownership.
- Pedestrians often experience a disproportionate number of fatalities and severe injuries when involved in a crash. Pedestrian facility expansion can provide safer facilities for the most vulnerable users.
- Pedestrian connections can provide a first and last mile connection to transit.
- Pedestrian routes may be vital for evacuation in the event of emergencies and can contribute to community resiliency.

► COST CONSIDERATIONS

Depending on the improvement, capital and infrastructure costs may be high, particularly if curb and gutter need to be constructed or moved. However, improvements to the pedestrian network will increase pedestrian activity, which can increase businesses patronage and provide a local economic benefit. The City may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

An FHWA Complete Streets Cost Case Study finds the unit cost for sidewalk construction to be approximately \$5 per linear foot. The case study finds the cost of curb ramps to be approximately \$156,600 per square foot.

► GHG IMPACT ESTIMATION METHODOLOGY

Annual Auto Vehicle Miles Traveled Displaced		
$A_{VMT} = D \times ADT \times (M + C) \times L$		
Where,		Units
A_{VMT}	Annual Auto Vehicle Miles Traveled Displaced	Miles per year
D	Annual days of use of new facility; default is 365 days	Days per year
ADT	Average two-way daily traffic on road parallel to facility	Vehicle Trips per day
M	Mode Shift Factor (see table below)	Unitless
C	Credit for key destinations near facility (see table below)	Unitless
L	Average length of auto trip replaced by walking trip; default is 0.5 miles	Miles

Mode Shift Factor

Average Daily Traffic (vehicle trips per day)	One-way Facility Length (miles)	Mode Shift Factor (M)
1 to 12,000	≤ 1	0.0019
1 to 12,000	1.01 to 2	0.0029
1 to 12,000	> 2	0.0038
12,001 to 24,000	≤ 1	0.0014
12,001 to 24,000	1.01 to 2	0.0020
12,001 to 24,000	> 2	0.0027
24,001 to 30,000	≤ 1	0.0010
24,001 to 30,000	1.01 to 2	0.0014
24,001 to 30,000	> 2	0.0019

Credit for Key Destinations Near Facility

Number of Key Destinations	Credit Within 1/2 Mile of Facility (C)	Credit Within 1/4 Mile of Facility (C)
0 to 2	0	0
3	0.0005	0.001
4 to 6	0.001	0.002
7 or more	0.0015	0.003

Annual GHG Emission Reductions

$$E = A_{VMT} \times EF$$

Where,

		Units
E	Annual GHG Emission Reductions	Grams CO ₂ e
A_{VMT}	Annual Auto Vehicle Miles Traveled Displaced	Miles per year
EF	Emission Factor; default is 355.48 grams CO ₂ -eq per mile	Grams CO ₂ e per mile

► EXAMPLE GHG IMPACT CALCULATION

A new pedestrian path is constructed on a street that carries average daily traffic of 10,000 vehicles. The new bicycle lane is 0.75 miles long and has 3 key destinations within a half-mile buffer of the facility.

EXAMPLE: Annual Auto Vehicle Miles Traveled Displaced by New Pedestrian Path

$$A_{VMT} = 365 \times 10,000 \times (0.0019 + 0.0005) \times 0.5 = 4,380 \text{ miles per year}$$

EXAMPLE: Annual GHG Emission Reductions

$$E = 4,380 \text{ miles per year} \times 355.48 \text{ grams CO}_2\text{e per mile} = 1,493.8 \text{ kilograms} = 1.49 \text{ metric tons}$$



Transit Service Improvements

The improvement or expansion of public transit service can help to make transit competitive with automobile travel, thereby causing mode shift and a reduction in VMT and GHG emissions. Transit service expansion can include new conventional fixed bus routes or rapid bus routes. Specific examples of transit system improvements are:

- ▶ Increasing bus service frequency on current routes
- ▶ Running longer bus routes (service area expansion)
- ▶ Street treatments for transit, such as curb extensions, signal preemption, and bus pull-out bays
- ▶ Converting an existing conventional bus route to bus rapid transit (BRT) with dedicated right of way or guide ways
- ▶ Bus building/depot improvements

New transit service can incorporate amenities to improve the rider experience, thereby helping to encourage new riders to try transit. Transit also has the added benefit of providing mobility to disabled, low-income, or other users for whom driving may be inaccessible or cost prohibitive. With a focus solely on capital improvements, this chapter does not address the potential GHG impacts from increasing transit frequencies or reducing transit fares.

▶ IMPACT ON GHG EMISSIONS

Expansion of transit facilities would result in a reduction of VMT and GHG emissions through mode shift from automobile to transit. GHG impacts are estimated for new or expanded service based on number of destinations served and trip length. New or expanded service is estimated to result in a daily VMT reduction of 19,700–28,000 miles and a corresponding GHG reduction of 7.0–10.0 metric tons of CO₂ equivalent reductions per day when serving at least 8,000 new riders. Illustrative examples of how to estimate GHG impacts for hypothetical bus or BRT expansion are provided at the end of this chapter.

▶ IMPLEMENTATION CONSIDERATIONS

The GHG reduction of this project type is based on the VMT reduction associated with expansion of transit coverage. Implementation considerations for transit facilities include:

- Capacity and quality of transit service affects ridership; for example, high-frequency bus rapid transit may have greater potential to shift people away from driving alone than traditional fixed-route transit with fewer amenities, depending on the origins and destinations served.
- Service expansion will be most effective when accompanied by transit speed and frequency improvements.
- Expansions in the transit network should be paired with bike and pedestrian facility enhancements that facilitate safe and easy access to transit services, particularly for first and last mile connections.

- Consider implementing mobility hub improvements that may improve the overall transit rider experience.

► **COMPLEMENTARY STRATEGIES**

- Transit frequency improvements
- Equitable Transit-Oriented Development
- Higher Density Development
- Street Connectivity Improvement
- Bikeway Network Expansion
- Pedestrian Network Expansion
- Reduced Transit Fares

► **CO-BENEFITS**

- Transit use is a form of active transportation, because most riders access it by walking or bicycling, which contribute to public health through increased exercise and better air quality.
- Improved local air quality.
- Ability to develop more compactly.
- Energy and fuel savings.
- Greater people throughput using the same right-of-way

► **COST CONSIDERATIONS**

Infrastructure costs for extending the physical network coverage of a transit system can be significant. Costs to expand vehicle-dependent transit, such as buses, are likewise high but may be limited to procurement of additional vehicles. BRT, with corresponding guideways or station areas is not as costly as light rail transit; however, is more costly than traditional fixed route buses, and may require right of way acquisition. Any expansion of transit, including service hours, would increase staffing and potentially maintenance costs. A portion of these costs may be offset by increased transit usage and associated income; however operational costs are rarely fully recovered through transit use. Commuters who may more easily be able to travel without a car may also observe cost savings from reduced vehicle usage or ownership.

► **GHG IMPACT ESTIMATION METHODOLOGY**

The general approach used to estimate the GHG impacts of transit service improvements accounts for emission reductions from displaced VMT, vehicle and equipment replacement, and the generation and use of renewable fuels/energy. Default values and regional or state averages can be used where necessary, but use of project-level data will result in more accurate GHG emission reduction estimates.

A new or expanded service could be, for example, a new BRT project or expansion of local bus route. At a high level, the GHG emission reductions (in metric tons of CO₂ equivalent, MTCO₂e) of a new or expanded transit service are estimated as the difference in emission reductions from displaced autos and emissions caused by the expanded transit service.

Net Emission Reductions from New Service

$$E = E_{Reduced} - E_{New}$$

Where,

		<u>Units</u>
E	Net emission reductions	Metric tons CO2e
E _{Reduced}	Total emission reductions from displaced auto VMT	Metric tons CO2e
E _{New}	Total emissions produced by new service	Metric tons CO2e

The methodology and accompanying formulas are adapted to provide examples of project-level GHG emission reduction potential for new service projects in the City of Honolulu. To calculate the total emission reductions from displaced auto VMT, displaced daily auto VMT is multiplied by a fleetwide automobile emission factor:

Emission Reductions from Displaced Auto VMT

$$E_{Reduced} = (R \times A \times L) \times \frac{EF}{CF}$$

Where,

		<u>Units</u>
E _{Reduced}	Total emission reductions from displaced auto VMT	Metric tons CO2e
R	Daily increase in unlinked passenger trips directly associated with the project	Riders
A	Adjustment factor to account for transit dependency; default is 0.56; best to use project-specific or system average from survey	Unitless
L	Estimated length of average unlinked passenger trip, calculated as passenger-miles divided by unlinked trips	Mile(s) per rider
CF	Conversion factor	Grams/Metric ton
EF	Emission factor based on weighted automobile fleet average	Grams/mile

And the emissions associated with the operation of the new transit service are calculated using the product of the new service VMT, a transit vehicle emission factor, and applicable fuel discount factor, (see explanation below):

Emissions from New Service

$$E_{New} = \frac{NSVMT \times NSEF \times HDF}{CF}$$

Where,

		<u>Units</u>
E _{New}	Total emissions from new transit service	Metric tons CO2e
NSVMT	Estimated daily bus VMT attributed to the operation of the new service	Miles
NSEF	Transit vehicle emission factor based on service type	Grams/mile
HDF	Vehicle type factor, used to reflect transit bus tailpipe emissions; default value is 1 for conventional powertrain, 0.80 for hybrid powertrain, and 0 for electric powertrain	Unitless

► EXAMPLE GHG IMPACT CALCULATION

Illustrative examples for new local bus and BRT projects in the City of Honolulu are provided to show potential GHG emission reductions. The variable “*L*”, or estimated length of average unlinked passenger trip, is taken from the 2021 National Transit Database (NTD). According to the 2021 NTD, the estimated length of the average unlinked passenger trip for local buses in the City of Honolulu is 4.4 miles, calculated as the quotient between passenger miles and unlinked passenger trips:

City of Honolulu Estimated Length of Average Unlinked Passenger Trip for Local Buses

$$L_{LocalBus} = \frac{\text{Passenger-miles}}{\text{Unlinked Passenger Trips}} = \frac{122,372,662}{27,814,569} = 4.40 \text{ miles}$$

An estimate for the variable “*R*” from the equation above—the increase in unlinked passenger trips associated with the new service—is required to calculate the daily auto VMT displaced by the new service. According to the 2021 NTD, the City of Honolulu serves a primary urbanized area population of 802,459 people. For these examples, it is assumed that a new service project could yield an increase in unlinked passenger trips equal to at least one percent of the primary urbanized area population—this percentage should be modified based on local conditions and is an arbitrary value for demonstrative purposes. Therefore, for these examples, it is assumed that a new service project could yield at least 8,025 more unlinked passenger trips per day. In subsequent applications, the City of Honolulu may consider reviewing NTD data or conducting a local study to better estimate the likely new number of riders a new service project could yield.

To compare the potential GHG emission reduction potential of a new local bus or new BRT project, the increase in unlinked passenger trips will be kept constant between the two project types. However, both the adjustment factor “*A*” and estimated length of average unlinked passenger trip “*L*” can differ between project types. BRT service typically results in longer average trip length compared to local bus service. Data from the NTD suggest that BRT has average trip lengths 41% greater than local buses.

Percent Increase in Average Trip Length for BRT

$$\text{Percent Increase} = \left(\frac{L_{BRT} - L_{LocalBus}}{L_{LocalBus}} \right) = \frac{4.61 - 3.29}{3.29} = 41\%$$

Thus, in absence of an average trip length by BRT for the City of Honolulu from the 2021 NTD, an estimate of 6.23 miles is assumed for the following examples:

City of Honolulu Estimated Length of Average Unlinked Passenger Trip for BRT

$$L_{BRT} = L_{LocalBus} \times \text{Percent Increase} = 4.40 \times 41\% = 6.23 \text{ miles}$$

Assuming an average trip length of 4.40 miles for local buses and 6.23 miles for BRT, the GHG emission reductions from avoided auto VMT, “*E_{Reduced}*”, can be calculated. To calculate the total net emissions (i.e., calculate the emissions associated with operation of the new service, the transit agency would need to provide additional details about the type of transit bus and daily mileage expected to serve in the project, so for the purposes of these examples, only the GHG emission reductions from avoided auto VMT are calculated.

Emission Reductions from Displaced Auto VMT using Local Bus

$$E_{Reduced} = (R \times A \times L) \times \frac{EF}{CF} = (8,025 \times 0.56 \times 4.40) \times \frac{355.48}{1 \times 10^6} = 7.0 \text{ MTCO}_2\text{e}$$

Emission Reductions from Displaced Auto VMT using BRT

$$E_{Reduced} = (R \times A \times L) \times \frac{EF}{CF} = (8,025 \times 0.56 \times 6.23) \times \frac{355.48}{1 \times 10^6} = 10.0 \text{ MTCO}_2\text{e}$$



Roadway and Intersection Improvements

Roadway and intersection improvements include a variety of project types that generally are focused on improving the efficiency and/or safety of vehicle travel. Some roadway projects involve large capital expenditures, such as roadway widening to add travel lanes or replacement of a signalized or signed intersection with a roundabout. Many roadway projects involve modifications to signalized intersections to improve operating efficiency for vehicles, such as by adding turning lanes or adjustments to traffic signal timing. Roadway projects for motor vehicles can sometimes be combined with improvements for pedestrians, bicyclists, or buses. Roadway improvement projects that improve the flow of vehicles can result in reduced vehicle emission rates; however, because projects that improve traffic flow are likely to cause more vehicle travel, they typically result in a net increase in GHG emissions over time.

► IMPACT ON GHG EMISSIONS

The impact of a roadway and intersection improvement project on GHG emissions will depend on the extent to which the project improves traffic flow and induces new vehicle travel. For a hypothetical 5-mile improvement project on a roadway carrying average daily traffic of 10,000 vehicles, the expected GHG impact is as follows:

- If the roadway improvement project results in a 5 mph increase in average traffic speed, the project GHG impact would range from an *increase* of 1.4 metric tons to an *increase* of 4.3 metric tons of CO₂-equivalent emissions.
- If the roadway improvement project results in a 2 mph increase in average traffic speed, the project GHG impact would range from a *reduction* of 0.48 metric tons to an *increase* of 0.34 metric tons of CO₂-equivalent emissions.

These results would scale linearly with the facility length and the traffic volume.

► IMPLEMENTATION CONSIDERATIONS

The GHG reduction of this project type is based on the VMT changes associated with roadway and intersection improvements focused on improving efficiency and/or safety of vehicle travel. Implementation considerations include:

- Use of safe system approach to guide project development. Safe system approach aims for zero deaths based on the principles that people make mistakes, and that people are vulnerable to crash impacts. The approach involves anticipating potential mistakes and designing roadways to keep risks low and impacts less severe.
- Anticipate maintenance and operational impacts of roadways in the project development process.
- Preservation and maintenance projects provide an opportunity for some types of roadway improvements.

- Roadway and intersection improvements should be paired with bike, pedestrian, and transit facility enhancements to create a multimodal system.

► COMPLEMENTARY STRATEGIES

- Street connectivity improvement
- Complete streets
- Creating greater separation between modes
- Dynamic pricing

► CO-BENEFITS

- Potentially better local air quality due to less congestion
- Fewer conflict points and potential crashes
- Reduced travel time and greater reliability

► COST CONSIDERATIONS

A benefit cost analysis (BCA) approach could aid decision-making, providing a more holistic assessment. BCAs for roadway and intersection improvements include direct project costs (agency costs), project benefits (reduced travel time, improved reliability, reduced crash frequency and severity), and externalities, such as environmental impacts including GHG emissions.

► GHG IMPACT ESTIMATION METHODOLOGY

The net GHG impact of roadway improvement projects depends on two major components: the change in traffic speeds and corresponding change in emission rates, and any induced vehicle travel. To understand the effects of intersection improvements, the same methodology below can be used for roadway segments that contain intersections.

Traffic Speed Effects

Predicting changes in travel speeds can be complex because it depends on current levels of traffic congestion and the extent to which the roadway project will reduce congestion and increase traffic speeds. Because of this complexity, traffic flow and speed changes are usually estimated using software tools like Synchro or Highway Capacity Manual (HCM) tools. Using these tools, the analysis should estimate the current average traffic speed and future speed with completion of the project over the affected segment of roadway. Such a tool is ideally used during project development and likely requires too great a level of effort for a capital improvement programming process.

The vehicle fuel consumption rate is related to traffic speeds and can be estimated using relationship in the U.S. EPA's MOVES model. The following equation, derived from MOVES, calculates the fuel consumption rate (in gallons per mile) as a function of average cruise speed for a light-duty gasoline vehicle:

Fuel Consumption Rate		
$K = 0.000019137 \times (v_c)^2 - 0.0020660 \times v_c + 0.088916$		
Where,		<u>Units</u>
K	Fuel consumption rate; running fuel use factor	Gallons per mile
v_c	Cruise speed	Miles per hour

Multiplying the fuel consumption rate by the roadway segment length and traffic volume will calculate the vehicle fuel use (e.g., gasoline consumption) for the roadway. Gasoline consumption can then be multiplied by a scalar (e.g., GHG emission factor) to determine GHG emissions.

Induced Vehicle Travel Effects

Induced vehicle travel occurs when roadway improvements reduce congestion and vehicle travel times. The phenomenon of induced vehicle travel is widely accepted and well documented.³ In the short term, expansion of roadway capacity can cause new vehicle trips that would otherwise would not be made, longer vehicle trips to more distant destinations, shifts from off-peak to peak travel hours, and shifts from other modes to driving. Longer term changes can include an increase in more dispersed, low density development patterns that are dependent on automobile travel.

Researchers typically seek to identify induced vehicle travel effects in terms of an “elasticity”, which is the ratio of the percentage change in one variable associated with the percentage change in another variable. For example, an elasticity value of 0.5 suggests that a 1% increase in roadway capacity is associated with a 0.5% increase in VMT, or a doubling (100% increase) in roadway capacity is associated with a 50% increase in VMT. Most of the induced vehicle travel research has focused on highway capacity expansion, not local roadways. The research has found elasticity values ranging from 0.1 to 0.6 in the short term (typically defined as one year or less) and 0.4 to 1.06 in the long term (5 to 10 years or more). The induced vehicle travel literature has been used to create on-line calculators for estimating the additional VMT that will result from a highway capacity expansion project. For example, the SHIFT Calculator, created by the Rocky Mountain Institute (RMI), enables these calculations for every metropolitan area in the U.S.⁴

There has been little to no research regarding the induced vehicle travel impacts of improvements to minor arterial and local roadways. In theory, however, any project that reduces roadway congestion (i.e., improves travel speeds) will lead to an increase in vehicle travel and VMT. This includes physical expansion to roadway capacity as well projects that improve the operational capacity of the roadway, such as signal timing adjustments. However, the magnitude of the induced vehicle travel impacts is likely to be smaller for arterial and local roadways than for highway projects. This is in part because highways carry a larger proportion of longer trips during peak periods, including traditional home-based work trips, so highway travel speed improvements are more likely to affect development patterns than similar speed improvements on the local roadway system.

For minor arterial and local roadway projects, the induced vehicle travel elasticity can be estimated to be a fraction the value for highway projects. Specifically, it can be assumed that the induced vehicle travel effects of minor arterial and local roadway projects includes only vehicle travel changes like mode shift,

³ Milam, Ronald T., Marc Birnbaum, Chris Ganson, Susan Handy, Jerry Walters, “Closing the Induced Vehicle Travel Gap Between Research and Practice,” Transportation Research Record, Volume 2653, Issue 1, 2017

⁴ See: <https://shift.rmi.org/>

longer trips, and more frequent trips, and not changes in land development patterns. Based on the literature, it can be assumed that the average short-term elasticity is 40% of the long-term elasticity value. Applying 40% to the 0.75 elasticity value used in the RMI SHIFT tool, an elasticity of 0.3 can be assumed for capacity expansion to minor arterial and local roadway projects. Roadway projects that focus on operational improvements rather than physical capacity expansion can be expected to cause induced vehicle travel to the extent that they improve travel speeds in a corridor.

Combined Net GHG Impact

Fuel Consumption Reduced		
$F_C = D \times AADT_{NoBuild} \times [K_{Speed,noBuild} - (1 + EID) \times K_{Speed,build}]$		
Where,		<u>Units</u>
F _C	Fuel Consumption Reduced	Gallons
D	Corridor Distance	Miles
AADT _{NoBuild}	Annual average daily traffic under the no-build condition	Vehicles per day
K _{Speed,NoBuild}	Running fuel use factor under the no-build condition	Gallons per hour
EID	Elasticity of induced VMT due to improved corridor speed; see list of values below	Percent
K _{Speed,Build}	Running fuel use factor under the build condition	Gallons per hour

Elasticity of Induced VMT (EID)	
$\text{Induced VMT Elasticity} = \begin{cases} \text{Speed Improvement} \leq 5\%, 0 \\ 5\% < \text{Speed Improvement} \leq 20\%, 2 * \text{Speed Improvement} (\%) - 0.1 \\ \text{Speed Improvement} > 20\%, 0.3 \end{cases}$	
Where,	
$\text{Speed Improvement} (\%) = [\text{cruise-speed}_{\text{build}} - \text{cruise-speed}_{\text{no build}}] / \text{cruise-speed}_{\text{no build}}$	

GHG Emission Reduction		
$E = F_C \times EF$		
Where,		<u>Units</u>
E	GHG Emission Reductions	Kilograms
F _C	Fuel Consumption Reduced	Gallons
EF	Emission Factor; default of 9.915 for gasoline	Kilograms of CO2 per gallon

► **EXAMPLE GHG IMPACT CALCULATION**

A roadway improvement project proposed for a 5-mile-long corridor with an AADT of 10,000 vehicles per day is expected to increase average speeds from 40 to 45 miles per hour.

Example Calculation

$$K_{speed, NoBuild} = 0.000019137 \times (40)^2 - 0.002066 \times 40 + 0.088916 = 0.0369 \text{ gallons per hour}$$

$$K_{speed, NoBuild} = 0.000019137 \times (45)^2 - 0.002066 \times 45 + 0.088916 = 0.0347 \text{ gallons per hour}$$

$$\text{Speed Improvement (\%)} = (45 - 40) / 40 = 12.5\%$$

$$\text{Induced VMT Elasticity} = 2 \times 0.125 - 0.1 = 0.15$$

$$\begin{aligned} \text{Fuel Consumption Reduced (F}_c\text{)} &= 5 \times 10,000 \times [0.0369 - (1 + 0.15) \times 0.0347] \\ &= -150 \text{ Gallons} \end{aligned}$$

$$\text{Emission reduction} = -150 \times 9.915 = -1,487 \text{ kilograms CO}_2\text{-equivalent}$$

Or 1.5 metric ton CO₂-equivalent *increase*



EV Charging Station Development

Electric vehicle (EV) charging infrastructure is an important component for maximizing the deployment and use of EVs. Many studies have shown that large reductions in transportation sector GHG emissions cannot be achieved without electrifying the vehicle fleet. While most EV charging is expected to occur at residences, public charging is needed to alleviate range anxiety, enable longer trips by EVs, and provide charging options for Honolulu residents who may lack a garage or other location for home-based charging. In addition, public charging stations can enable drivers of plug-in hybrid electric vehicles (PHEVs) to drive a larger share of miles in electric mode (eVMT), as opposed to gasoline-powered mode, thereby displacing GHG emissions from gasoline consumption with a lesser amount of indirect emissions from electricity. Public EV charging stations can be installed in City-owned parking lots and garages or even curbside locations.

► IMPACT ON GHG EMISSIONS

The impact of EV charging station development on GHG emissions will depend on a combination of factors, including the number of charging stations by power level, level of utilization, annual availability to charging stations, and the carbon intensity of the electric grid. The expected range of these GHG reductions is as follows:

- Single EV charging station with single plug rated at 50kW: 65.6 metric tons CO₂e reduced per year.
- Ten EV charging stations with ten plugs rated at 150kW: 1,967 metric tons CO₂e reduced per year.

► IMPLEMENTATION CONSIDERATIONS

- For public EV charging stations, encouragement programs can help existing EV owners or interested owners choose to purchase and use EVs
- EV charging stations can be implemented in conjunction with vehicle replacements in publicly owned fleets
- Local market conditions, pricing, and type of EV charging stations can all affect EV charging and resulting GHG emissions

► COMPLEMENTARY STRATEGIES

- Encouragement programs that provide education and outreach to the public about EV charging and ownership

► CO-BENEFITS

- Fewer localized, negative air quality impacts
- Fewer noise and vibration effects
- Less environmental pollution related to internal combustion engines
- Lower maintenance costs for owners compared to internal combustion engine vehicles
- Adjacent businesses can derive benefits from patronage of station users if nearby

► COST CONSIDERATIONS

The primary costs associated with electric vehicle charging infrastructure include the capital costs of purchasing and installing charging stations, electricity costs from use of stations, and maintenance costs of keeping the charging stations in working order. Government agencies typically benefit from private sector partnerships when pursuing EV charging infrastructure deployment. A number of EV infrastructure companies operate in Honolulu. Local governments often contract with these providers to install, operate, and maintain charging stations.

► GHG IMPACT ESTIMATION METHODOLOGY

Annual Auto VMT Affected		
$A_{VMT} = \sum N_i P_i U_i H_i \div EVEF \times FICE$		
Where,		Units
A_{VMT}	Annual Auto VMT converted from gasoline-powered to EV	Miles per year
N_i	Number of chargers by power level	Units
P_i	Charger power level (e.g., 50kW = 50,000W)	Watts
U_i	Average charger utilization (percent of time when charger is actively in use)	Percent
H_i	Annual total hours that chargers are online and available for charging	Hours
$EVEF$	Average energy efficiency values (in Wh per mile) for light duty EV; default values can be retrieved using commercially available EV data	Wh per mile
$FICE$	Current fraction of light duty vehicle fleet that is gasoline-powered (internal combustion engines).	Percent

Annual GHG Emission Impacts		
$E = A_{VMT} \times (CI_G - CI_E \times EVEF \div 1000)$		
Where,		Units
E	Annual GHG Emission Impacts	Grams
CI_G	Carbon intensity that accounts for the light duty (gasoline) vehicle well-to-wheel emissions; default values can be retrieved from the GREET model, or use an average of 409.7	Grams CO2e per mile
CI_E	Carbon intensity of local electricity grid; default value for 2022 from HECO is 585 (excluding biogenic sources)	Grams CO2e per kWh
$EVEF$	Average energy efficiency values (in Wh per mile) for light duty EV; default values can be retrieved using commercially available EV data, or use an average of 330	Wh per mile

► EXAMPLE GHG IMPACT CALCULATION

A hypothetical project will install ten single-port 50 kilowatt charging stations. The site's charging stations are expected to have a 30% utilization rate and anticipated to be online and available for 80% of the 8,760 hours in a year. This site is located in a region that currently has a gasoline vehicle fleet share of 95%.

For this example, a gasoline vehicle well-to-wheels carbon intensity of 409.7 grams of CO₂e per mile is assumed. The carbon intensity of the electric grid is assumed to be 585 grams per kWh. Multiplying the carbon intensity of the grid by the electric vehicle's efficiency yields an EV carbon intensity value of 193.1 grams CO₂e per mile.

The annual emission reduction would be 655.7 metric tons CO₂e per year, or 1.8 metric tons per day.

EXAMPLE: Annual Auto VMT Affected by Charging Stations

$$A_{VMT} = \frac{10 \times 50,000 \text{ W} \times 0.30 \times 8760 \text{ hours} \times 0.80}{330 \text{ Wh per mile}} \times 0.95 = 3,026,182 \text{ miles}$$

EXAMPLE: GHG Emission Impacts

$$\begin{aligned} E &= 3,026,182 \text{ miles} \times \left(409.7 \frac{\text{grams CO}_2\text{e}}{\text{mile}} - 193.1 \frac{\text{grams CO}_2\text{e}}{\text{mile}} \right) = 655,713,076 \text{ grams CO}_2\text{e} \\ &= 655.7 \text{ metric tons CO}_2\text{e per year or 1.8 metric tons CO}_2\text{e per day} \end{aligned}$$



Use of Cleaner Fuel Vehicles

This project type involves use of cleaner-fuel vehicles in lieu of similar vehicles powered by gasoline or diesel fuel. Cleaner-fuel vehicles addressed in this project type include electric vehicles, natural gas and propane vehicles, and vehicles powered by biofuels such as composite diesel (blend of renewable diesel, biodiesel, and conventional fossil diesel), ethanol, and renewable natural gas. To help decision-making around capital project selection, the methodologies cited in this chapter provide calculations for GHG emissions impact of cleaner fuels based on the emissions from the vehicle's tailpipe during vehicle operations. Methods for upstream emissions associated with production of the fuel (sometimes termed "upstream" emissions) are not included.

► IMPACT ON GHG EMISSIONS

The impact of transitioning fleets to use cleaner fuel vehicles on GHG emissions is primarily driven by the change in the share of near- or zero-emission vehicles compared to internal combustion engine vehicles. At a high level, GHG emission reductions can be quantified as a percent reduction from baseline emission projections; the expected range of GHG emission reductions varies widely based on each capital improvement project. To best describe the percent GHG emission reductions that could be realized through the implementation of battery electric- and plug-in hybrid electric vehicles, readers are referred to the GHG impact estimation methodology, which details how GHG emission reductions are a function vehicle fleet transition and electric grid carbon intensity. The expected range of these GHG reductions depends primarily on the number of vehicles being replaced, annual mileage, and the technology of the cleaner vehicles. Examples reductions include:

- Replacing a single light duty gasoline vehicle with 8,000 annual mileage with a battery electric vehicle results in a reduction of 1.7 metric tons of CO₂e per year.
- Replacing 20 light duty gasoline vehicles, each with an average of 12,000 annual mileage, with battery electric vehicles results in a reduction of 52 metric tons of CO₂e per year.

► IMPLEMENTATION CONSIDERATIONS

The implementation of cleaner vehicles by local governments creates the initial demand for fueling facilities, which creates pre-conditions for making cleaner vehicles more popular among individual car users and private fleet managers. This is the first step to establish the wide-spread use of cleaner vehicles.

► COMPLEMENTARY STRATEGIES

- Provide EV charging infrastructure
- Educational and encouragement programs can help increase awareness and use of cleaner fuels, including vehicle adoption
- Incentive programs aimed to increase vehicle adoption
- Use of cleaner fuels in government owned vehicles

► CO-BENEFITS

- Using cleaner-fuel vehicles increases transportation resilience by providing a wider range of available vehicles if other fuels (like gasoline) become unavailable.
- Most cleaner fuels reduce both GHG and criteria air pollutants; however, a few may increase criteria pollutant emissions. The most prominent example of this is biodiesel, which generally results in higher NOx emissions, but lower PM emissions compared to diesel.

► COST CONSIDERATIONS

Cleaner fuel vehicles typically carry a higher initial purchase price as compared to similar sized gasoline or diesel vehicles, although this difference is shrinking as battery prices fall. Fueling infrastructure may be required, which will add to the upfront cost of transitioning to cleaner fuel vehicles. Fueling costs are typically lower compared to gasoline and diesel but will vary depending on the type of fuel and market conditions. It is feasible to expect reduced fuel costs from cleaner fuels with an increased market and overall fuel cost savings over the life of the vehicle fleet. Battery electric vehicles also have substantially lower maintenance costs.

► GHG IMPACT ESTIMATION METHODOLOGY

An emission calculation that considers only tailpipe emissions is referred to as a “tank to wheels” analysis.

GHG Reduction from Use of Cleaner Fuel Vehicles		
$E = N \times M \times (EF_G - EF_{BEV})$		
Where,		<u>Units</u>
E	Emission reduction per year	grams CO2e
N	Number of vehicle replaced	units
M	Annual mileage per vehicle	miles
EF _G	Well-to-wheels emission factor for existing (gasoline fuel) vehicle	grams CO2e per mile
EF _{BEV}	Well-to-wheels emission factor for battery electric vehicle	grams CO2e per mile

► EXAMPLE GHG IMPACT ESTIMATION

This example calculates the emissions impact of replacing 20 light-duty gasoline vehicles with battery electric vehicles. The vehicles drive an average of 8,000 miles per year. For this example, a gasoline vehicle well-to-wheels emission factor of 409.7 grams of CO2e per mile is assumed. The carbon intensity of the electric grid is assumed to be 585 grams per kWh. Multiplying the carbon intensity of the grid by the BEV efficiency of 330 Wh per mile yields a BEV emission factor or 193.1 grams CO2e per mile.

GHG Reduction from Use of Cleaner Fuel Vehicles	
$E = 20 \times 8,000 \times (409.7 - 193.1) = 34,656,000 \text{ gCO}_2\text{e per year} = 34.7 \text{ MT CO}_2\text{e per year}$	

Energy and Emissions Reduction Plan for Transportation

Task 7: Transportation Demand Management (TDM) Framework for City Employees

Introduction

The Transportation Demand Management (TDM) Framework for City Employees establishes high-level parameters for a TDM program focusing on the City's Downtown Honolulu worksites employing approximately 3,000 staff. The framework identifies key issues, TDM program goals, priority strategies, implementation needs, key performance indicators, and program evaluation. The priority strategies recommended in this framework are estimated to provide a **10% to 14% direct return on investment over a 10-year period** from cost savings related to subsidized employee parking. This framework is an internal strategic planning resource for City department leadership to plan for implementation of a City employee commute program. This document is accompanied by an executive summary, employee-facing promotional material, and supporting data with vehicle trip reduction and cost estimates for each TDM strategy.

TDM is a set of strategies that maximize traveler choices, including the mode of transportation, the route they take, and the time they travel. Reducing drive-alone trips is a central output of TDM that supports various City goals like reducing emissions, reducing congestion, alleviating parking pressure, enhancing employee recruitment and retention, and leading by example as a major employer in the downtown area. TDM also enables the City to use land more productively and reduce annual net revenue loss to public parking (\$4.75 million citywide), while accommodating access needs for the City's growing workforce.

The Department of Transportation Services (DTS) led the development of the TDM framework, which was informed by the following activities:



Figure 1: Transportation demand management (TDM) is a set of strategies that maximizes traveler choices with the central output of reducing drive-alone trips.

- Review of the City’s baseline transportation benefits and practices, including enrollment in parking and transit benefits and the results of the Work Where You Live survey.
- Coordination with the concurrent Communitywide TDM Plan to ensure consistency of approach and to minimize duplicative efforts.
- Engagement with City departments and leadership to vet TDM framework elements.

Key Issues

This TDM framework supports a TDM program that addresses the following key issues facing the City:

- High parking operational costs (\$4.75 million annual revenue loss citywide).
- Demand exceeds capacity for vehicle parking and roadways.
- Growing workforce with expectation to fill 3,000+ vacant positions over the next several years.
- High vacancy and turnover rates among City personnel.
- Lack of incentives for sustainable transportation options.
- Inequitable distribution of current transportation benefits (subsidies have only been available for parking, and no other modes).

Figure 2 at right illustrates these key issues.

TDM Program Goals

City employee TDM program goals and their alignment with the Communitywide TDM Plan goals are summarized in Table 1 below.

Table 1. TDM Program Goals

TDM Goals for City Employees	Alignment with Communitywide TDM Plan Goals
Increase employee commute options and flexibility	Long-Term Resilience
Reduce employee cost of living	Equity
Improve employee health through increase in active living	Long-Term Resilience
Reduce costs for City employee access as the workforce grows	Long-Term Resilience
Enhance employee recruitment and retention	Long-Term Resilience
Optimize use of City assets and facilities	Land Use & Development
Lead by example as major employer implementing TDM in the downtown area	Equity

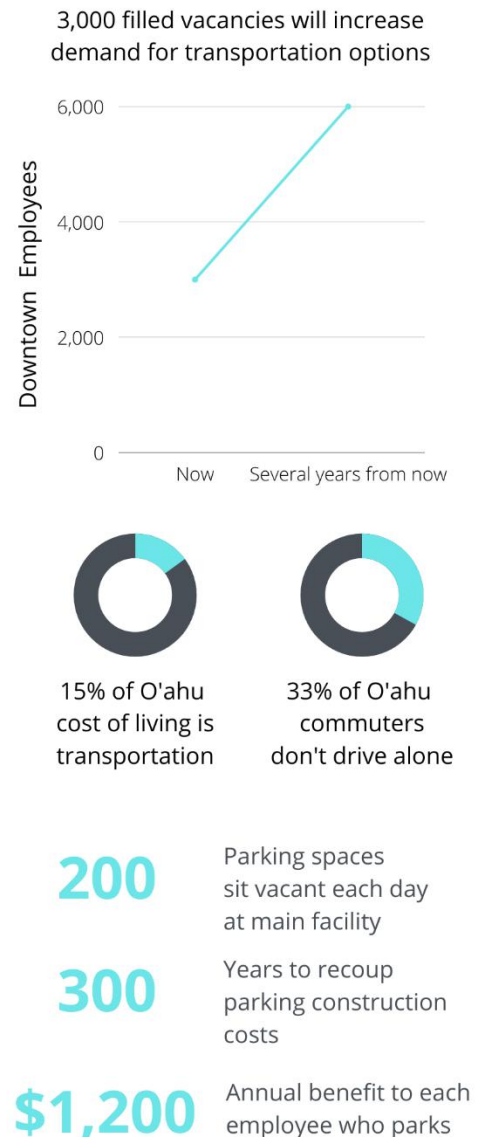


Figure 2: Key issues by the numbers

TDM Goals for City Employees	Alignment with Communitywide TDM Plan Goals
Reduce employee commute-related emissions	Environment

Priority TDM Strategies

This section summarizes priority TDM strategies recommended for the City employee TDM program, including City employee strategies (existing and new) and communitywide TDM program strategies that the City can leverage to the benefit of employees.

Traditionally, City employee commute benefits have only provided subsidies for parking costs in City facilities, benefiting drivers without commensurate benefits for employees who take transit, bike, or walk.

City-Administered Strategies

City-administered TDM strategies are a value-add resource to enhance employee satisfaction and quality of life. It is important to note that new TDM strategies may require notification, consultation, and/or negotiation with labor unions.

Each City employee strategy is scored qualitatively based on the three criteria of return on investment, emissions reduced, and employee benefits. Quantitative estimates of strategy impacts are provided in **Error! Reference source not found.** on page 11. Existing and new proposed strategies are presented in this section in descending order based on their qualitative scorecard.



Return on investment (ROI): Scale from 1 to 3¹



Potential Emissions Reduced: Scale from 1 to 3²



Employee benefits: Related to  Health  Cost savings  Flexibility

Existing Strategies

Existing TDM strategies implemented by the City include pre-tax parking and transit commuter benefits, carpool parking, telecommuting, and flexible work schedules.

Telecommuting Program

On July 1, 2022, the City released a [Telecommuting Program policy](#) for implementation by departments based on voluntary participation. This policy formalizes telecommuting work arrangements and enables the City to better track telecommute practices across departments. The policy provides clear guidelines for telecommuting and allows departments to establish their own telecommuting practices within

Telecommuting Score Card



¹ The ROI scale is based on the following estimate thresholds. Score of 1 = ROI between 0 and 1. Score of 2 = ROI between 1 and 4. ROI of 3 = ROI is 4 or greater.

² The emissions reduction scale is based on estimated vehicle mile travelled (VMT) reduction estimates for each strategy with the following thresholds. Score of 1 = VMT reduction between 0%/unknown to 5%. Score of 2 = VMT reduction between 5% and 10%. Score of 3 = VMT reduction of 10% or greater.

those guidelines. In order to participate, employees must submit a [fillable telecommute form](#) signed by their supervisor and department director.

Additional recommendations from the Work Where You Live best practices report for a telecommuting program include:

- Provide ongoing training and support when requested, and clear communication of updates as needed.
- Provide technology and tools necessary for employees to perform their duties including file sharing and collaboration.
- Engage in frequent consultations with unions to ensure a clear understanding of policy and procedures and how it benefits employees.
- Appropriate allocation of resources to support technology investment and on-going training and support.
- Develop plans to identify the best design and use of onsite work facilities to accommodate the changing needs of the workforce.

In March 2021, the Work Where You Live survey results indicated that 1,602 employees were approved to telecommute, and 80% of those approved had been telecommuting. The survey found that 3,241 driving trips would be saved per week if all City employees were granted their preferences for the number of days they would like to telecommute.

Carpool Parking

The City employee carpool parking program provides discounted pricing, designated parking spaces in preferential locations, and priority on waiting lists for carpool parking permit holders, as established in the Revised Ordinances of Honolulu (ROH) Sections 15-16.5, 15-23.1, and 15-23.2. Under this program, City employees who hold carpool parking permits pay 75% of the specified rate with two occupants, 50% of the specified rate with three occupants, and 0% (no charge) with four or more occupants. A valid carpool parking program permit is required for any vehicle to park in designated carpool spaces.

Carpool Parking Score Card



Pre-Tax Parking and Transit Commuter Benefits

Employees may designate as a pre-tax item, their monthly City parking fee, bus pass, or mass transit fare via payroll deduction. Mass transit alternatives include: The Bus, LOTMA, VanPool Hawaii, and Handi-Van. Employees who ride TheBus receive their pre-tax transit fare via a HOLO smart card, which uses monthly fare capping and thereby benefits even occasional riders. Currently, 80 downtown employees are enrolled in the pre-tax transit benefit and about 950 are enrolled in pre-tax parking benefits.

Pre-Tax Benefits Score Card



Flexible Work Schedules

The City has maintained a [Flexible Work Hours](#) program since 2005 for employees to establish their schedules to fit personal needs and operational needs of departments. Starting times may be between the hours of 7:00 a.m. and 8:30 a.m., except those employees who normally ride express buses may start as early as 6:30 a.m. Ending times are between the hours of 3:15 p.m. and 5:15 p.m., provided that the 8-hour work requirement is met by employees. Departments must ensure that there is adequate staffing to serve the public between the core hours of 7:45 a.m. and 4:30 p.m., Monday through Friday except legal holidays. In effect, this program enables employees to alter their work schedules to better fit personal needs, including transit schedules.

Flexible Schedule Score Card



New Strategies

New TDM strategies have not been implemented by the City as of Summer 2022. Recommended strategies include free bus passes, a city employee parking program, parking cash-out, compressed work schedules, free or subsidized Biki passes, guaranteed ride program, leave time reward, and enhanced multi-modal access facilities.

City Employee Parking Program

DTS will lead the setup of a city employee parking program including onboarding and training for new employees. The parking program will enable employees to reserve and pay for parking spaces on a daily (rather than monthly) basis to support flexible commute and telecommute options. These features will also facilitate optimal use of parking facilities accounting for days that employees work from home, are sick, on vacation, or use non-vehicular commute modes.

Parking Program Score Card



Parking Cash-Out

Within the City Employee Parking Program, a parking cash-out option would enable employees to choose to cash out the value of City-provided parking. The City would transfer the cash value of the parking benefit to employees who forgo parking either as a taxable cash benefit or as a tax-free transit or vanpool benefit.

Free Bus Passes

As authorized in ROH Ch. 13-2.1 (h), the City intends to provide free monthly TheBus passes for all City employees who opt out of parking. This benefit is anticipated to launch by January 2023. The Department of Information Technology (DIT) is currently exploring integration of City identification badges with the HOLO smart card system to enable employees to use their ID badges for onboard fare validation.

Free Bus Pass Score Card



Compressed Work Schedules

On a compressed schedule, employees work longer but fewer days to meet their weekly or biweekly requirements for work hours. Schedule arrangements may include:

- Four ten-hour work days and one day off in a one-week period.
- Eight nine-hour days, one eight-hour day, and one day off in a two-week period.

Compressed Schedule Score Card



Schedule Increase in Monthly Parking Rates Over Long-Term (Parking Pricing)

The City should schedule an increase in monthly parking rates to help recover net revenue losses to parking operations while managing employee parking demand as the City's workforce grows. The current parking structure only meets the parking needs of a fraction of the employees who park at the Civic Center, and the City charges less than 50% of market rate for parking. Currently, 950 employees receive subsidized parking; they pay \$80 out of pocket and receive a \$100 subsidy from the City each month. This subsidy makes other commute options less attractive to employees and represents an inequitable distribution of public resources. By publicizing that the monthly rate will increase by \$15 per year, every year until the market rate is achieved, the City can move gradually towards market rates and encourage more employees to consider commute options beyond driving alone.

Parking Pricing Score Card



Free or Subsidized Biki Pass

A free or subsidized monthly [Biki Bikeshare](#) pass (\$15-\$25 each) would encourage employees living within the Biki service area to use bikeshare to work. For all employees, a free or subsidized monthly Biki pass would encourage them to use bikeshare for office-based trips such as local meetings or for lunch. Bikeshare expenses are not considered a qualified transportation fringe benefit for tax purposes. Employer bulk discount plans may be available for the City to purchase employee passes at discounted rates.

Biki Pass Score Card



Leave Time Reward

Employees qualify for additional paid time off by tracking commute trips by sustainable transportation modes. This strategy depends on timely procurement or development of a tool/technology for employees to track their commute trips. The City of Austin piloted this strategy in 2017, and it became a permanent program in 2019. This strategy reduced drive alone trips from 53% to 41% among program participants, and 1,224 or 13% of eligible employees enrolled.

Leave Time Reward Score Card



Guaranteed Ride Program

A significant barrier for commuters to give up driving alone is concern that they would be stranded at work without a ride home if an unexpected situation came up. A guaranteed ride program would enable City employees who commute by sustainable modes (including transit, vanpool, carpool, walking, or biking) to access a free ride home in case unexpected circumstances interrupt their normal commute. This “just in case” service makes it easier for commuters to give up driving by providing them with a reliable ride home in case of emergency.

Guaranteed Ride Score Card



Guaranteed ride programs can operate on a reimbursement basis or through corporate accounts with Transportation Network Companies such as Uber or Lyft. Guaranteed ride programs typically set limits on per-ride dollar values, the frequency of rides (e.g., two times per month), and total per-person limits (e.g. \$300 per year).

Enhanced Multi-Modal Access Facilities

Enhanced multi-modal access facilities serve commuters who use active or shared modes of transportation at the work end of their trip. In addition to the already-established carpool parking spaces in preferential locations, other multi-modal access facilities may include:

- Secure bike parking, lockers, showers, and bike fix-it stand
- Transit shelters and real-time information screens for riders without smart phones or reliable data plans. Other riders can use the Transit app and DaBus app for real-time bus arrival information.

Access Facilities Score Card



While not considered a TDM strategy, preferred parking stalls and charging stations for electric and hybrid vehicles would encourage low-emissions commuting.

Communitywide TDM Program Strategies

Concurrently with this TDM Framework, DTS is leading a communitywide TDM Plan to establish the program **Honolulu Connect**. The City can leverage communitywide TDM strategies prioritized in this plan to the benefit of City employees.

Carpool Matching Webpage

The State of Hawaii Department of Transportation (HDOT) maintains the [HIRideshare](#) Statewide Rideshare Carpool Matching webpage as a free service to the public. In addition to account-based carpool matching, the website provides a commute calculator to estimate cost savings, reduced emissions, and reduced miles travelled. HDOT provides other resources such as the [Carpooler's Survival Guide](#).

Oahu Vanpool Incentive Program

The [Oahu Vanpool Incentive program](#) will offer a monthly fare subsidy of \$500 per van. Program funding lapsed in 2021 but is expected to resume in the future as part of the Honolulu Connect communitywide TDM Plan recommendations. Vanpool leasing and formation is administered by vendors including Enterprise and KAK Vanpool Services LLC.

Contests and Gamification

Communitywide contests and gamification may include an annual week-long commute challenge, hosted by DTS.

Targeted Marketing Campaigns

Outside of specific contests and gamification initiatives, there may be targeted marketing campaigns for specific modes or for the broader Honolulu Connect program. The City would market and distribute campaign materials to City employees as applicable.

Microtransit and Micromobility

The City is considering the establishment of microtransit and micromobility services, and the Honolulu Connect program will support and market these services as they are established. The City would also market and distribute supporting materials to City employees as a commute option.

If operated by the City, new microtransit or micromobility service(s) could be covered under the free transit passes for City employees and potential HOLO integration with City employee ID badges.

Other Partners

External stakeholders may occasionally implement TDM strategies that are open to City employees, such as the Blue Planet Foundation's [2020 Oahu Commute Challenge](#). Similar to communitywide contests, gamification, and marketing campaigns, the City can leverage efforts led by other partners by sharing promotional materials with City employees.

Implementation Needs

The implementation needs for the City employee TDM program include staff roles and responsibilities, budget and resources, and administrative policies and procedures.

Staff Roles and Responsibilities

The City departments that will be most involved with implementation of the TDM framework include DTS, the Office of Climate Change, Sustainability, and Resilience (CCSR), the Department of Human Resources (DHR), and DIT. The Department of Facility Maintenance (DFM) and the Department of Budget and Fiscal Services (BFS) will coordinate on physical and monetary resources, respectively.

DTS: DTS staff will lead the following elements of the TDM program:

- Program setup
- Promotion and communications to employees
- Onboarding and training for new employees on available benefits
- Act as a data clearinghouse for employee participation in TDM strategies, compiling data from other City departments and/or commute management tool(s).
- Coordination between City departments and external partners (e.g., HDOT on City employee participation in HIRideshare ridematching platform)
- Register employee IDs for HOLO benefits, and reconcile transit benefits with payroll monthly
- Coordinate with labor unions regarding new strategies (e.g., free monthly transit pass)

CCSR: CCSR staff will support the following elements of the TDM program:

- Promote program benefits in Annual Sustainability Report and other City sustainability communications
- Partner with departments to promote sustainability options to employees
- Integrate employee TDM program into City's broader sustainability commitments

DHR: DHR staff will support the following elements of the TDM program:

- Maintain the following TDM-related policies in the Personnel Manual—the Telecommuting Program Policy and Flexible Work Hours Program Policy
- Assist DTS in promoting commute options to employees through existing DHR communication channels (e.g., new hire orientation materials, intranet, and email updates).
- Integrate commute options into new employee orientation materials and other hiring practices

DIT: DIT staff will support the following elements of the TDM program:

- Create and maintain in-house technology solutions (e.g., parking reservation system) as needed
- Support integration of third-party technology solutions with City IT systems (e.g., commute trip tracking platforms, HOLO smart cards) as needed
- Provide data to DTS for performance evaluation and reporting

DFM: DFM staff will be responsible for the installation and maintenance of multi-modal access facilities at City worksites, including:

- Parking garage enhancements (e.g., access control gates)
- Enhanced bicycle facilities (e.g., secure storage, lockers, and showers)
- Transit and bikeshare facilities in coordination with operators
- Designated carpool/vanpool parking areas

BFS: BFS staff will be responsible for administering the City's operational budget, which will provide resources for implementation of the City employee TDM program.

Budget and Resources

Budget and resources for the City employee TDM program include direct costs for incentives or vendors, as well as staff time to execute the roles and responsibilities outlined in the previous section. **Error! Reference source not found.** below summarizes high-level impacts and real direct costs (excluding in-kind and indirect costs) for implementation of various TDM strategies. Citations for vehicle miles travelled (VMT) reduction estimates are provided in endnotes at the end of the document.

The recommended annual budget for the City Employee TDM program is \$1.11 million with \$70 thousand in initial capital investments. The 10-year expect return on investment (ROI) is estimated at 1.10. This positive ROI estimate of 10% derived from cost savings related to fewer parking subsidies for employees of \$1.23 million per year. By reducing parking demand, the TDM program provides the additional budgetary benefits to the City:

- Reduce employee vacancy and turnover costs (i.e., improve recruitment and retention), by:
 - Reducing wait lists and wait times for existing parking facilities.
 - Providing an attractive and flexible set of employee transportation benefits.

- Mitigate the need to construct new parking to accommodate the City's growing workforce (3,000 expected) over the next several years. New parking can cost \$40,000-\$80,000 per space, or \$120 to \$240 million total to accommodate another 3,000 employees who drive and park.

The totals in Table 2 include scenarios both with and without the parking pricing strategy, which would reduce the employee parking subsidy by \$15 each year, until the \$100 subsidy is entirely eliminated in Year 7. Implementing the parking pricing strategy would reduce for the other strategies the estimated cost savings from the employee parking subsidy (as well as operational cost of parking cash-out) to 28.5% of current estimates over a 10-year period. The parking pricing strategy would in effect reduce average annual operational costs to \$1.02 million, decrease annual cost savings to \$1.17 million, and increase ROI to **1.14**.

Table 2. High-level impacts and costs of TDM strategies

TDM Strategy	VMT Reduction Estimate	Parking Reduction Estimate (Spaces) ³	Parking Reduction Ranking ⁴	Capital Cost (\$)	Annual Operating Cost (\$)	Cost Notes	Annual Cost Savings (\$)	ROI (10 years)	ROI Score (1-3)	Employee Benefits		
										Cost Savings	Health	Flexibility
Telecommuting program	44% ⁱ	418	High		418,000	\$1,000/employee annual operating costs	501,600	1.20	1	•		•
Flexible work schedules	0% ⁱⁱ	0	Low	0	0	N/A	0	0.00	1			•
Compressed work schedules	5% ⁱⁱⁱ	48	Low	0	10,000		57,000	5.70	3	•		•
City carpool parking program	8% ^{iv}	76	Medium	10,000	0	Indirect costs: Loss of revenue from discounted parking passes	91,200	N/A (no direct costs)	3	•		
City employee parking program: Daily parking products and online reservation	15% ^v	143	Medium	40,000	25,000	Capital costs assume four access control gates at \$10,000 each.	171,000	5.90	3	•		•

³ Estimates apply to City employee parking spaces at Civic Center Parking Structure. Parking reduction assumptions:

- Number of current parkers: 950
- Monthly parking subsidy: \$100

⁴ High (200+ spaces reduced), Medium (50-200 spaces reduced), Low (<50 spaces reduced)

TDM Strategy	VMT Reduction Estimate	Parking Reduction Estimate (Spaces) ³	Parking Reduction Ranking ⁴	Capital Cost (\$)	Annual Operating Cost (\$)	Cost Notes	Annual Cost Savings (\$)	ROI (10 years)	ROI Score (1-3)	Employee Benefits		
										Cost Savings	Health	Flexibility
City employee parking program: Parking cash out	12% ^{vi}	114	Medium	0	320,314	Assumes cash out value of \$100/month to all downtown employees who don't receive subsidized parking.	136,800	0.43	1	•		•
Parking pricing	7.5% ^{vii}	71	Medium	0	0	Fee schedule reduces employee subsidy ⁵	Average of \$815,100 ⁶	N/A (no direct costs)	3			
Free bus pass for opting out of parking	11% ^{viii}	105	Medium	0	0	Indirect costs: Loss of revenue from existing and new employee transit riders	125,400	N/A (no direct costs)	3	•		•
Free Biki pass	Unknown	10	Low		270,000	Assumes half of downtown employees claim a Biki pass.	12,000	0.04	1	•	•	•
Leave time reward	4% ^{ix}	38	Low	0	10,000		45,600	4.56	3		•	•

⁵ Fee schedule reduces employee subsidy by \$15 until full value of \$100 monthly subsidy is recovered in year 7.

⁶ Costs reduced by additional \$171,000 each year until full employee subsidy of \$1.14 million is recovered in Year 7. Average of \$815,100 over first 10 years.

TDM Strategy	VMT Reduction Estimate	Parking Reduction Estimate (Spaces) ³	Parking Reduction Ranking ⁴	Capital Cost (\$)	Annual Operating Cost (\$)	Cost Notes	Annual Cost Savings (\$)	ROI (10 years)	ROI Score (1-3)	Employee Benefits		
										Cost Savings	Health	Flexibility
Guaranteed ride program	Minimal in isolation ^x	5	Low	0	5,000		6,000	1.20	2	●		●
Enhanced multi-modal access facilities: bicycle parking and amenities	Minimal in isolation ^{xi}	5	Low	20,000	200		20,000	2.73	2		●	●
Vanpool subsidies	7% ^{xii}	67	Medium	0	49,875		0	1.60	2	●		
Total (excluding parking pricing)⁷	N/A	1,027	N/A	70,000	1,108,389	N/A	1,232,400	1.10	2			
Total (including parking pricing)	N/A	1,098	N/A	70,000	1,017,100 ⁸	N/A	1,166,334 ⁹	1.14	2			

⁷ Note, reductions in vehicle miles travelled and parking demand are not directly additive across TDM strategies. Total parking reduction estimate is shown to provide a sense of scale.

⁸ Under the scenario including parking pricing, annual operating costs for the parking cash-out benefit are reduced to 28.5% of the scenario excluding parking pricing. The value of 28.5% is derived from the assumption in the parking pricing scenario that monthly employee parking subsidies are reduced by \$15 every year until they reach 0 (i.e., \$85 in year 1, \$70 in year 2, \$55 in year 3, \$40 in year 4, \$25 in year 5, \$10 in year 6, and \$0 in years 7, 8, 9, and 10.) The parking pricing scenario totals \$3,420 in employee parking subsidies over 10 years, or 28.5% of the \$12,000 in employee parking subsidies in the scenario excluding parking pricing (where the \$100 per month subsidy is kept constant).

⁹ Under the Total (including parking pricing) scenario, average annual cost savings (over 10 years) due to reduced parking subsidies are 28.5% of value of the Total (excluding parking pricing scenario), plus the average of \$815,100 cost savings attributed to the parking pricing strategy specifically. See footnote above for explanation of the 28.5% value of the parking subsidy to employees under the parking pricing scenario versus the scenario excluding parking pricing.

Technology Solutions

Technology solutions offer a wide range of commute management features to facilitate a City employee TDM program, including trip planning, trip tracking, incentives, telecommute management, and parking management. The package of third-party and in-house technology solutions can be customized based on the City's priorities. Annual subscription costs vary from approximately \$15,000 for a modular technology solution to \$25,000 for a more holistic solution that integrates multiple commute management features.

When considering technology solutions, the City can give preference to systems with expandable capacity so that the City employee TDM program can expand and evolve over time based on employee feedback.

Table 3 below summarizes commute management features that are currently available from the more holistic commute technology vendors.

Table 3. Commute Management Features of Technology Solutions

Commute management features	<u>Luum</u>	<u>RideAmigos</u>	<u>TripSpark/Ridepro</u>	RideShark	Agile Mile	<u>Commutifi</u>	DIT (in-house)
Ridematching (car/vanpool)	•	•	•	•	•		?
Trip planning	•	•	•	•	•	•	•
Incentives	•	•		•	•	•	•
Gamification	•	•		•	•		?
Guaranteed ride home	•	•	•	•	•		•
Trip tracking (active)	•	•		•	•		
Trip tracking (passive)	•	•					•
Telecommute admin						•	•
Data dashboard	•	•		•	•	•	•
Parking management	•	•				•	?
Daily parking charges	•	•					•
Parking reservations	•	•					?
Parking cash-out	•	•					?
Parking vendor integrations	•						•
Carpool parking				•			
Mobility app integrations	•	•				•	•
Payroll integration	•	•		•			•
Pre-tax benefit cards	•	•				•	•

Commute management features	Luum	RideAmigos	TripSpark/Ridepro	RideShark	Agile Mile	Commutifi	DIT (in-house)
City Active Directory Integration							•
eForms Leave Integration							•

Staff Time

As noted in the Staff Roles and Responsibilities section, staff across DTS, CCSR, DIT, DHR, DFM, and BFS will be involved in implementation of the TDM program. DTS planning staff (0.2 full-time equivalent) will provide primary oversight of the City employee TDM program. Additionally, the City employee TDM program can leverage the staff capacity of the communitywide TDM program, Honolulu Connect. Starting in FY 2024, the City will allocate \$1,000,000 annually (80% federal funding and 20% local match) for City and consultant staff to operate Honolulu Connect.

Program Documentation

Program documentation establishes clear eligibility requirements, expectations, and processes for participating in TDM program offerings. Program documentation may take the form of administrative policies and procedures, as well as employee marketing materials such as brochures and new hire orientation packets.

Administrative policies and procedures for existing TDM strategies are located within the City's [Department of Human Resources Personnel Manual](#). These include the [Flexible Work Hours Program](#) and the [Telecommuting Program](#). The format, location, and lead department for new policies and procedures may vary by TDM strategy. For example, some new policies may be most appropriate within the City's Administrative Directives manual, while others may be adopted through the Personnel Manual by DHR.

DTS will define and document implementation details for the overall TDM program in coordination with other departments as needed (e.g., in coordination with DFM on parking rules).

Key Performance Indicators

Tracking key performance indicators (KPIs) is essential to ensure that the TDM program is effectively meeting its goals. Since behavior change can be a gradual process, it is best to track TDM program impacts through a broad range of KPIs that encompass commuter awareness, activities, outputs, and outcomes. KPIs can evolve over time if needed, but they are most effective at demonstrating progress when they are kept consistent across program evaluation cycles.

Awareness

Commuter awareness of travel options and travel information is the first step toward taking actions that will meet the TDM program goals. Awareness can be tracked through digital media including web traffic analytics. General employee awareness could also be assessed through an employee survey.

Recommended KPIs of awareness include:

- # monthly/annual visitors to employee TDM program intranet page

- # opens or clicks on newsletter or other TDM communications
- % of employees that are aware of commute options (measured through survey)
- % of new City employees that are aware of the City commute program (measured through survey)

Activities

Activities are the actions that commuters take resulting from awareness, usually participation or enrollment in a commuter benefit. Recommended KPIs of activities include:

- # employees enrolled in commuter benefits, such as:
 - Pre-tax benefits (transit and parking)
 - Vanpool program
 - Daily parking passes
 - Telecommute program
 - Carpool parking permits
- # employees participating in commute challenge
- # employees registered for HIRideshare program

Activities may also represent programmatic actions, such as # of outreach events held or # of newsletters sent.

Outputs

Outputs are the direct results of the TDM program on travel behavior and utilization of transportation facilities and services. Outputs are generally measured as increases or decreases relative to a pre-program baseline. They may be self-reported, tracked passively or automatically through technology solutions. Recommended KPIs of outputs include:

- Reduced drive-alone trips
- Increase in commuting by sustainable modes, including telecommuting
- Reduced parking demand (as indicated by length of wait list)
- Increase in transit ridership
- Reduced costs for parking operations

Outcomes

Outcomes relate to the overall goals of the City employee TDM program. Some outcomes are derived from applying assumptions to output measures. For example, assumptions about average driving trip length would transform the output “decrease in drive-alone trips” to the outcomes of “reduced vehicle miles travelled” and corresponding emissions. Some outcomes such as employee retention and turnover cannot be attributed directly to the TDM program; they have a correlative rather than a causative relationship. Recommended KPIs of outcomes include:

- Return on investment (cost savings relative to investment)
- Increased employee retention
- Reduced employee turnover
- Reduced vehicle miles travelled
- Reduced emissions

Program Evaluation

Program evaluation requires data collection and management to track and update KPIs, data review to connect observed changes in performance with specific TDM activities (what's working and what's not), and regular reporting to share program performance with appropriate stakeholders.

Data collection and management

DTS will lead data collection and management in coordination with DIT to ensure adherence to the city's privacy policy and secure handling of personally identifiable information. Recommended data collection mechanisms are outlined below.

- Annual commuter survey distributed to employees with questions addressing:
 - Frequency of commute by mode
 - Commute length
 - Attitudes and preferences for commute options (e.g., reasons for driving)
 - Participation in commuter benefits
 - Feedback on existing benefits, including barriers to participation
- Monthly operations and program participant data
 - Trip tracking (from commute challenge)
 - Enrollment in commuter benefits, including:
 - Pre-tax transit and parking passes
 - Monthly Biki passes
 - Daily parking reservations
 - Telecommute program
 - City employees registered for HIRideshare
 - Web traffic analytics from intranet pages, social media, newsletters, and other digital communications.

Data Review and Reporting

Monthly, DTS will compile and review operations and program participant data. Annually, DTS will synthesize monthly trends with highlights from the annual commuter survey and derive annual program output and outcome KPIs recommended in the previous section.

Annual TDM program reports can serve as an internal strategic planning tool for the City's DTS, CCRS, DIT, DHR, DFM, and BFS to make future refinements to the program. Reporting can also serve as an external outreach tool for the City to influence other major employers in Downtown Honolulu through best practices and lessons learned.

Endnotes

ⁱ The Work Where You Live survey found that 3,241 driving trips would be saved per week (648 per day, 324 each way) if all City employees were granted their preferences for the number of days they would like to telecommute.

Cambridge Systematics. Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions. 2009. Technical Appendices.

www.reconnectingamerica.org/assets/Uploads/2009movingcoolerexecsumandappend.pdf

California Air Pollution Control Officers Association. "Quantifying Greenhouse Gas Mitigation Measures." August, 2010. www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

ii None. Indirectly supports mode shift by providing schedule flexibility for employees based on their commute.

iii Assume that half of current parkers enroll. Eliminates one commute day out of 10 within biweekly period for participants.

iv Association for Commuter Transportation, "Getting to Work: Spotlight on employer-sponsored commuter programs, 2017, <https://www.actweb.org/files/ACT/Publications/Getting%20to%20Work%20Jan%202017%20-%20Final.pdf>

TRIMMS (Trip Reduction Impacts of Mobility Management Strategies) tool, developed by the National Center for Transit Research and the Center for Urban Transportation Research at the University of South Florida, <http://trimms.com/>

v Massachusetts Institute of Technology reduced daily parking demand by 15% with free transit and daily parking rates, among other strategies launched in 2016. <https://ops.fhwa.dot.gov/publications/fhwahop18071/ch4.htm>

Commuter platform vendor Luum reports that customers observed 12-15% reduction in drive alone commutes as a result of switching to daily parking rates.

vi Shoup, Donald C., Parking Cash Out, Planners Advisory Service, American Planning Association, 2005. <http://shoup.bol.ucla.edu/ParkingCashOut.pdf>.

vii Spears, Steve et al., "Impacts of Parking Pricing and Parking Management on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief. https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Parking_Pricing_Based_on_a_Review_of_the_Empirical_Literature_Policy_Brief.pdf

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viii California Air Resources Board. "Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emission." October 8, 2013. [DRAFT Technical Background Document on the Impacts of Transit Service Strategies Based on a Review of the Empirical Literature](https://www.arb.ca.gov/qa/impacts/impacts_tdm/impacts_tdm_draft_tech_background_document_on_the_impacts_of_transit_service_strategies_based_on_a_review_of_the_empirical_literature.pdf)

City of Carlsbad. "Ordinance No. CS-350." Transportation Demand Management. March 12, 2019. <http://edocs.carlsbadca.gov/HPRMWebDrawer/RecordHTML/533069>

ix The City of Austin's program reduced drive alone trips from 53% to 41% (a 33% reduction) among program participants, and 1,224 or 13% of eligible employees enrolled. 33% drive alone reduction x 13% of employees = 4% reduction in drive alone trips. <https://toolsofchange.com/en/case-studies/detail/739>

x Victoria Transport Policy Institute, TDM Encyclopedia: Guaranteed Ride Home, www.vtpi.org/tdm/tdm18.htm

TRIMMS (Trip Reduction Impacts of Mobility Management Strategies) tool, developed by the National Center for Transit Research and the Center for Urban Transportation Research at the University of South Florida, <http://trimms.com/>

xi Victoria Transport Policy Institute, TDM Encyclopedia: Bicycle Parking www.vtpi.org/tdm/tdm85.htm

xii TCRP Report 95: Traveler Response to Transportation System Changes Handbook, Third Edition, Chapter 5, Vanpools and Buspools, 2005 www.trb.org/Publications/Blurbs/156124.aspx



2024

ENERGY CONSERVATION AND EMISSIONS REDUCTION PLAN

Task 8 – Regional Mobility Corridor Scenarios

Introduction and Key Findings

Honolulu's proposed bus rapid transit (BRT) network will connect with the existing (and proposed) Skyline rail service, expanding the reach of quality, high-capacity transit in O'ahu. This memo evaluates considerations in BRT systems, such as potential impacts of BRT on traffic operations and level of service, considerations for concurrent operations of BRT and commercial freight vehicles, while also identifying best practices and case studies from other jurisdictions.

The key findings from the three components of this memo are summarized here:

- **Traffic Operations:** Converting a general-purpose traffic lane to a bus-only or commercial vehicle lane is projected to decrease level of service (LOS) at the Nimitz Highway/Waiakamilo Road intersection
- **BRT Considerations:** Best practices for maximizing BRT operations include maximizing dedicated right-of-way along all BRT corridors, providing pullouts for all BRT stations to limit conflicts with commercial trucks, designing frequencies and timetables to allow for timed transfers to the Skyline, and integrating fare systems between the BRT and Skyline.
- **BRT/Commercial Freight Considerations:** To avoid further congestion when combining BRT and commercial freight transportation, transit agencies should anticipate changes in land use to accommodate residential and commercial activities. To minimize operational conflicts, modifying freight access points along the corridor should be considered and evaluated when new warehouses or loading facilities are proposed along the corridor. Honolulu should consider policies and measures to limit the interaction between modes, which may include measures such as off-peak delivery hours, staggered delivery times, and other traffic management strategies.

Analysis of Traffic Operations: Nimitz Highway (US-92)/Waiakamilo Road

A traffic analysis of the Nimitz Highway and Waiakamilo Road intersection was conducted to better understand how a potential bus rapid transit (BRT) route will impact traffic operations and level of service. This section summarizes the analysis's assumptions and key findings.

Existing Conditions

The existing conditions at the Nimitz Highway/Waiakamilo are characterized by the following:

- Three through lanes in each direction on Nimitz Highway, with channelized right-turns onto Waiakamilo Road and dedicated left-turn lanes with protected phasing.
- Split phasing on Waiakamilo Road since northbound volumes are much lower (Waiakamilo Road is not a through street to the south), with channelized right-turns onto Nimitz Highway.
- Existing traffic volumes from 2017 at the Nimitz Highway (US-92)/Waiakamilo Road intersection were provided by the City and County of Honolulu for use in this analysis.
- Average daily traffic on Nimitz Highway of 55,000–60,000 vehicles (total of both directions).
- Heavier eastbound volumes than westbound volumes on Nimitz Highway in both the AM and PM peak periods.
- Based on the Synchro analysis, the intersection is operating at LOS C overall for existing conditions, with several individual movements operating at LOS F, including the eastbound left-turn from Nimitz Highway onto northbound Waiakamilo Road and all minor street movements on Waiakamilo Road.

Methodology

The Synchro model for existing conditions included the following parameters and assumptions:

- Cycle length, loss time, and other relevant signal timing parameters input based on the current signal timing plans provided by the City and County of Honolulu.
- The westbound left-turn (northwest left-turn in the model) from Nimitz Highway to Waiakamilo Road had zero volume during the AM peak hour, and a volume of one (1) in the PM peak period (zero in the peak hour). Signage at the intersection indicated “No Left-Turn When Coned.” For this preliminary analysis, the signal timing as provided, including green time for this left turn, was utilized.
- Based on the provided turning movement count data, the intersection peak hour factor is 0.97 for both the AM and PM peak hours.

Findings

Synchro does not provide a direct means to analyze an intersection with a dedicated bus/truck lane. To model the bus/truck lane LOS in Synchro, since it is not the limiting factor, this analysis conducted a version of Synchro assuming Nimitz Highway as a single through/right-turn lane with the volume being the truck/bus and right turn volumes (i.e., the two through lanes dedicated to personal vehicles were removed). Additionally, available literature about how to analyze best an intersection with this type of configuration in Synchro was also considered.

As shown in the table below, the intersection is projected to operate at LOS E in the AM peak hour and LOS D in the PM peak hour assuming conversion of the number 3 lane to a bus/truck-only lane. Delays and queues would increase for the general purpose northbound and southbound Nimitz Highway movements at the intersection. The queues for the general purpose through lanes, already considerable, would lengthen with the conversion of one lane to a truck/bus lane. The truck/bus lane would experience shorter queues.

Potential Impacts

Based on this analysis, the dedicated bus/truck lane is expected to operate at an acceptable level of service, as it will serve a fraction of the volume of the two remaining general purpose through lanes in each direction of Nimitz Highway. Table 1 shows the existing intersection level of service as modeled in Synchro and the intersection's level of service with one lane on Nimitz Highway and truck/bus volumes removed. Table 2 summarizes existing and expected queuing at the intersection. The queues for the general purpose through lanes, already considerable, would lengthen with the conversion of one lane to a truck/bus lane. The truck/bus lane would experience shorter queues.

Table 1: Intersection Level of Service in the AM/PM Peak Hours

	Existing Conditions				With Dedicated Bus/Truck lane			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Overall Intersection	31.6	C	34.1	C	58.3	E	50.8	D
Eastbound Nimitz Highway Approach	28.9	C	25.0	C	67.2	E	46.3	D
Eastbound Left-Turn	120.6	F	152.0	F	120.6	F	257.0	F
Eastbound Through (Cars)	25.6	C	19.4	B	65.1	F	35.7	D
Eastbound Through (Truck/Bus)					7.2	A	7.6	A
Westbound Nimitz Highway Approach	16.3	B	32.6	C	17.6	B	45.5	D
Westbound Through (Cars)	16.3	B	32.6	C	17.6	B	45.5	D
Westbound Through (Truck/Bus)					17.6	B	13.5	B
Northbound Waiakamilo Rd Approach	154.5	F	108.1	F	154.5	F	108.1	F
Northbound Left-Turn	172.7	F	108.0	F	172.7	F	108.0	F
Northbound Through	113.9	F	108.1	F	113.9	F	108.1	F
Southbound Waiakamilo Rd Approach	107.5	F	104.0	F	107.5	F	104.0	F

Table 2: Intersection Queuing in the AM/PM Peak Hours

	Existing Conditions				With Dedicated Bus/Truck lane			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	50th %	95%	50th%	95th%	Delay	LOS	Delay	LOS
Eastbound Nimitz Highway Through	2071 ¹	2193 ²	1232	1313	2792 ¹	2982 ²	2172 ¹	2278 ²
Truck/Bus Lane	N/A	N/A	N/A	N/A	238	339	171	226
Westbound Nimitz Highway Through	484	607	1711 ¹	1831 ²	514	664	1923 ¹	2045 ²
Truck/Bus Lane	N/A	N/A	N/A	N/A	251	382	508	651

Note: Queue shown in Feet

1 = volume exceeds capacity queue theoretically infinite

2 = 95th percentile volume exceeds capacity, queue may be longer

Honolulu's Existing BRT Network

Honolulu's Department of Transportation Services (DTS) operates several existing BRT lines and infrastructure. Below is a summary of Honolulu's current BRT lines and past plans to expand upon the BRT system.

Honolulu's original three BRT routes entered service in 1999 and 2000. Route A CityExpress! began as a 6.6-mile route running between the Kalihi Transit Center and UH Mānoa. Expansions to Pearlridge Center was later added, expanding Route A by 13 miles. Notable destinations and neighborhoods include Aloha Stadium, Aiea, Kalihi, Downtown Honolulu, Ala Moana, and Mānoa. The route runs from 5:30 am–10:30 pm with 15–20-minute headways on weekdays and 30-minute headways on Saturdays. Route A intersects with the Skyline at the Kalauao (Pearlridge) and Hālawā (Aloha Stadium) stations. Route B CityExpress! entered service in August 2000 and runs 7 miles between the Kalihi Transit Center and Waikīkī. Notable stations include School Street, King Street, Beretania Street, and Kuhio Avenue. Route C CountryExpress! runs from the Waiʻanae Coast to downtown Honolulu via Kapolei. Route C has limited stops and runs 7 days a week with 30-minute headways. Service runs from 5 am–10 pm. Along with the addition of Route C, Honolulu added 10 community circulators and four new transit centers. The route connects these four transit centers then travels to Ala Moana Center. Route C intersects with the Skyline at the Kualakaʻi (East Kapolei) and Keoneʻae (UH West Oʻahu) stations. Notable destinations and neighborhoods include Mākaha, Waiʻanae, Māʻili, Nānākuli, Kapolei, Kalihi, downtown Honolulu, and Ala Moana.

Honolulu outlined its plans to improve and expand upon its first three BRT routes. The plan would add a Regional BRT route on the H-1 freeway, an in-town line, a University Branch, and a line running from Downtown Honolulu to Kakaʻako/Waikīkī. Service updates include expanding signal prioritization at major intersections, adding smart card technology payment, and all-door boarding to reduce dwell times. Additionally, the plan discusses adding GPS tracking systems so passengers can personally track buses as well as adding traveler information systems to stations. However, only automatic vehicle location technology was implemented.

2006 Federal Transit Administration and Department of Transportation Evaluation

The 2006 Federal Transit Administration (FTA) and U.S. Department of Transportation (DOT) Honolulu BRT Project Evaluation Final Report is a case study of the existing three BRT routes (A, B, and C) in Honolulu. Route E, a 6-mile route connecting Downtown Honolulu, Ala Moana, and Waikīkī opened in November 2004 but was discontinued in June 2005 due to poor performance. Routes A and B operate mainly in mixed traffic lanes while Route C runs in HOV freeway lanes. Routes have limited stations with shelters and benches at stations. Route A has 35 westbound and 34 eastbound stations, Route B has 28 westbound and 29 eastbound stations, and Route C has 39 westbound and 42 eastbound stations. BRT successfully reduced travel times and improved service for riders compared to local bus service. Reduced travel times can largely be attributed to greater average spacing between bus stops and shorter headway times. The study concluded that Honolulu DTS can improve BRT service by investing in more dedicated running ways, advanced vehicle stations, intelligent transportation system (ITS) elements, and fare collection. Travel times could be further decreased by implementing more dedicated or exclusive lanes and expanding ITS operations within the existing corridors. It is worth noting that Honolulu explored multiple ITS solutions in 2002 and 2003 and some were not suitable for Honolulu. Signal prioritization, for example, would have negatively impacted corridor traffic and thus was not implemented. The evaluation also found that most BRT riders were previous users of local bus routes and not new riders.

Proposed BRT Network

Additionally, Honolulu's proposed bus rapid transit (BRT) network will extend four existing routes and the reach of O'ahu's zero-emission Skyline rail. These four BRT routes will align with major destinations, feature limited stops (emulating rail operations), and will be served primarily by electric buses. Combined, the four routes will create 121 BRT miles—with 19 percent of the system (22.8 miles) operating in dedicated lanes—and will serve approximately 1,000 daily riders. To expedite

service along these routes, TheBus will deploy transit signal priority (TSP) technology, to sync real-time TheBus automatic vehicle location (AVL) data with traffic signal controllers via a designed software bridge. This will allow late-running buses to receive additional green light time and to trigger transit-only turn signals at intersections. This priority given to transit riders will increase rider satisfaction, improve travel time reliability on connecting bus services, elevate transit as a superior mode, and grow ridership. Cities with comparable population and transit densities that have implemented BRT upgrades have experienced a 30 percent increase in ridership and a 20 percent reduction in travel time. BRT implementation will be supplemented by fortified bicycle and pedestrian infrastructure to improve pedestrian safety along high-traffic corridors that experience high crash and injury incidents.¹

Route	Route Length (miles)	Future Bus Lane Length (miles)	Skyline Stops	Running Way	Local Bus Routes
Route W	10	6.6	Lelepua, Āhua, & Kahuaiki	Mixed-traffic, dedicated lanes	91, 91A, 92, 94, & 94
Route C	20	4.1	Keone'ae	Mixed-traffic, dedicated lanes	46
Route E	23	0.8	Waiawa, Hālaulani, Pouhala, & Ho'ae'ae	Mixed-traffic, dedicated lanes	--
Route A	13 miles (existing), 8 future miles proposed	0.3	Āhu & Ho'ae'ae	Mixed-traffic, dedicated lanes	--

¹ 2023 Bus-Rail Network Phase 1: East Kapolei to Aloha Stadium, https://www.honolulu.gov/rep/site/dts/Transit_Guide_TheBus_x_Skyline_compressed_1.pdf

Route W: Honolulu on Nimitz Highway and Ala Moana Boulevard

Route W will serve the Nimitz Highway and Ala Moana Boulevard corridors, connecting Honolulu International Airport to Waikīkī via Kalihi/Kaka’ako in approximately 40 minutes. The proposed route is 10 miles and will feature 6.6 miles of transit-priority bus lanes. Currently, five TheBus routes operate in these corridors (91, 91A, 92, 94, and 94). Projected to serve 120 daily trips, with 10-minute headways, BRT service on Route W will increase time savings by 20 percent along the corridor, compared to existing TheBus service. Route W will connect with the Skyline near Honolulu International Airport, with transfers at the Lelepaua (Daniel K. Inouye International Airport), Āhua (Lagoon Drive), and Kahauiki (Middle Street – Kalihi Transit Center) stations, and will operate along the Nimitz Highway and Ala Moana Boulevard Transit Lines. Proposed TSP technology includes a direct left turn from the Kalākaua Avenue transit priority lane to Ala Moana Boulevard.

Route C: Kapolei on Wākea Avenue, Kapolei Parkway, and Kualaka’i Parkway

Route C will serve the Wākea Avenue, Kapolei Parkway, and Kualaka’i Parkway corridors, connecting Mākaha to University of Hawai’i (UH) West O’ahu via Downtown Kapolei. The proposed route is 20 miles long, running along Farrington Highway, featuring 4.1 miles of transit-priority bus lanes. The route will run have a 10-minute frequency and take approximately 60 minutes to travel, improving trip time by 20 percent. Route C will intersect with the Skyline at the Keone’ae (UH West O’ahu) station. The project also includes plans to improve the Wākea/Kapolei Parkway/Kialala’i Eastbound and Westbound Transit Lanes. Currently, TheBus Route 46 connects UH West O’ahu to Kapolei Commons but runs through downtown Kapolei instead of on the Kapolei Parkway. Route C will benefit from the island-wide TSP technology described above, allowing buses to receive increased green light time.

Route E: Pearl City on Kamehameha Highway

Route E will run from 'Ewa Beach to Wahiawā via the Waipahu and Mililani corridors. The proposed route is 23 miles long and adds 0.8 miles of transit-only bus lanes branching off the H-2 Freeway NB Waiawa Station Transit Offramp Lane. The full length of the trip will take approximately 85 minutes and run 120 daily trips with 10-minute headways, reducing travel times by 20 percent. The project also includes plans to improve the offramp lane. Route E will intersect with the Skyline at the Waiawa (Pearl Highlands), Hālaulani (Leeward Community College), Pouhala (Waipahu Transit Center), and Ho'ae'ae (West Loch) stations. Route E will benefit from the island-wide TSP technology outlined above, allowing buses to receive increased green light time.

Route A: Palama on Vineyard Boulevard

Route A will run eight miles from Kalihi to UH Mānoa, adding 0.3 miles of transit-priority bus lanes along the Vineyard Boulevard corridor. Route A will complete 120 35-minute trips per day with 10-minute headways, reducing trip times by 20 percent². Route A will intersect with the Skyline at the Āhu (Lagoon Drive), and Kahuaiki (Middle Street – Kalihi Transit Center) stations. Route A will benefit from the island-wide TSP technology described above, allowing buses to receive increased green light time.

Case Studies

Honolulu DTS can gain valuable insight from other cities' BRT projects. Below are three case studies of BRT systems that interact with light rail and heavy rail in the U.S. The case studies detail the characteristics of BRT systems, how BRT implementation impacted transit ridership, how bus systems interact with rail, and any notable changes made to improve the BRT systems. While there are few cases of BRT systems sharing running ways and facilities with freight, Honolulu DTS can learn lessons from BRT systems that operate in mixed traffic and share facilities with

² Per analysis completed by Honolulu DTS.

other transit methods. Additionally, each transit agency implemented features tailored to the city's needs that facilitate BRT and light rail interactions.

	Number of Routes	Open Date	Running Way(s)	Interactions with Rail	Notable Features
Twin Cities Metro Transit	Five	2013	Mixed-traffic and dedicated lanes	Mall of America Station	Bus-only entrance, skyway connection
Boston MBTA	Five	2002	Primarily dedicated lanes	South Station	Dedicated tunnel under the Fort Point Channel
Pittsburgh PRT	Three	1997	Primarily dedicated lanes	South Busway offers five light rail connections	Dedicated lane in Wabash tunnel.
Cleveland RTA	Two	2008	Dedicated lanes and mixed traffic	Louis Stokes/Windermere, Superior, and Tower City stations	Median-aligned, dedicated lanes

Metro Transit (Minneapolis/St. Paul, MN)

Metro Transit operates five BRT lines in conjunction with light rail, fixed-route bus service, commuter rail, and on-demand transit, and is developing seven more BRT lines by 2030. The Red Line, Metro Transit's inaugural BRT line, began service in 2013 and connects Apple Valley to the Mall of America via Cedar Avenue. The Red Line has five stations and connects with light rail at the Mall of America station, where passengers can transfer to the light rail Blue Line which travels to the Minneapolis-St Paul International Airport via downtown Minneapolis. Metro Transit stations are enclosed with on-demand heating and amenities such as way-finding signs, real-time vehicle arrival information, emergency phones, and bike racks. BRT stations have level-boarding platforms to enable faster boarding, which improves access for passengers with limited mobility. The highly frequented Mall of America station was

renovated in 2019 to improve BRT and rail interaction. The renovation created a bus-only entrance which reduced traffic delays and ensured that buses no longer cross the light rail tracks, improving passenger safety.

The Red Line operates in mixed traffic lanes along the Cedar Avenue corridor with the option to divert onto bus-only shoulder lanes. In 2022, the Red line average weekly ridership was only 344 rides. However, the Red Line still struggled to achieve ridership goals prior to the Covid-19 pandemic due to a lengthy detour off the highway to the Cedar Grove station. Metro Transit has since built a skyway connection to the Cedar Grove station to avoid this detour. Despite this obstacle, the implementation of BRT service resulted in a 33 percent increase in ridership on the Metro A Line and C Line (compared to pre-Covid-19 pandemic ridership levels). The Metro A Line runs in mixed traffic lanes, stopping at curbs rather than bus bays, but still increased ridership without significantly impacting traffic. This is due to the A Line's all-day service with 10-minute headways, off-board fare payment, and all-door boarding. While buses do not run in dedicated lanes, they have the option to use MnPASS lanes which are located in the median lanes of highways. This is the preferred method for express lines, but not lines with station-to-station service.

Massachusetts Bay Transit Authority (Boston, MA)

The Massachusetts Bay Transit Authority (MBTA) has successfully implemented multiple BRT routes that interact with its light-rail system, the T. The Silver Line commenced operations in 2002 and consists of five routes that expand the T's service area to the Boston waterfront and South Boston. The Silver Line has a dedicated fleet of all diesel-electric and battery-electric buses that operate primarily via dedicated lanes and utilize the same on-board payment system as the T, allowing for streamlined and free transfers. The Silver Line has successfully increased ridership to areas underserved by the T, recording an average daily weekday ridership increased by 96 percent and average Sunday ridership increased by 127 percent from 2001 to 2005.

The Silver Line connects to the T at South Station, which services the Red Line as well as fixed-route bus routes (4, 7, and 11), the MBTA Commuter Rail, and Amtrak.

The Silver Line was constructed in conjunction with Boston's Central Artery project, which replaced the central artery that carried I-93 and I-90 with the Rose Kennedy Greenway. Within the first 10 years of operation, the Silver Line did not decrease travel times compared to fixed-routes, but did improve reliability and service frequency, with 10-minute headways on weekdays and 12-minute headways on weekends. Since entering into service, the MBTA has improved signal prioritization and added free fares on the return trip from Logan Airport. Current Silver Line challenges include delays caused by waiting for the Chelsea Street and Alford Street Bridges to lift, congestion in the Ted Williams Tunnel (where SL3 uses regular traffic lanes) and needing to circulate Seaport in mixed traffic lanes.

Notable Silver Line routes include:

- **SL1:** Serves multiple terminals at Boston Logan International Airport via a mixed traffic lane in the I-90 Ted Williams Tunnel and a dedicated right-of-way under the Fort Point Channel.
- **SL3:** Connects Boston to Everett via a combination of mixed-use lanes and curbside bus lanes separated by low barriers that provide access to emergency vehicles. Adding a dedicated lane for the SL3 in 2016 reduced wait times and improved boarding/exiting, especially for people with mobility challenges and children in strollers. Additionally, the MBTA re-timed traffic signals to give southbound buses extended green light time. The MBTA is planning to extend the SL3 to Sullivan Square, connecting it to the Orange Line and additional fixed-route bus routes.

Pittsburgh Regional Transit (Pittsburgh, PA)

Pittsburgh Regional Transit's (PRT) first BRT line, the South Busway, began in 1977 and PRT has since expanded its BRT network to include the P1 East Busway and the G2 West Busway. PRT busways are two-lane dedicated runways along which local and express buses operate, which has reduced travel times and increased reliability along high-traffic routes. The busways successfully driven increases in ridership; as of 2002, BRT accounted for about 20 percent of PRT's ridership systemwide. As of 2017, the busways experienced an average weekday ridership of about 25,600

passengers. PRT's \$2.75 base fare includes unlimited transfers for three hours for riders paying using a ConnectCard, Connectix, or a mobile ticket application. PRT's Bus Line Redesign project is proposing changes to Pittsburgh's BRT network to improve service quality, expand connections, and to prioritize equitable investment. PRT intends to improve frequency and reliability, two elements that riders determined were important but lacking among PRT buses, by increasing bus service and improving frequency outside of normal peak hours. PRT also plans to expand service in disadvantaged communities and areas where there is more demand than there is bus service.

The West Busway, which opened in 2000, connects downtown Pittsburgh to the Pittsburgh International Airport via dedicated lanes and through the upgraded Wabash tunnel. The West Busway has 18 stations, six of which are PRT stations, and the route takes approximately 22 minutes to travel. After the West Busway became operational, buses became 68 percent more reliable, bus speeds increased by 2.4 mph or 13 percent, and reduced passenger wait time by 78 percent. While PRT does have light rail lines, the West Busway does not interact with any of these. As of January 2024, PRT buses services 1198 riders on average on weekdays. The PRT South Busway, which opened in 1977, connects the Pittsburgh Central Business District to the South Hills neighborhood. The South Busway offers transfers to light rail at the Station Square, South Hills Junction, Palm Garden, Dawn, and South Bank stations. The busway runs along dedicated lanes, sharing use of the Mt. Washington Tunnel with the Overbrook Trolley Line.

Regional Transit Authority (Cleveland, OH)

The Regional Transit Authority (RTA) operates light rail, bus, BRT, and trolley lines. The RTA has two BRT lines: the HealthLine and the Cleveland State Line, which has three alternate routes (55, 55B, and 55C). The Healthline connects Public Square to the Louis Stokes Station at Windemere via 35 stations. Notable destinations include Cleveland State University, John Hay High School, Case Western Reserve University, Cleveland Clinic Main Campus, University Hospitals, and University Circle. The HealthLine connects to light rail at the Louis Stokes/Windermere, Superior, and Tower City rapid stations. The Cleveland State Line also intersects with light rail at

the Tower City rapid station. Light rail stations vary in the amenities they offer, but most feature elevated platforms separated from the roadway.

The HealthLine runs in both median-aligned, dedicated lanes and mixed traffic. The service operates 24 hours daily with 15-minute headways during the daytime and 30-minute headways at night. Since entering into service, travel times have improved by 12 minutes compared to fixed-route bus service. Within the first year of service, ridership increased by 48 percent. The RTA converted one car lane into a dedicated bus lane along the Euclid corridor after determining that the parallel streets could adequately accommodate the diverted traffic. The RTA also added left-turn bays at intersections with bus stations, bike lanes, and parallel parking lanes. When operating in mixed traffic, the HealthLine runs in thru-lanes in either direction and serves stations at bump-outs to prevent delays from private vehicles. To further reduce travel times, Cleveland BRT benefits from extended green time, intermediate phases, and queue jumps. The RTA designed its BRT system to closely resemble light rail. To achieve this, station facilities have raised platforms, real-time bus arrival updates, and modern upgrades and safety features to make the service more pleasing to riders.

As of July 2022, the Healthline accounted for 8 percent of RTA's ridership. The overall system ridership in July 2022 was 1.5 million, so the RTS BRT system transports roughly 120,000 monthly riders. The RTA has experienced general ridership declines since 2014, when HealthLine ridership peaked. These ridership declines are likely a combination of service reductions, increased fares, fluctuating gas prices, and the introduction of ride-hailing companies, such as Uber and Lyft. The Cleveland State Line, however, gained ridership from its operational debut in 2014 and has maintained this increase. It is worth noting that the RTA HealthLine is the only route with full BRT features and the Cleveland State Line only incorporates some BRT features, but both routes increased ridership.

Best Practices

Physical characteristics of BRT guideways and stations are critical to maximizing BRT ridership. Per the Institute for Transportation and Development Policy's *"Bus Rapid Transit Standard"*, busway best practices include:

- Designing BRT systems to maximize dedicated right-of-way, by providing a two-way, median-aligned busway in the median of two-way road; a bus-only corridor with a fully exclusive right-of-way and no parallel mixed traffic; or busway that runs adjacent to an edge condition (i.e., a park) where there are few intersections; or a busway that runs two-way on the side of a one-way street
- Station best practices include setting back stations from intersections or having over 80 percent of turns prohibited across the busway, providing passing lanes for potential express BRT service, offsetting stations several hundred feet from larger intersections, constructing center-running stations, and providing level boarding with automatic doors, and fare gates at every door.
- Service best practices include operating a multi-corridor BRT network, where corridors connect to each other and offer timed-transfers, operating multiple routes in high-frequency corridors, ensuring that the highest-demand segments within a given corridor are served and connected to the local pedestrian and bicycle network. Aligning Matching the service frequency to the demand during peak/off-peak hours ensures that BRT is cost-effective.³

Additionally, end of line stations and park-and-ride facilities should be located near major destinations, major intersecting roadways, and in areas served by inline stations. Inline stations (located adjacent to the running way, requiring vehicles to exit to access a station) are the most cost-effective and save time

³ Highway Transitway Corridor Study: Final Report, <https://metro council.org/Transportation/Publications-And-Resources/Transit/TRANSITWAYS/HTCSFinal.aspx>

because buses don't need to leave the highway to access stations. Online stations (located within the running way, on the median or side of the highway) also save time but are less cost-effective since they require lane construction in the median of highways.

Integrating BRT with rail/other transit is essential to streamlining transfers and raising ridership. Transit agencies should consider how stations are spaced, and work with local planning agencies and governments to ensure that high-capacity transit corridors serve the densest areas, as well as serving populations that have the highest need (e.g., low-income, zero-vehicle households. Concurrently, BRT investments can result in displacement and gentrification. Policies should be considered and enacted along future BRT corridors to subsidize the provision of affordable housing and protect existing residents.

Several other BRT systems offer useful corollaries for Honolulu, including Fort Collins, Colorado, and Hartford, Connecticut. Two-thirds of Fort Collins (CO) Max BRT operates in a freight rail right-of-way. BRT lanes run adjacent to freight tracks and buses need to stop to wait for trains to pass, causing delays. One section of CTfastrak busway runs in an easement parallel to an Amtrak right-of-way, requiring CTDOT to coordinate extensively with Amtrak. If a train is passing, buses need to pause at the signal but then can proceed. Previously, buses needed to stop the entire time a train was passing despite running parallel.⁴

Funding

Funding for BRT systems is a critical component, with capital improvements typically funded by grants from the Federal Transit Administration (FTA). FTA's Capital Investment Grants program (Includes New Starts and Small Starts) and the Expedited Project Delivery Pilot program fund local, new, large transit capital projects. Eligible projects include BRT. These programs are part of nearly \$100

⁴ Getting to BRT: An Implementation Guide for U.S. Cities, <https://www.itdp.org/wp-content/uploads/2019/09/2019.08.04.US-BRT-Implementation-Guide.V7.pdf>

billion of BIL funds to support transit agencies.⁵ Other grant programs that can be utilized to fund capital or operating improvements include the following:

- **Low or No Emission Grant Program.** Funds buses and facilities but is not limited to BRT projects. The FTA provides grants to local and state government entities to purchase or modernize buses and bus facilities. Eligible activities include acquiring low or zero emission buses, constructing leasing facilities or new public transportation facilities to accommodate low or zero emission buses, and improving existing facilities to accommodate low or no emission buses. The federal cost share must not exceed 90 percent of the net project cost of leasing or acquiring bus-related equipment and facilities.⁶
- **Grants for Bus and Bus Facilities Program.** The FTA provides funding for states and local government entities that operate fixed route bus service to rehabilitate and purchase buses, bus-related equipment, and bus-related facilities. This includes technological changes or innovations to modify low or zero emission vehicles or facilities. The federal cost share is 80 percent of the net project cost and 90 percent for the leasing or acquiring of low or zero emission bus-related equipment and facilities.⁷
- **Rebuilding American Infrastructure with Sustainability and Equity (RAISE, formerly BUILD and TIGER) Grants.** Eligible projects include public transportation projects eligible under 49 U.S. Code 53, which stipulates that a bus rapid transit system refers to a transit system in which 1) the majority of each line operates in a separated right-of-way dedicated for public transportation use during peak periods and 2) includes features that emulate the services provided by rail fixed guideway public transportation systems. Examples of these features

⁵ Biden-Harris Administration Announces Nearly \$4 Billion in Support for 14 Major Transit Construction Projects Across the U.S., <https://www.transportation.gov/briefing-room/biden-harris-administration-announces-nearly-4-billion-support-14-major-transit>

⁶ Low or No Emission Grant Program, <https://www.transit.dot.gov/lowno>

⁷ Low or No Emission and Grants for Buses and Bus Facilities Competitive Programs FY2024 Notice of Funding Opportunity, <https://www.transit.dot.gov/notices-funding/low-or-no-emission-and-grants-buses-and-bus-facilities-competitive-programs-fy2024>

include defined stations, traffic signal priority, and short headway bidirectional services. The U.S. Department of Transportation offers grants of a minimum of \$5 million for capital projects in urban areas. The Federal share of costs must not exceed 80 percent of total project cost, unless located in a rural area, a historically disadvantaged community, or an area of persistent poverty. The project budget narrative should include information on the sources, uses, and availability of project funds, the contingency amount, the degree of design completion, the cost estimates, and the cost share. Applications must include a merit criteria review, a project readiness review, and a benefit-cost analysis. Both state and local governments and transit agencies are considered eligible applicants.

- **Urbanized Area Formula Grants.** The FTA provides funding for transportation-related planning in urban areas. Eligible activities include the planning and design of transit projects, capital investments in bus and bus-related activities, station infrastructure, and signals, communications, and computer hardware and software. In urban areas with a population of 200,000 or more, funding is apportioned based on a combination of bus vehicle revenue miles, bus passenger miles, fixed guideway miles, and operating expenses, as well as population, low-income population, and population density. The federal share must not exceed 80 percent of net project costs. Operating assistance is only an eligible activity in urban areas with populations under 200,000.⁸
- **Urbanized Area Formula Grants.** The FTA provides funding for transportation-related planning in urban areas. Eligible activities include the planning and design of transit projects, capital investments in bus and bus-related activities, station infrastructure, and signals, communications, and computer hardware and software. In urban areas with a population of 200,000 or more, funding is apportioned based on a combination of bus vehicle revenue miles, bus passenger miles, fixed guideway miles, and operating expenses, as well as population, low-income population, and population density. The federal share must not exceed 80 percent of net

⁸ Urbanized Air Formula Grants, <https://www.transit.dot.gov/funding/grants/urbanized-area-formula-grants-5307>

project costs. Operating assistance is only an eligible activity in urban areas with populations under 200,000.

- **Congestion Mitigation and Air Quality (CMAQ) Improvement Program.** The CMAQ Program provides funding to state DOTs, local governments, and transit agencies for projects that reduce mobile source emissions and regional congestion on transportation networks. Eligible projects include transit improvements, congestion relief efforts, alternative fuel vehicles and infrastructure, and medium- or heavy-duty zero emission vehicles and infrastructure. Funding is available for areas that do not meet the National Ambient Air Quality Standards and for former nonattainment areas now in compliance. Funding is provided to state governments then divided among apportioned programs.⁹

Considerations for Concurrent Operations of Bus Rapid Transit and Commercial Freight Vehicles

BRT and Freight Interaction in Urban Environments¹⁰

It is important to consider how BRT implementation will impact other transportation systems, such as freight. A 2021 study¹¹ found that the implementation of BRT systems with dedicated lanes reduced freight traffic in the corridor, but exacerbated freight congestion in surrounding areas. Freight traffic is often diverted to alleviate congestion in the BRT corridor, but this traffic is simply moved, not reduced. As a result, citywide congestion increases overall.

⁹ Congestion Mitigation and Air Quality (CMAQ) Improvement Program, <https://www.fhwa.dot.gov/bipartisan-infrastructure-law/cmaq.cfm#:~:text=The%20BIL%20continues%20the%20Congestion%20Mitigation%20and%20Air,meet%20the%20requirements%20of%20the%20Clean%20Air%20Act.>

¹⁰ Bus Rapid Transit (BRT) and Urban Freight—Competition for Space in Densely Populated Cities, <https://doi.org/10.3390/su13126611>

¹¹ Bus Rapid Transit (BRT) and Urban Freight—Competition for Space in Densely Populated Cities, <https://doi.org/10.3390/su13126611>



The implementation of BRT also impacts land use in surrounding areas. Land around BRT corridors is typically used for housing projects, commercial uses, and daily services, which need to integrate with industrial and logistic services to accommodate shared BRT and freight operations. To avoid further congestion when combining BRT and freight transportation, transportation agencies should anticipate changes in land use to accommodate residential and commercial activities.

Additionally, building freight loading and unloading infrastructure along BRT corridors prevents double parking and further congestion. Areas lacking in space to accommodate additional freight infrastructure may wish to establish measures such as off-peak delivery hours, staggered delivery times, traffic management, freight platforms, and cargo cycles to mitigate curbside traffic.



2023

CITY AND COUNTY OF HONOLULU

ENERGY AND EMISSIONS REDUCTION PLAN FOR TRANSPORTATION

Honolulu Emissions Reduction Plan—Parking Framework

Prepared by the City and County of Honolulu Office of Climate Change, Sustainability and Resiliency in Cooperation with the Oahu Metropolitan Planning Organization and the United States Department of Transportation.

This report was funded in part through grants from the Federal Highway Administration and Federal Transit Administration, U.S. Department of Transportation. The views and opinions of the agency expressed herein do not necessarily state or reflect those of the U.S. Department of Transportation.

Introduction

Oahu aims to reduce greenhouse gas (GHG) emissions by 45 percent over by 2025 and achieve carbon neutrality by 2045 in accordance with state law. Ground transportation currently accounts for 19 percent of Oahu's GHG emissions, so policies and programs that encourage more sustainable travel present exciting opportunities to reduce emissions while also promoting equity, health, and well-being for residents. Research suggests that there are strong relationships between parking management strategies, personal travel choices, and greenhouse gas emissions. Attention to parking management from the lens of sustainability may result in:

- Eliminating the superfluous vehicle travel, wasted time, and associated emissions that result from “cruising” to find a parking space
- Repurposing space to make it safer and more pleasant to walk or bike
- Efficiently managing access to limited parking areas
- Encouraging other modes of travel
- Requiring equal benefits for commuters who choose not to drive alone
- Reinvesting revenues in TDM initiatives to provide more convenient and attractive travel options that reduce the need to drive

In addition to these environmental benefits, approaching parking management from the lens of sustainability may result in numerous co-benefits, including:

- Continued parking availability, given user-friendly parking areas within walking distance of key locations
- A realization of the actual greater value of public space

Honolulu Emissions Reduction Plan—Parking Framework

- Increased roadway safety
- General support when people realize its positive impacts, and a good impact-to-acceptance ratio compared to other TDM measures (e.g., road pricing)
- Support to the local economy through attractiveness of main streets
- New business investments, as companies are attracted to cities that can function with less traffic congestion and more travel options
- Assurance that parking spaces will be available for employees
- Economic health and fiscal sustainability for the City

This report begins by exploring the relationships between parking management and GHG reduction and then presents a framework for considering parking solutions based on parking demand observations and CCH guiding principles and goals. It highlights how various parking pricing and technology solutions have been successfully implemented in other cities.

To develop the parking framework, we first reviewed the existing conditions in Honolulu, including:

- Parking inventory and occupancy data provided by City and County of Honolulu (CCH) staff
- Parking rate data
- IPS Smart Meter data by area
- The OahuMPO Travel Demand Forecasting Model findings
- Existing plans, policies, and transportation resources
- City and County of Honolulu mobility and climate goals

Based on our review of the existing parking conditions and CCH mobility and climate goals, we suggest a set of principles to guide the consideration of various parking pricing strategies and the complementary solution of cordon pricing that make up the parking framework for this study. The parking pricing models include:

- Demand-based pricing
- Tier-based pricing
- Blanket price increases

Honolulu Emissions Reduction Plan—Parking Framework

Each pricing model has unique benefits and challenges, with impacts that can be analyzed from various perspectives, considering the potential for emissions reduction, technology needs and opportunities, the potential to improve the parking experience for users, the impact on City and County resources, the effects on the local economy, and the social equity associated with each model.

Many of the same climate and sustainable mobility goals supported by parking pricing models are also supported by cordon pricing. This report also explains cordon pricing, evaluates its potential benefits, and considers how it might work in Honolulu and eventually synergize with parking pricing.

After exploring and evaluating each parking pricing model, this report introduces the opportunity for CCH to develop a hybrid approach that incorporates features of each pricing strategy, to fit the local context in Honolulu. The implementation guidelines provide a practical strategy that responds to the various considerations and decision points involved in developing a pricing model aligned with Honolulu's goals for social equity, economic health, and environmental sustainability. The implementation section also highlights opportunities for CCH to take advantage of new technology that will reduce friction, save time, and provide a seamless parking experience for users. When it comes to parking strategy, the same actions that support climate goals and protect the natural environment also help reduce budget shortfalls, attract new businesses, and increase the ease of travel and access for everyone.

Relationships between Parking Management and GHG Reduction

The precise way that parking relates to greenhouse gas emissions differs from one context to another. Areas with high demand for parking pose a unique challenge, but even in areas with ample parking available, there are still opportunities to reduce greenhouse gas emissions through implementing parking management and pricing best practices. This section explores how parking prices affect (1) GHG emissions from “cruising” and (2) GHG emissions from single occupant vehicle (SOV) travel, and it also examines the impact of parking requirements in development standards on travel behavior choices. It briefly introduces parking solutions best suited for reducing each of these parking-related emissions sources and highlights several examples of how other cities have successfully reduced their transportation-related emissions through parking pricing and management.

When Occupancy is above 85 Percent: GHG Emissions from Cruising

When free or underpriced street parking results in a lack of available spaces, drivers often circle around the area until they find an open space to park. This “cruising” for parking can add up, increasing vehicle miles traveled and greenhouse gas emissions. For example, one study examined an area where curbside parking rates were half the rates for off-street parking. The average driver hunting for this underpriced street parking circled around for an additional half mile before finding a space, which, when combined with parking turnover data, equated to an extra 4,000 VMT per year, or 730 tons of CO₂ from a single curbside space.¹ If occupancy data from Honolulu show high utilization rates for on street parking, that means current parking management of street parking (or lack thereof) in busy places may be responsible for similarly high emissions. If hundreds or thousands of curbside spaces are currently underpriced, price adjustments could greatly reduce greenhouse gas emissions from transportation,

¹ Shoup, D. (2007). Cruising for Parking. ACCESS Magazine 30 (Spring), 16-22.

Honolulu Emissions Reduction Plan—Parking Framework

while also making the system more user friendly, reducing congestion, and eliminating parking search costs for drivers.

Reducing cruising emissions through demand-based pricing: Setting meter prices just high enough to result in at least one or two open spaces per block can prevent this superfluous travel while still allowing for access. In practice, this means increasing the cost of parking or expanding paid parking enforcement hours on streets where occupancy rates exceed 85 percent. When the City of San Francisco first experimented with demand-based pricing for parking on some blocks, researchers found that the policy reduced cruising VMT by approximately 50 percent relative to the control blocks.² The demand-based pricing model is developed and analyzed in the Pricing Models section, beginning on page 25.

Even when Occupancy is below 85 Percent: GHG Emissions from Single Occupancy Vehicle (SOV) Travel

Even in areas or at times when utilization rates are below 85 percent, charging for parking can be a valuable strategy to reduce emissions, discourage driving and encourage active travel, and promote shared mobility. For decades, all new developments were required to dedicate a certain amount of land to parking to meet minimum requirements. This resulted in an overabundance of parking supply, which still affects communities today by making low-cost parking more prevalent, effectively subsidizing its cost. Parking that is abundant and unpriced makes solo driving more attractive relative to more sustainable modes, such as carpooling, public transit, walking, and biking.

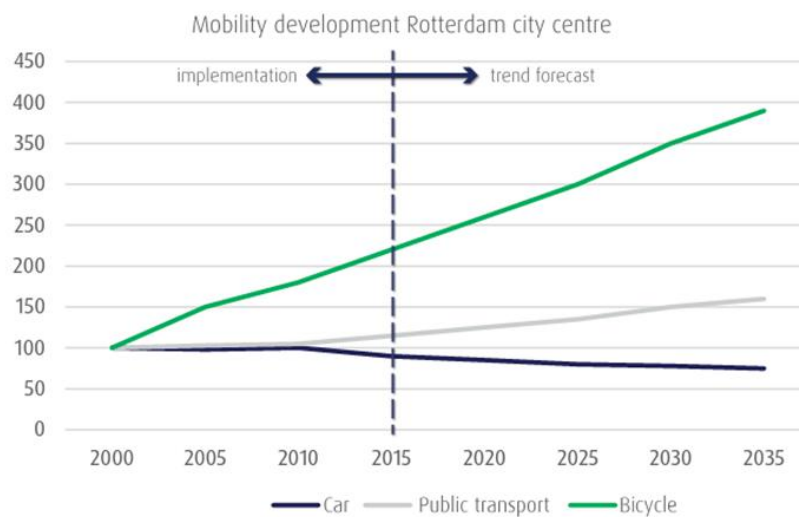
Reducing SOV travel emissions by allowing street parking to be repurposed: Charging for parking even in areas with relatively low occupancy can reduce parking demand and allow Honolulu to gradually reclaim public land, reducing the parking footprint to create safer and more welcoming spaces for walking and biking to reduce emissions.

² Millard-Ball et al. (2014). Is the curb 80% full or 20% empty? Assessing the impacts of San Francisco's parking pricing experiment. Transportation Research Part A: Policy and Practice 63, 76-92.

Honolulu Emissions Reduction Plan—Parking Framework

For example, between 2016 and 2020, the Dutch city of Rotterdam repurposed 3,000 parking spaces and created more bike lanes, walking areas, bike parking, terraces, and green areas. As a result, car use decreased, and more people traveled by public transit or bicycle (see Figure 1). This approach would be likely to yield positive results in Honolulu as well, where in an island-wide survey, 32 percent of respondents said they do not walk to their destinations, and 47 percent do not bike, due to concerns about traffic safety.³

Figure 1: Mobility Transition Projection in Rotterdam



Source: Rotterdam Urban Traffic Plan 2017 – 2030.

Reducing SOV travel emissions by expanding the paid parking area:

Even without initially repurposing parking spaces, expanding the area where there is a charge for street parking can help encourage more sustainable modes of travel. In 2007, Strasbourg, France increased its paid parking area by 2,500 spaces. The next year, a survey revealed that there was an 11.5 percent increase in walking and a 3.2 percent decrease in vehicle traffic entering the inner city.⁴ By expanding its paid

³ Climate Action Plan 2020-2025.

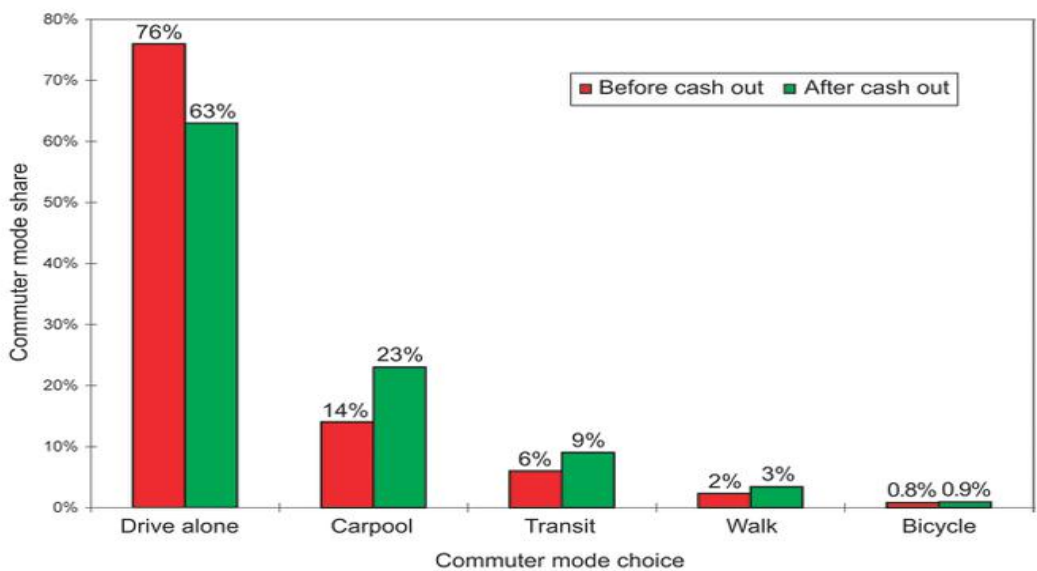
⁴ <https://www.itdp.org/2011/01/18/europes-parking-u-turn-from-accommodation-to-regulation/>

Honolulu Emissions Reduction Plan—Parking Framework

parking area, Honolulu could make solo vehicle travel less attractive and boost the share of trips made by carpool, transit, walking, and biking.

Reducing SOV travel emissions through parking cash out: Numerous studies have shown that while free parking makes driving more attractive, charging for parking—or even keeping parking free but offering an equivalent subsidy for choosing another mode of travel—can make people more likely to walk, bike, carpool, or take transit. For example, after California required large firms to provide a “cash out” option for employees equal to the cost of a subsidized parking space, a case study of eight firms found that the drive-alone share fell from 76 to 63 percent, and more people carpooled, rode transit, walked, and biked (see Figure 2). Vehicle travel to work fell by 652 vehicle miles traveled (VMT) per year per employee, or about 12 percent, for a yearly reduction of approximately 800 pounds of CO₂ per employee.⁵

Figure 2: Commuter Mode Shares Before and After Parking Cash Out



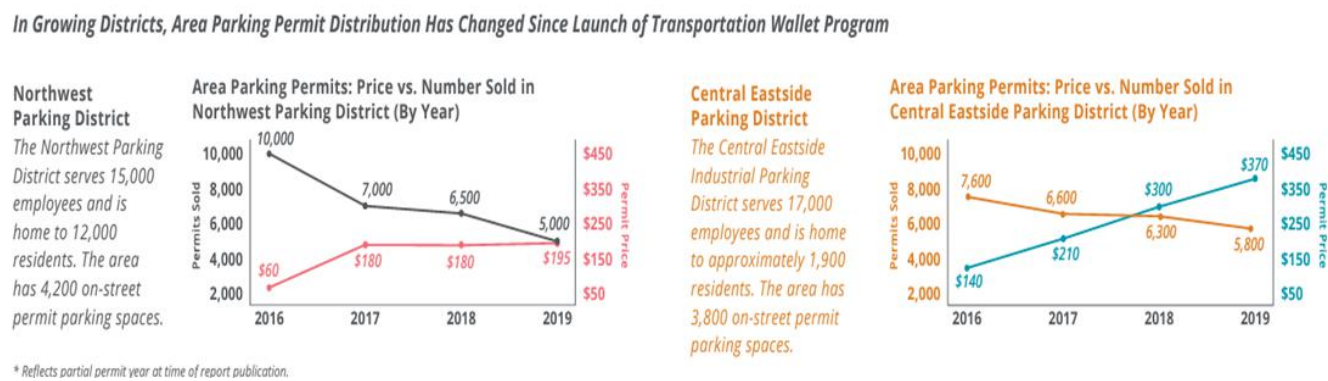
⁵ Shoup, 2005. Parking Cash Out. <http://shoup.bol.ucla.edu/Parking%20Cash%20Out%20Report.pdf>

Honolulu Emissions Reduction Plan—Parking Framework

Source: Parking Cash Out Report, 2005.

Reducing SOV travel emissions by reinvesting parking revenues in sustainable travel: Parking prices can further reduce parking demand when revenues are reinvested into transportation demand management (TDM) initiatives. For example, Strasbourg changed its structure from Parking Enterprise (internal circular funding, where parking fees pay for the cost of the parking program) to instead direct parking revenues toward public transit. The City of Boulder, Colorado also uses parking revenues to pay for TDM initiatives, including the EcoPass, which provides unlimited access to various public transportation services. Portland, Oregon charges an additional “Parking Climate and Equitable Mobility” transaction fee of 20 cents per parking meter transaction, which furthers the City’s TDM initiatives. Portland also funds “transportation wallets” through residential parking permit surcharge fees and allows people to exchange their parking permits for a Transportation Wallet, a collection of passes and credits for use on transit, streetcar, bike-share, e-scooters, and car-share. Increasing the cost of parking while also promoting alternative travel has reduced the demand for parking (see Figure 3). Increasing the cost of parking can help reduce greenhouse gas emissions, and reinvesting the revenue to promote walking, biking, and public transit can help ensure residents still have access to a variety transportation options.

Figure 3: Yearly Parking Permit Prices and Sales in Portland Area Parking Permit Districts



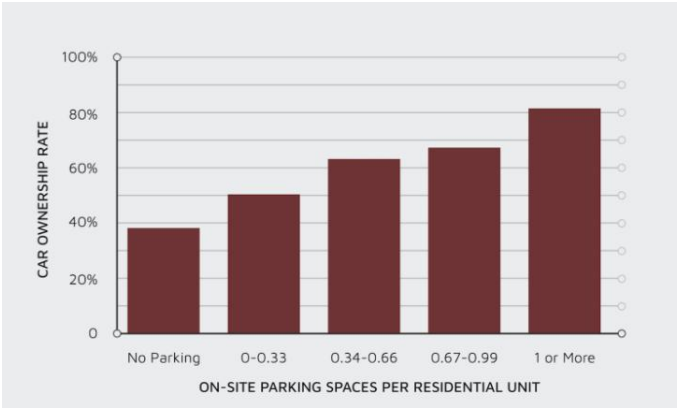
Source: Transportation Wallet 2020 Program Report.

Honolulu Emissions Reduction Plan—Parking Framework

Development Standards and Travel Behavior

Parking supply greatly influences travel behavior and vehicle ownership decisions, with clear implications for GHG emissions. Researchers often question whether walkable neighborhoods with limited parking cause people to drive less, or merely attract people already interested in driving less. A recent study used San Francisco’s lottery for below-market-rate housing units as a “natural experiment” through which to examine this question. Only two percent of lottery participants were offered an affordable housing unit, and participants tended to accept whatever housing units they were offered. The below-market-rate units assigned via lottery varied in their walkability, bike-ability, access to transit, and parking availability. Researchers asked lottery winners about their travel behavior and found that parking access was three times more influential a variable on transit use than living in a neighborhood with good transit access.⁶ Of those contacted for the survey, 779 lottery winners responded, a response rate of 29 percent. Parking availability was not found to affect employment rates or job mobility. People may or may not have had a vehicle before winning the housing lottery, but the parking availability at their new affordable unit was clearly associated with their subsequent car ownership (see Figure 4).

Figure 4: Car Ownership Rate by Parking Spaces per Unit



⁶ Millard-Ball, A., West, J., Rezaei, N., & Desai, G. 2021. What Do Residential Lotteries Show Us About Transportation Choices? *Urban Studies*.

Honolulu Emissions Reduction Plan—Parking Framework

Source: Millard–Ball et al., 2021.

For cities interested in encouraging sustainable travel, the findings from the study on San Francisco’s naturally occurring experiment support policies that not only remove minimum parking requirements for new development, but also that prohibit or create incentives against providing a large supply of parking. Even in cities or areas where minimum parking requirements have been repealed to promote housing affordability or environmental goals, developers often still provide an abundance of parking to satisfy their lenders. Some cities have developed strategies to mitigate this through their development standards, such as establishing maximum parking requirements in their Transit–Oriented Development (TOD) areas or linking Transportation Demand Management (TDM) requirements to the amount of parking a developer plans to supply.

For example, the City of San Francisco has a flexible points–based TDM program where developments are assigned “points” based on the number of parking spaces they wish to provide, and they mitigate the negative impacts of that parking by providing additional TDM strategies from a menu of options (see Figure 5). The options include improving walking conditions, secure bicycle parking, showers and lockers, bike share memberships, bicycle valet services, car share parking and memberships, on–site childcare, on–site access to healthy food, shuttle bus services, vanpool, real time transportation information displays, unbundling parking, pricing parking, offering parking cash out, and reserving some units for affordable housing.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 5: San Francisco TDM Points Requirements by Number of Proposed Parking Spaces

<i>Land Use Category</i>	<i>Typical Land Use Type</i>	<i># of Parking Spaces proposed by Land Use</i>	<i>Target</i>
Ⓐ	Retail	Base number: $0 \leq 4$	Base Target: 13 points
		Each additional 2*	1 additional point
Ⓑ	Office	Base number: $0 \leq 20$	Base Target: 12 points
		Each additional 10*	1 additional point
Ⓒ	Residential	$0 \leq 5$	10 points
		$6 \leq 10$	11 points
		$11 \leq 15$	12 points
		$16 \leq 20$	13 points
		Each additional 10*	1 additional point
Ⓓ	Other	Any # of parking spaces	3 points

Source: City of San Francisco, 2021.

Washington D.C. also ties TDM requirements to parking ratios, land use, and proximity to transit. All new developments are expected to provide fewer parking spaces or mitigate their parking through TDM initiatives and site design, and developments near transit are expected to provide even fewer parking spaces. District Department of Transportation Staff estimated that their policy prevented the creation of approximately 1,000 new parking spaces between 2017 and 2019 (Guidance for Comprehensive Transportation Review (CTR) Presentation, 2019).

Existing Conditions

The previous section explored various relationships between parking management practices and policies and greenhouse gas emissions. An understanding of the existing conditions in Honolulu will help inform analysis of which strategies will best fit the local context and which focus areas might hold the greatest potential for emissions reduction. This section provides an overview of the on-street and off-street paid public parking inventory in Honolulu, the rates charged at each location, and the hours of enforcement. It presents new parking demand data based on revenue from the IPS Smart Meters, as well as a sample of occupancy observations collected by CCH staff. It also summarizes existing CCH plans, policies, and ordinances related to parking and travel in the study area.

Public Parking Inventories and Rates

On-Street Metered Parking

According to data shared by CCH staff, the City and County of Honolulu currently manages approximately 3,113 on-street metered parking spaces, including approximately 1,838 IPS Smart Meters, which also allow for payment by phone or credit card, and approximately 1,275 active coin meters. There is ongoing conversion of coin meters to IPS Smart Meters, and therefore the number of each type of meter is likely to change over time. CCH also plans to allow users to pay for parking with the HOLO card, which is currently used for public transit. See Appendix A for a full list of the streets with metered parking. Section 15-22.4 of the Traffic Code establishes rates and hours for on-street paid public parking. The code allows the director of transportation services to set the enforcement hours in other paid parking zones.

Paid parking rates:

- The rate for parking in the Downtown and Civic Center area and in the Waikiki area is \$3 per hour.
- The rate for all other parking zones is \$1.50 per hour.

Honolulu Emissions Reduction Plan—Parking Framework

Enforcement hours for paid parking:

- Downtown and Civic Center area – 7:00 am to 6:00 pm on any day except Sundays and public holidays.
- Waikiki area – 6:00 am to 10:00 pm on any day.

The City and County of Honolulu also has efforts underway to provide spaces for on-street electric vehicle (EV) charging and is in the process of developing a pricing structure for on-street vehicle charging.

Off-Street Parking

Additionally, the City and County of Honolulu manage several paid off-street lots and garages. Typical rates range from \$0.75 per hour to \$1.50 per hour. Some facilities are metered and allow hourly parking only; these facilities generally have maximum time limits. Other facilities have attendants, and offer daily or monthly parking in addition to hourly.

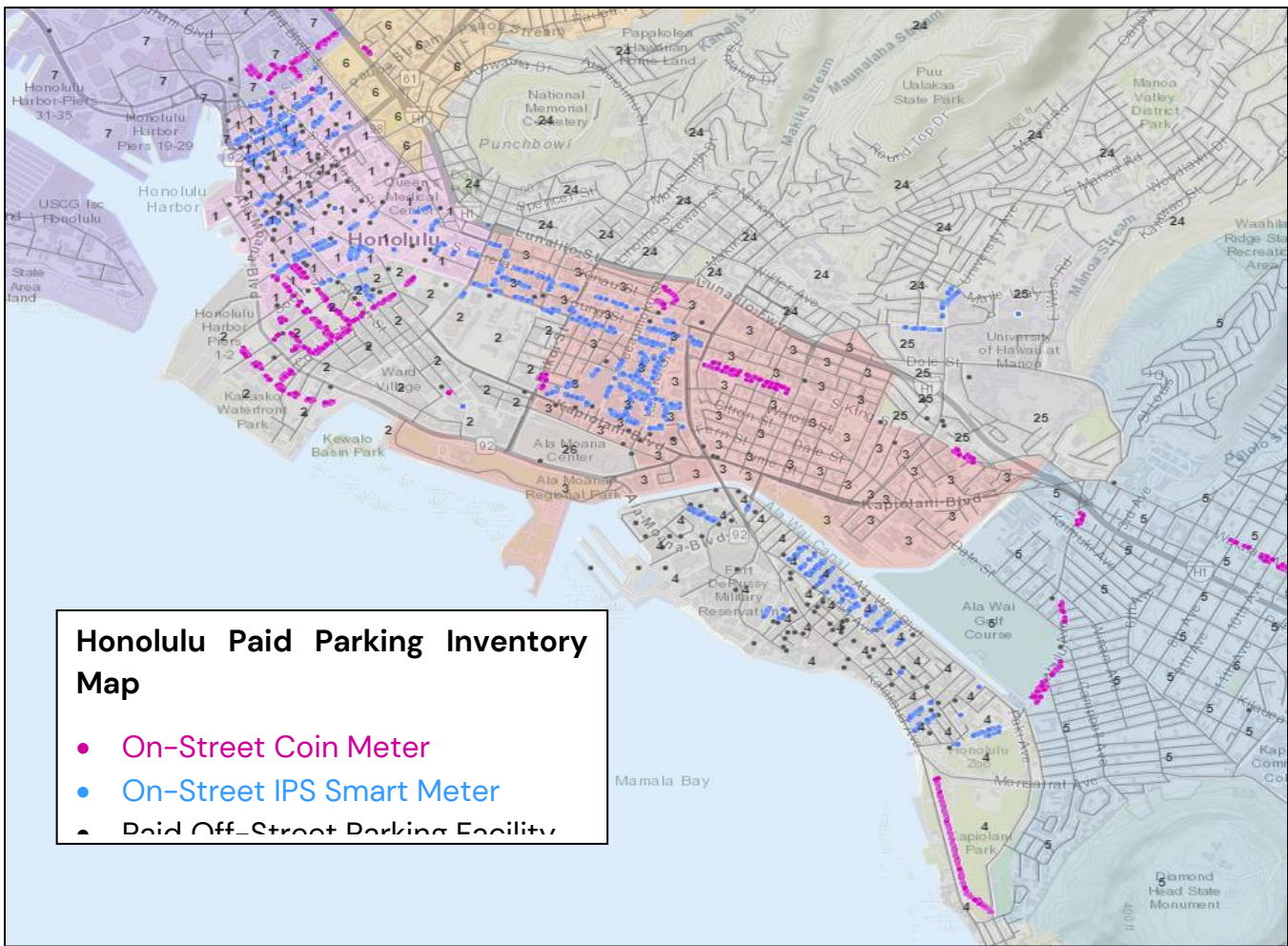
Section 15–23.A of the Traffic Code establishes base primary and secondary rates for attendant parking facilities. Primary rates apply during peak hours, which vary by facility but most frequently are from 6:00 am to 5:00 pm. Many of the facilities offer a discounted primary rate for the first few hours and increase the rate thereafter. Secondary rates generally apply on weekends, holidays, and overnight.

The Traffic Code also requires the director of transportation services to increase rates when occupancy exceeds 90 percent of capacity, to a maximum of \$3 per hour for the first two hours and \$4.50 per hour thereafter. The director must lower rates if occupancy decreases more than 20 percent from the previous observation period. Adjustments are made on a semiannual basis.

Figure 6 displays a map of paid parking locations in Honolulu near the downtown area. The paid off-street parking facilities shown on the map include privately owned and operated facilities with parking available to the public at market rates. There are also some on-street coin meters in the town of Kailua, shown in Figure 7.

Honolulu Emissions Reduction Plan—Parking Framework

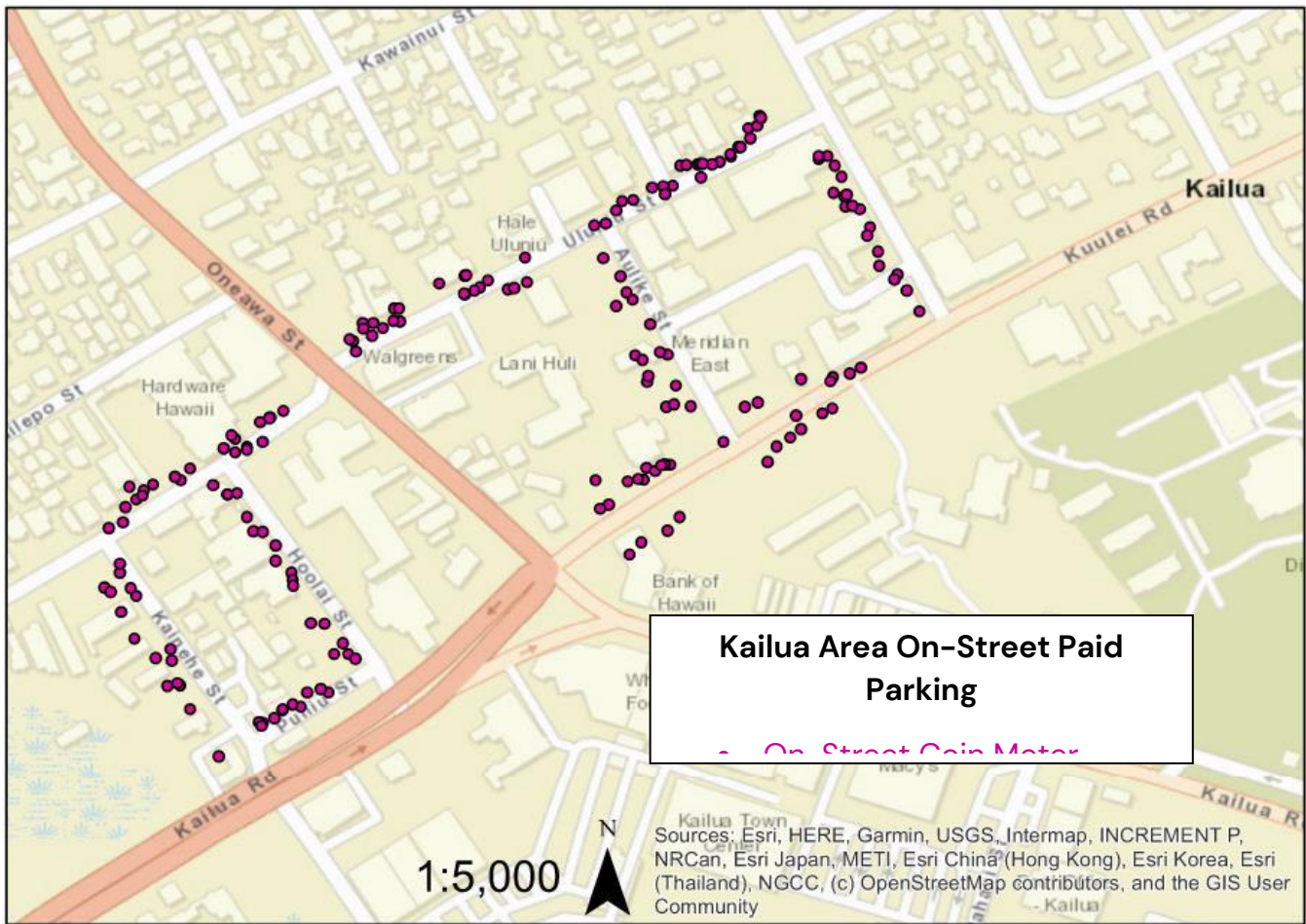
Figure 6: Honolulu Paid Parking Inventory Map



Source: Walker Consultants, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 7: Kailua Coin Meter Locations



Source: Walker Consultants, 2023.

Honolulu Emissions Reduction Plan—Parking Framework

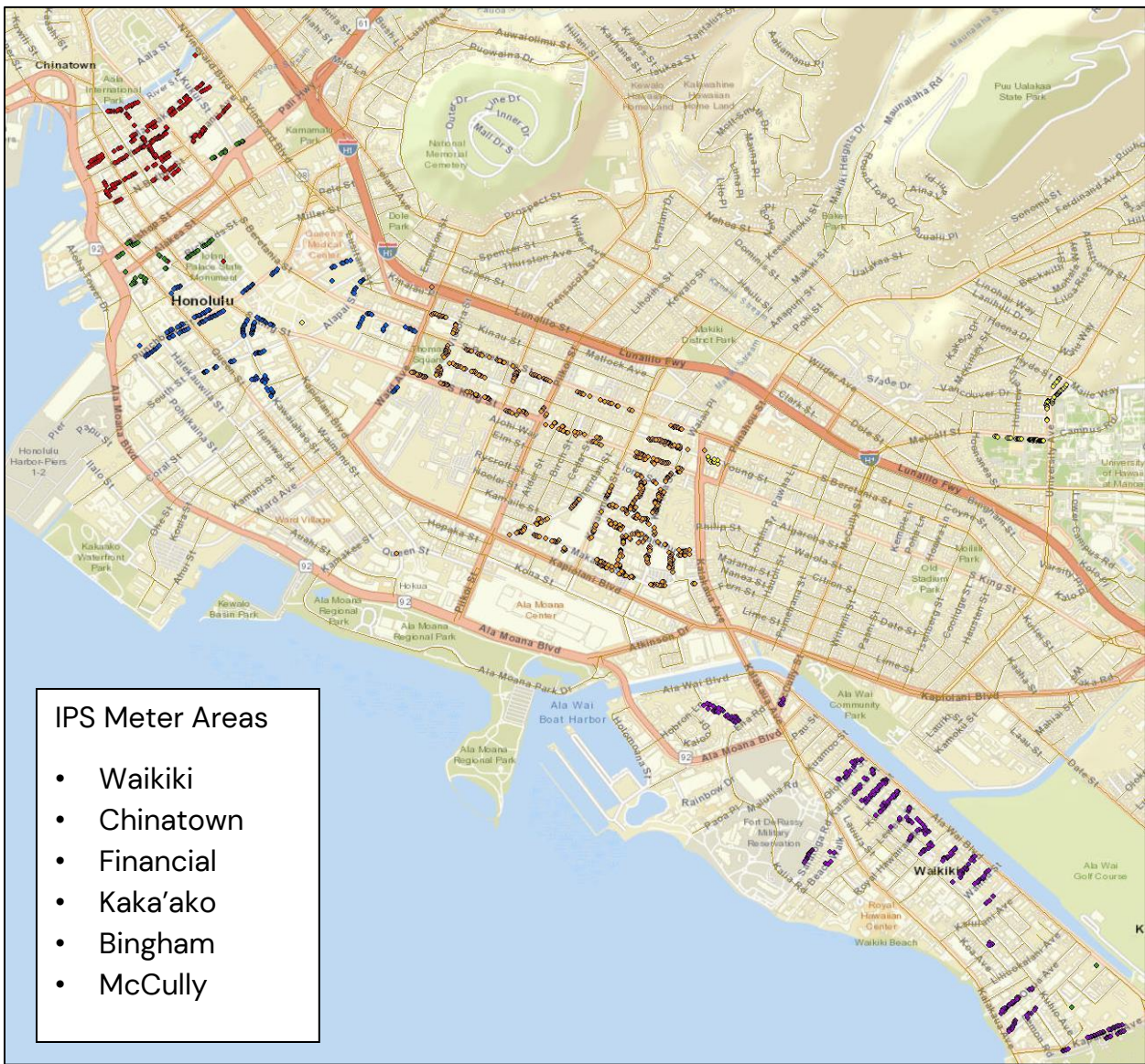
Public Parking Demand Data

The City and County of Honolulu use both traditional coin meters and IPS Smart Meters, which also allow for payment by phone or credit card. The IPS meters collect transaction and revenue data, which can provide insight into parking demand patterns and allow for comparison across locations. IPS groups the meters into six areas: Waikiki, Chinatown, Financial, Kaka’ako, Bingham, and McCully (see Figure 8).

Because not everyone pays the meter, there may be gaps in the IPS meter data. The citation fee for a parking violation in Honolulu is \$35, and some people may feel it is worth it to not pay the meter and risk the citation. To provide a fuller picture of the parking utilization on a typical week and weekend day and the hours of peak parking demand, City and County of Honolulu staff conducted parking occupancy counts at a sample of both paid and unpaid parking locations every two hours between 8:00 am and 8:00 pm.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 8: IPS Smart Meter Areas



Source: Walker Consultants, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

IPS Smart Meter Occupancy Data

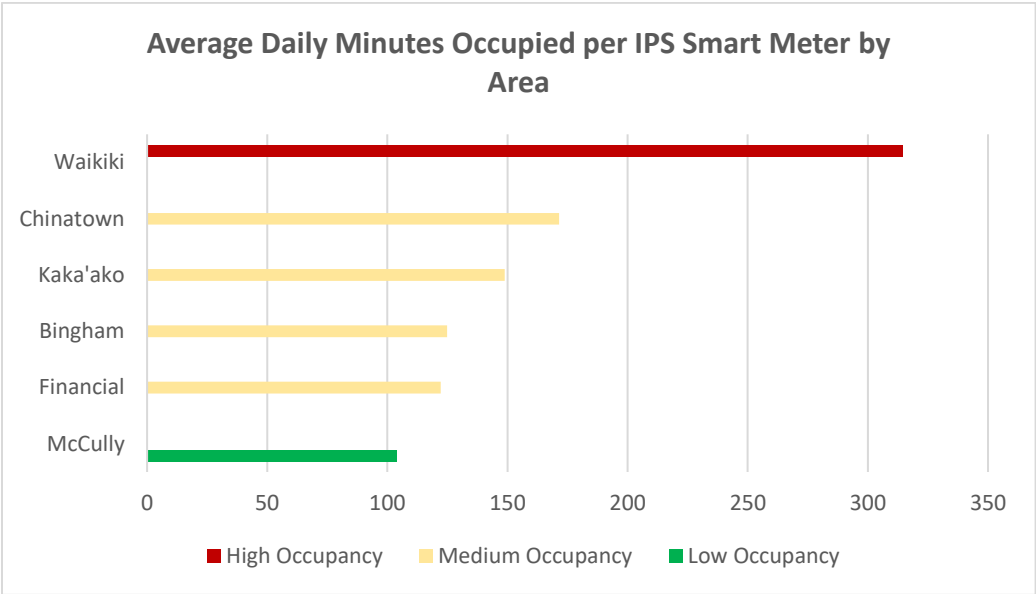
IPS provided a data set of all the Smart Meter transactions occurring between 1/1/22 and 8/29/22. Analyzing the revenue data by area—accounting for the hourly rates in each area—revealed that the meters in Waikiki and Chinatown had the highest average occupancies, despite the higher rates for on-street parking in these locations (see Figure 6 for average daily minutes occupied per meter by area and Figure 7 on page 10 for a map showing the average monthly revenue per meter).

The average paid occupancy minutes at the meter translate to lower utilization rates than those observed by in-person occupancy counts (as documented in the “City and County of Honolulu Staff Observations” section beginning on page 11). For example, based on the IPS meter data, the average Waikiki meter is paid for 314 minutes each day. This is just over five hours, which, based on the enforcement hours of 6:00 am to 10:00 pm, equates to just 33 percent, while the in-person occupancy counts show that in Waikiki, the average utilization of parking spaces is well above 60 percent in most areas, and over 85 percent in some areas.

One challenge is that throughout the paid parking areas, paid parking hours vary by street; some streets have regular afternoon hours in which parking is prohibited, paid only between 7:00 am and 6:00 pm, or not paid on Sundays. As noted, another challenge is that the IPS transaction data does not capture parking demand of people who may park without paying the meter. The IPS data may be too unwieldy and imprecise to use as a resource for accurately determining utilization rates, but the overall summary data can still serve as a helpful guide in determining which areas could most benefit from potential pricing updates.

Honolulu Emissions Reduction Plan—Parking Framework

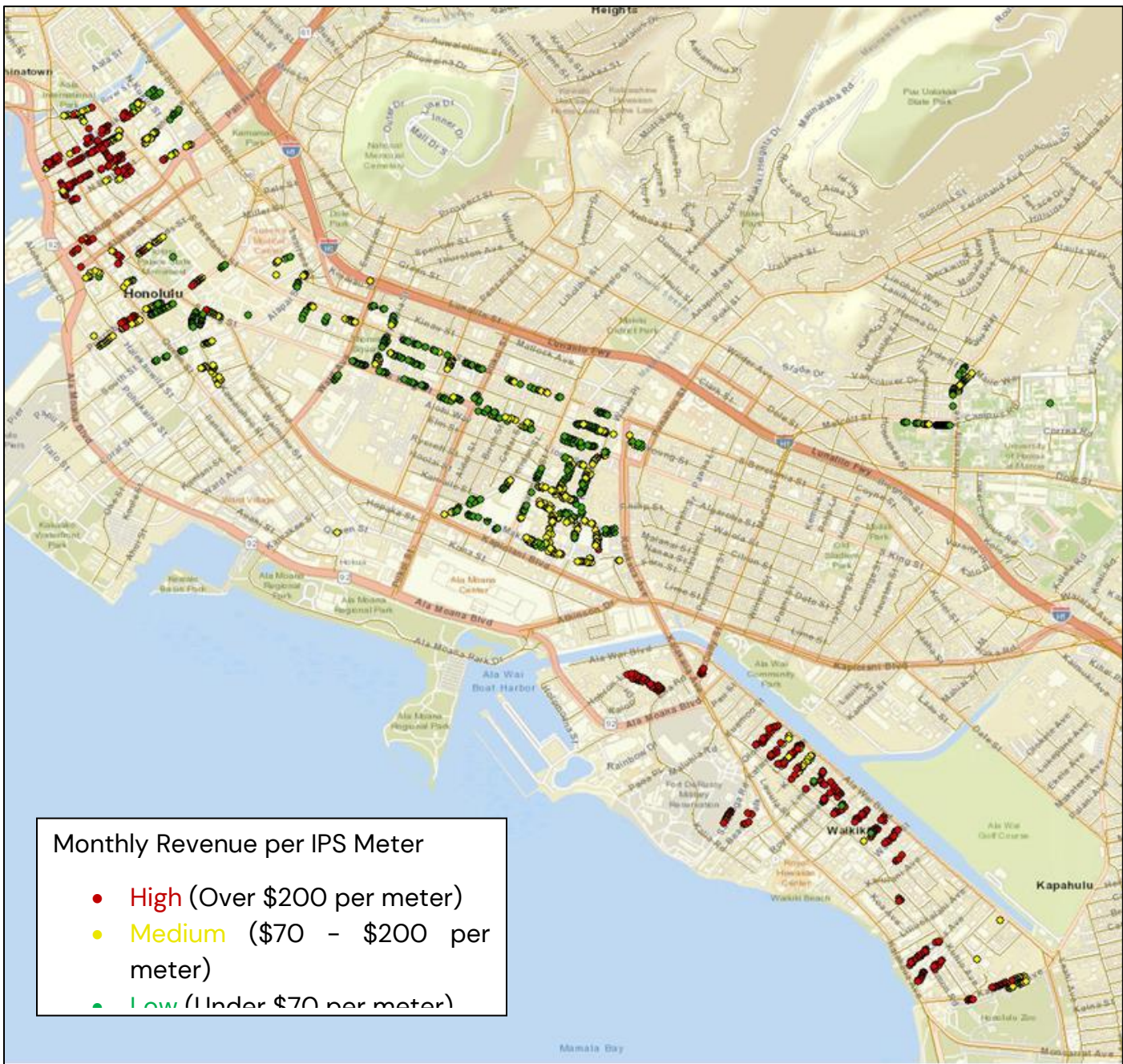
Figure 6: Average Daily Minutes Occupied per IPS Smart Meter by Area



Source: Walker Consultants, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 7: Average Monthly Revenue per IPS Smart Meter



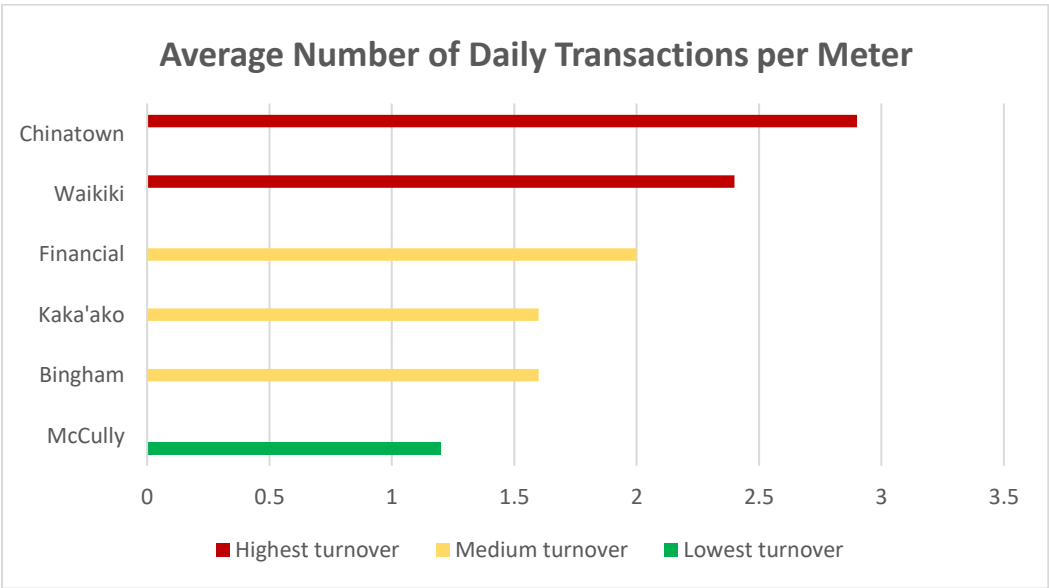
Source: Walker Consultants, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

IPS Smart Meter Transaction Count Data

The IPS data also allowed for analysis of the average number of transactions per meter by area (see Figure 8). This data roughly correlates with average minutes a parking space is occupied. Looking at average transaction counts in each area compared to the average minutes of paid occupancy reveals relatively shorter parking stays per transaction in Chinatown and the Financial district, and longer stays in Waikiki. Waikiki’s meters have a higher number of total minutes occupied relative to the average number of daily transactions, showing vehicles are parked for longer periods of time. In commercial areas, shorter stays are generally seen as desirable for business, representing higher turnover and greater numbers of customers who have access to the most convenient spaces.

Figure 8: Average Daily Minutes Occupied per IPS Smart Meter by Area



Source: Walker Consultants, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

City and County of Honolulu Staff Observations

Because the IPS data does not provide the entire picture of parking conditions, CCH Staff manually collected parking data on 77 sample blocks (on 35 streets) with on-street parking in the study area. Of these, 61 blocks charged for parking, and 16 did not. Staff also collected data at the Ala Wai Park parking lot in Waikiki, and at off-street public parking facilities in Kailua. CCH Staff members counted the inventories – the number of possible parking spaces in each location, as well as occupancies – the number of vehicles parked in each location. Occupancy counts were done every two hours between 8:00 am and 8:00 pm on a typical Wednesday (2/8/23) and a typical Saturday (2/4/23) in Kailua and on a typical Thursday (10/6/22) and a typical Saturday (10/22/22) in all other areas.

The data collection findings show that in Honolulu, many utilization rates on both the metered and unmetered streets exceeded the oft-cited best practice of an 85 percent occupancy threshold (see Table 1). On these streets, the lack of available parking likely generates needless vehicle travel as drivers are circling the surrounding area in their search for parking.

City staff observations found many areas with average utilization rates above 85% all day in some areas and during certain hours depending on location:

- Waikiki – 8pm weekday; 8pm weekend
- Chinatown – 6–8pm weekend
- Kanunu Street – 6–8pm weekday; 6–8pm weekend
- Makiki – 8pm weekday; 10am–12 pm and 6–8pm weekend
- Kalihi – 4pm–8pm weekday; 8am–8pm weekend
- Kailua – 10am weekday

During the 8:00 pm peak on Thursday, October 6th, utilization rates were above 85 percent on 21 of 29 observed block faces in Waikiki, 11 of 22 block faces in the Chinatown area, and 15 of 26 block faces in the Civic Center area (see Appendix B).

In the Makiki and Kalihi areas, where street parking is currently unmetered, all 17 observed block faces with street parking exceeded the recommended occupancy threshold. In these areas, 257 of 262 observed spaces were occupied on Thursday at

Honolulu Emissions Reduction Plan—Parking Framework

8:00 pm, a utilization rate of 98 percent. On the unmetered streets, occupancies were high not only during peak hours, but at almost all hours of the day, with approximately 89 percent of unmetered spaces occupied on average. Overall, the observed utilization rates suggest that drivers may be cruising for free or underpriced street parking in many areas of Honolulu, needlessly increasing greenhouse gas emissions.

In Kailua, occupancy observations were made on 17 metered blocks, 4 metered blocks, and in the municipal parking facilities. Overall, peak occupancy occurred at 10:00 am, with an overall occupancy rate of 86 percent on the weekday and 77 percent on the weekend. Individual blocks and facilities experienced occupancy rates above 85 percent at many points in time; of 448 unique location observations, utilization exceeded this threshold approximately 35 percent of the time. Unmetered block faces were especially likely to have occupancy rates above the threshold. Utilization at Kailua's 145-space municipal lot exceeded 85 percent between 10:00 am and 4:00 pm.

Honolulu Emissions Reduction Plan—Parking Framework

Table 1: Average and Peak Parking Utilization Rates in Sample Locations

Area	Location	Observed Inventory	Average Utilization (Weekday)	Average Utilization (Saturday)	Peak Utilization (Weekday)	Peak Utilization (Saturday)
Waikiki	Kapahulu Ave	91	32%	43%	57%	68%
	Lewers Street	6	81%	86%	83%	100%
	Launiu Street	27	60%	63%	96%	96%
	Kaiolu Street	24	61%	78%	96%	100%
	'Olohana Street	18	82%	73%	100%	94%
	Kalaimoku Street	19	73%	44%	100%	95%
	Saratoga Road	13	93%	95%	100%	100%
	Hobron Lane	35	87%	75%	97%	97%
	Ala Wai Park	96	39%	68%	16%	28%
	University Street*	83	87%	90%	100%	88%
Chinatown	Smith Street	36	74%	69%	78%	83%
	Nuuanu Ave	57	70%	73%	79%	98%
	N Pauahi Street	27	75%	76%	67%	93%
	Richards Street	12	43%	38%	33%	33%
Kanunu St	Kanunu St	47	65%	69%	94%	91%
Civic Center	Halekauwila Street	51	53%	55%	63%	86%
	Cooke Street	100	45%	49%	81%	63%
	Pohukaina Street	55	57%	63%	60%	78%
S King Street	S King Street	100	22%	33%	72%	64%
Makiki	Piikoi Street*	40	97%	91%	100%	78%
	Kinau Street*	120	69%	85%	99%	95%
Kalihi	Kali Street*	15	97%	94%	100%	93%
	Gulick Avenue*	23	79%	104%	100%	100%
	Mokauea Street*	31	76%	96%	94%	94%
	Kaumuali Street*	33	88%	88%	94%	97%
Kailua	Uluniu Street	52	83%	74%	98%	85%
	Maluniu Ave	19	65%	48%	74%	37%
	Aulike Street	19	61%	76%	84%	84%
	Kuulei Road* (partially metered)	44	45%	55%	77%	66%
	Kihapai Street	22	73%	71%	82%	95%
	Kainehe Street	18	80%	62%	94%	100%
	Hoolai Street	19	72%	67%	84%	95%
	Puniu Street	11	76%	88%	100%	91%
	Kailua Elderly Lot	145	52%	39%	66%	60%
	Kailua Open Air Lot	145	75%	57%	99%	80%
	Hekili Street*	47	76%	66%	100%	83%
	Hamakua Drive*	38	93%	79%	97%	100%
	Kailua Road*	11	68%	53%	82%	100%
*Denotes unmetered street						

Source: Observations collected by City and County of Honolulu staff, analysis by Walker Consultants, 2022.

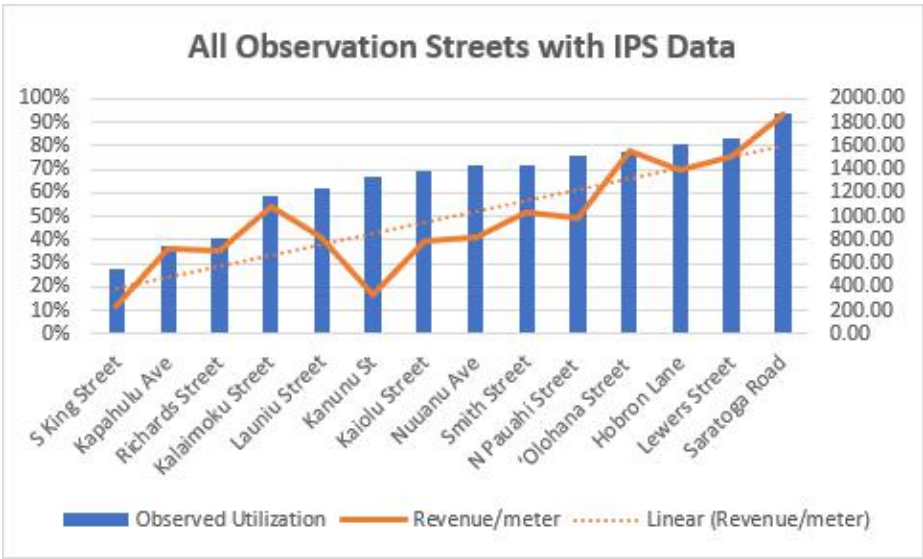
Honolulu Emissions Reduction Plan—Parking Framework

Comparing IPS Data with Field Observations

In total, 14 streets have both IPS Smart Meter transaction data and CCH staff observation data. There is a rough correlation between the amount of revenue generated per meter on each street and the occupancies observed by CCH staff (see Figure 9). Both the lowest observed utilization rates and the lowest revenue per meter were on South King Street, and both the highest observed utilization rates and the highest revenue per meter were on Saratoga Road. Based on the available data, on average, \$15 in daily IPS meter revenue equates to 1 percentage point of average observed occupancy.

Observations of high utilization on streets with low revenue per meter, such as on Kanunu Street and Kaiolu Street, may indicate some areas could benefit from stronger parking enforcement. In general, the rough correlation between IPS data and field observations confirms that IPS data is a useful starting point but should not be the sole source of occupancy data informing potential pricing decisions.

Figure 9: Streets with both IPS and Field Observation Data



Source: Walker Consultants, 2022.

Travel Demand Forecasting Model

Model Development

Transportation Demand Management (TDM) strategies can reduce the need to drive and park, and related emissions. Numerous TDM strategies were evaluated based on their feasibility and strategic fit and impact for the City and County of Honolulu and presented before the City Council on August 23, 2022. TDM strategies related to parking management programs and policies were found to have high scores for both feasibility and strategic fit and impact. A baseline OahuMPO Regional Travel Demand Forecasting Model was developed, which included inputs for:

- Parking inventory (on-street and off-street facilities)
- Parking price sensitivity
- Parking rates by District by parking type (public and private) for Low, Mid, High pricing scenarios
 - Base scenario: existing fees for CCH-owned facilities (lower fees than the “Low” scenario)
 - Low scenario: fees are lower than the average market rates
 - Mid scenario: fees approximately align with market rates
 - High scenario: fees above the average market rates, but no higher than the highest existing

For example, in Ward-Chinatown, the existing rate is \$1.50 for one hour of parking in an off-street CCH facility. However, the average private market rate was much higher, at approximately \$7.00. The existing 8-hour public parking rate is \$21.00, while the average private market rate is \$33.00. For monthly parking, the existing public rate averages about \$125.00 across facilities, compared to an average private market monthly rate of \$309.00.

The model then ran a scenario for increasing all of the CCH parking rates citywide to the market prices to find impact on vehicle miles traveled and walking, biking, transit, and driving. For example, for hourly public parking in Ward-Chinatown, the “High”

Honolulu Emissions Reduction Plan—Parking Framework

scenario used a rate of \$7.50, the “Mid” scenario used a rate of \$6.00, and the “Low” scenario used a rate of \$3.00 (see Figure 10). Similar inputs were developed for each pricing scenario for daily and monthly rates for all off-street parking facilities and for street parking. The next section shows the resulting projections for vehicle-miles traveled, trips, and annual gross revenue.

VMT, Trip, and Revenue Projections

The model forecasted VMT and trip projections as well as revenue projections. The VMT projections accounted for street types from local streets to freeways and showed the following relative to the base scenario:

- Low scenario: No significant change in total VMT
- Mid scenario: A 0.2 percent total decrease in VMT
- High scenario: A 0.5 percent decrease in VMT

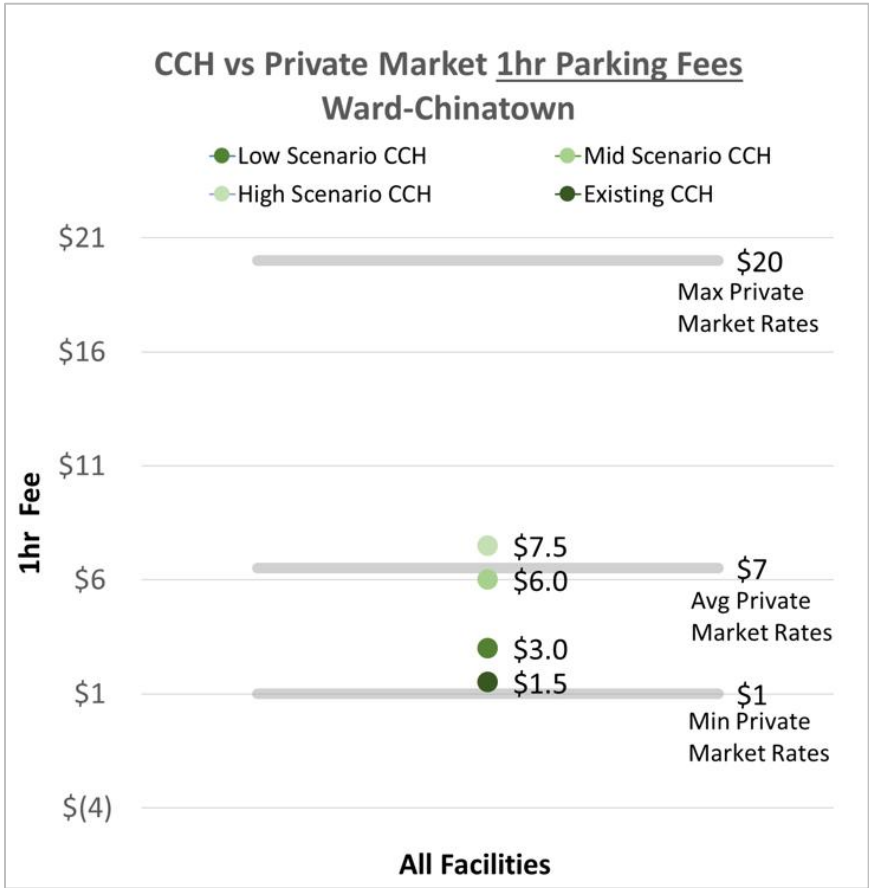
The trip type projections showed auto trips to decrease in all scenarios and transit, walking, and biking to increase in all scenarios. The Mid scenario increased transit by 1.3 percent and walking/biking by 1.2 percent, and the High scenario increased transit by 5.3 percent and walking/biking by 4.3 percent. Figure 11 displays the projected change in auto, transit, and walking/biking trips by district for each of the three pricing scenarios.

The annual gross revenue projections under each pricing scenario were as followed:

- Base scenario: \$15,577,000
- Low scenario: \$16,797,000 (+\$1,220,000 from base)
- Mid scenario: \$23,371,000 (+\$7,794,000 from base)
- High scenario: \$25,122,000 (+\$9,545,000 from base)

Honolulu Emissions Reduction Plan—Parking Framework

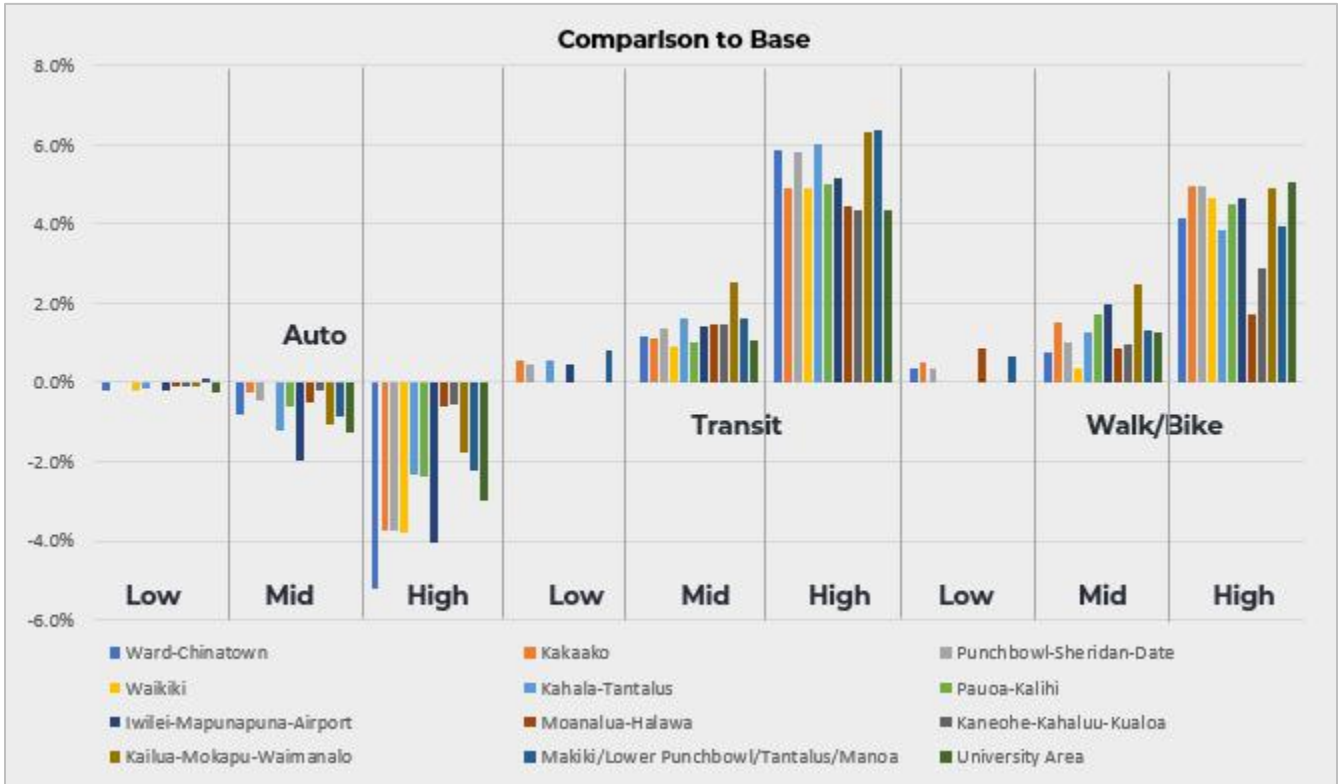
Figure 10: Sample of Travel Demand Forecasting Model Inputs



Source: Parking and TDM DTS Workshop Presentation, HNL Connect and Honolulu Complete Streets, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 11: Travel Demand Forecasting Model Trip Projections by Scenario and District



Source: Parking and TDM DTS Workshop Presentation, HNL Connect and Honolulu Complete Streets, 2022.

Existing Plans, Policies, and Transportation Resources

Honolulu has demonstrated commitment to reducing GHG emissions throughout its recent land use and transportation planning efforts, including the Oahu General Plan, the 2020–2025 Climate Action Plan, Transit-Oriented Development Plans, the 2022 Oahu Pedestrian Plan, the 2019 Oahu Bike Plan Update.

Furthermore, several existing policies in Honolulu showcase the City and County’s thoughtful approach and understanding of relationships between parking policy and sustainability, economic efficiency, and social equity. Urban Honolulu already offers alternatives to driving and parking and is dedicated to continually improving the transportation system to offer more attractive multimodal options and achieve ambitious mode share goals.

Existing Plans

Oahu General Plan (2021)

The General Plan sets forth an overarching goal of balancing and synthesizing the three elements of sustainability:

- Environmental protection
- Economic health
- Social equity

The plan highlights the importance of planning for population growth and establishes a targeted 43 percent of Oahu’s 2040 population residing in the Primary Urban Center, with the goal of more efficient use of land and infrastructure woven throughout multiple policies. The plan also seeks to encourage the viability of businesses and foster a healthy business climate. The first objective of the Transportation and Utilities section is, “To create a multi-modal transportation system that moves people and goods safely, efficiently, and at a reasonable cost and

Honolulu Emissions Reduction Plan—Parking Framework

minimizes fossil fuel consumption and greenhouse gas emissions; serves all users, including limited income, elderly, and disabled populations; and is integrated with existing and planned development.” Especially relevant policies under this objective include:

- Develop a comprehensive, well-connected, and integrated ground transportation system that reduces carbon emissions and enables safe, comfortable and convenient travel for all users, including motorists, pedestrians, bicyclists, and public transportation users of all ages and abilities.
- Support the development of transportation plans, programs, and facilities that are based on Complete Streets features. Maintain and improve road, bicycle, pedestrian, and micromobility facilities in existing communities to eliminate unsafe conditions.
- Make transportation services safe and accessible to people with limited physical mobility: the young, elderly, disabled, and those with limited incomes.
- Consider environmental, social, cultural, and climate change and natural hazard impacts, as well as construction and operating costs, as important factors in planning transportation system improvements.
- Reduce traffic congestion and maximize the efficient use of transportation resources by pursuing transportation demand management strategies such as carpooling, telecommuting, flexible work schedules, and incentives to use alternative travel modes.
- Enhance pedestrian-friendly and bicycle-friendly travel via public and private programs and improvements.

Additionally, the plan prioritizes health and well-being. The following policies from the Health and Education and Culture and Recreation sections highlight the importance of land use planning in reaching these goals:

- Integrate public health concerns such as air and water pollution as a consideration in land use planning decisions.
- Encourage healthy lifestyles through walkable and livable communities, safe street crossings, safe routes to schools, and parks and pathways for pedestrians and bicyclists.

Honolulu Emissions Reduction Plan—Parking Framework

- Develop, maintain, and improve urban parks, squares, and beautification areas in high-density urban places.

The final section of the General Plan sets forth goals for government operations and fiscal management that prioritize efficiency, effectiveness, and equity.

2020–2025 Climate Action Plan

The Climate Action Plan focuses on what the City can immediately affect. Three of the plan’s nine major strategies are tied to land use and transportation, with the third strategy specifically dedicated to encouraging mode shift through parking efficiency (see Figure 12). Feedback from the community gathered in the preparation of the plan revealed that over 80 percent of residents see climate change and its impacts as serious problems, and over 75 percent of voters expressed willingness to undertake personal action to address climate change, like using public transit for transportation.

Figure 12: Major Strategies of the 2020–2025 Climate Action Plan



Source: 2020–2025 Climate Action Plan, page 9.

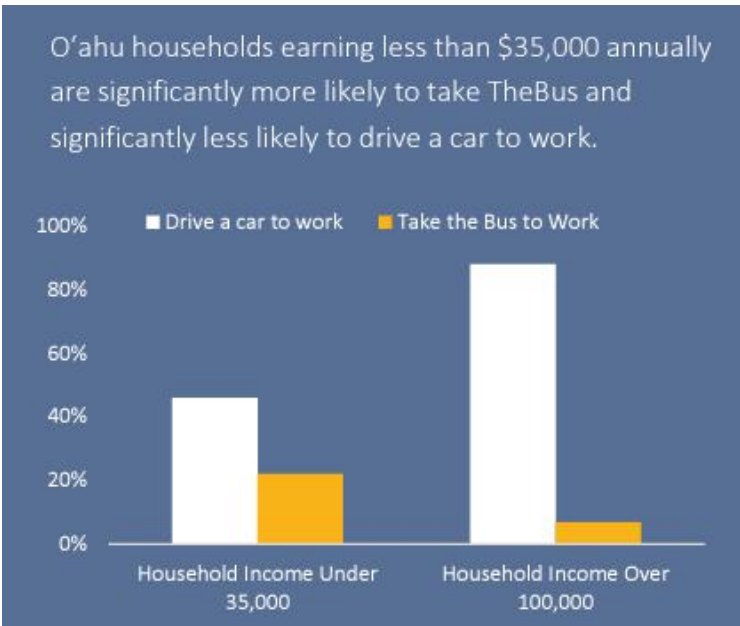
In addition to setting broad strategies and goals, the Climate Action Plan provided relevant background information. According to the plan, ground transportation currently accounts for approximately one-fifth of total island-wide emissions, about 90 percent of which comes from passenger vehicles. The plan stated that in 2018, there were 1.1 registered passenger cars and trucks per eligible driver on the island, that about 10 percent of Oahu’s households have no car, another 34 percent have only one car, and the remainder own two or more vehicles. Low-income households

Honolulu Emissions Reduction Plan—Parking Framework

are less likely than high-income households to own vehicles, and low-income households also tend to drive less. For example, Figure 13 shows how residents with incomes below \$35,000 were significantly more likely to take the bus and less likely to drive to work than those with higher incomes.

The community voiced the importance of equity in climate action, and potential solutions included improving transit access and service, such as through creating more Bus Rapid Transit (BRT) lanes. Other ideas to promote equity involved making walking and biking safer and more accessible, as concerns about traffic safety were revealed to prevent 32 percent of respondents from walking and 47 percent from biking to their destinations.

Figure 13: Mode Share to Work by Income Level



Source: 2020–2025 Climate Action Plan, page 37.

Honolulu Emissions Reduction Plan—Parking Framework

Transit-Oriented Development (TOD) Plans

In line with the broad goals of promoting environmental sustainability and social equity, Honolulu also has multiple plans designed to encourage density, mixed land use, and sustainable multimodal travel choices. These plans include the Aiea-Pearl City Neighborhood TOD Plan, the Airport Area TOD Plan, the Ala Moana Neighborhood TOD Plan, the Downtown Neighborhood TOD Plan, the East Kapolei Neighborhood TOD Plan, the Halawa Area TOD Plan, the Kalihi Neighborhood TOD Plan, and the Waipahu Neighborhood TOD Plan. Figure 14 shows the rail station areas included in each plan.

Figure 14: TOD Neighborhoods in Honolulu



Source: City and County of Honolulu, 2022.

Each plan includes circulation policies. The Ala Moana Neighborhood TOD Plan—a typical example—seeks to reduce auto dependency, manage parking facilities, promote transit usage, introduce bike friendly streets, make Ala Moana walkable, reduce conflicts between modes, and enhance Mauka-Makai links. Other policies seek to promote mixed use development, streetscape enhancement, open space, and appealing urban design. Specific strategies include phasing in maximum automobile parking requirements, requiring bicycle parking, unbundling parking from residential and commercial uses, providing for carshare and bikeshare facilities,

Honolulu Emissions Reduction Plan—Parking Framework

pricing parking based on demand, pricing parking to ensure adequate turnover in commercial areas, and considering establishing a parking district to manage parking operations and revenue.

2022 Oahu Pedestrian Plan

The City and County of Honolulu is committed to creating vibrant, safe, and accessible streets that make walking an attractive transportation option for all travelers. The pedestrian plan was informed by fatality and injury data analysis as well as by community outreach and identifies network needs, strategies, and actions. The plan documents the mileage of existing walkways, missing walkways, proposed walkways, and the proposed cost (see Figure 15). It prioritizes projects in areas of high need and with greatest potential to increase walking mode share. It also mentions that the plan’s walkability initiatives could be supported by a TDM program, transit improvement, police department involvement, the expansion of pedestrian rights in the traffic code, a new mobility program, and a curbside management program.

Figure 15: City and County of Honolulu Walkway Network

City and County of Honolulu Walkway Network	
EXISTING WALKWAYS	1,476 miles
MISSING WALKWAYS	901 miles
PROPOSED WALKWAYS	145 miles
PROPOSED COST	\$539 million

Source: Oahu Pedestrian Plan, 2022.

The Oahu Pedestrian Plan sets forth the goals of creating a transportation environment for Oahu that is safe and healthy, sustainable, responsive, and equitable. Commute mode share is one of several performance measures used to track progress toward walkability goals, with an island-wide 2031 target of 6.5 percent walk share and 10 percent transit share (see Figure 16).

Honolulu Emissions Reduction Plan—Parking Framework

Figure 16: Walk and Transit to Work Mode Shares



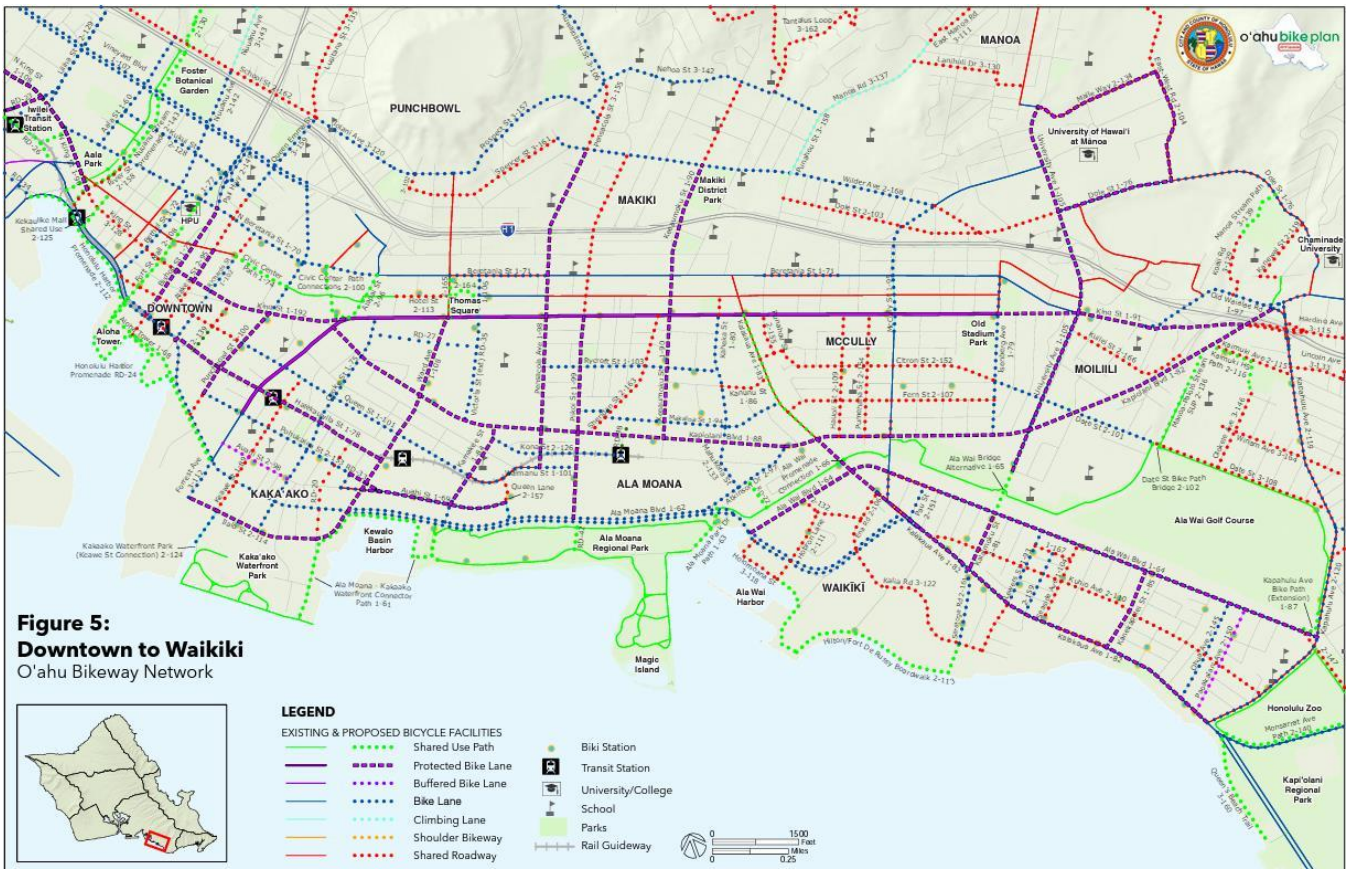
Source: Oahu Pedestrian Plan, 2022.

2019 Oahu Bike Plan Update

The City and County of Honolulu is also committed to helping Oahu develop as a bicycle-friendly community where bicycling is a safe, viable, and popular travel choice for residents and visitors of all ages and abilities. The League of American Bicyclists has awarded Honolulu the status of a bronze-level Bicycle-Friendly Community, and Honolulu continues to invest in creating lower-stress bikeways and improving conditions for bicyclists throughout the island. Figure 17 shows existing and proposed bikeways in the Downtown to Waikiki area. The goal of increasing bicycle mode share increases community health and wellbeing, advances social equity, and supports environmental goals. This increased mode share can result from making biking safer and more convenient, as well as from making driving and parking relatively less attractive.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 17: Existing and Proposed Bikeways -- Downtown to Waikiki



Source: Oahu Bike Update, 2019.

Honolulu Emissions Reduction Plan—Parking Framework

Transportation Demand Management (TDM) Plan

Honolulu is also developing a Transportation Demand Management (TDM) Plan, scheduled for March 2023. The TDM Plan will promote multimodal transportation align with the goals outlined in the General Plan, the Climate Action Plan, the TOD plans, the Pedestrian Plan, and the Bike Plan update. In particular, the plan focuses on environment, equity, land use and development, and long-term resilience (see Figure 18).

Figure 18: TDM Plan Goals



Source: City and County of Honolulu, 2022.

Honolulu Emissions Reduction Plan—Parking Framework

Existing Policies

The plans highlighted in the previous section work toward the General Plan’s goal of promoting the three elements of sustainability: environmental protection, economic health, and social equity. Several recent policies exemplify Honolulu’s commitment to these goals and acknowledge the important role of well-aligned parking management and land use practices.

Demand-based Rates for Attendant Parking Facilities (Ordinance 04-40)

Honolulu implemented demand-based parking rates as early as 2004 with the passage of Ordinance 04-40. Section 15-23.2A (Attendant parking facilities) of the municipal code establishes demand-based rate adjustments for attendant-operated public parking facilities.

The traffic code directs the director of transportation services to determine the occupancy rate of each facility on a semiannual basis, increasing rates when occupancy exceeds 90 percent, and decreasing rates if the occupancy rate decreases by over 20 percent from the previous period.

This policy balances environmental protection, economic health, and social equity. It ensures that parking resources are priced low enough to maintain a high level of access, but high enough to protect the environment and local air quality by preventing superfluous vehicle travel. This efficient pricing strategy also promotes long-term economic health by generating revenue for the City. Because off-street facilities have more parking spaces than individual street segments, an occupancy threshold of 90 percent is still sufficient to achieve the goal of ensuring some spaces remain available and drivers can find a space without circling.

Off-Street Parking and Loading Ordinance (Ordinance 20-41)

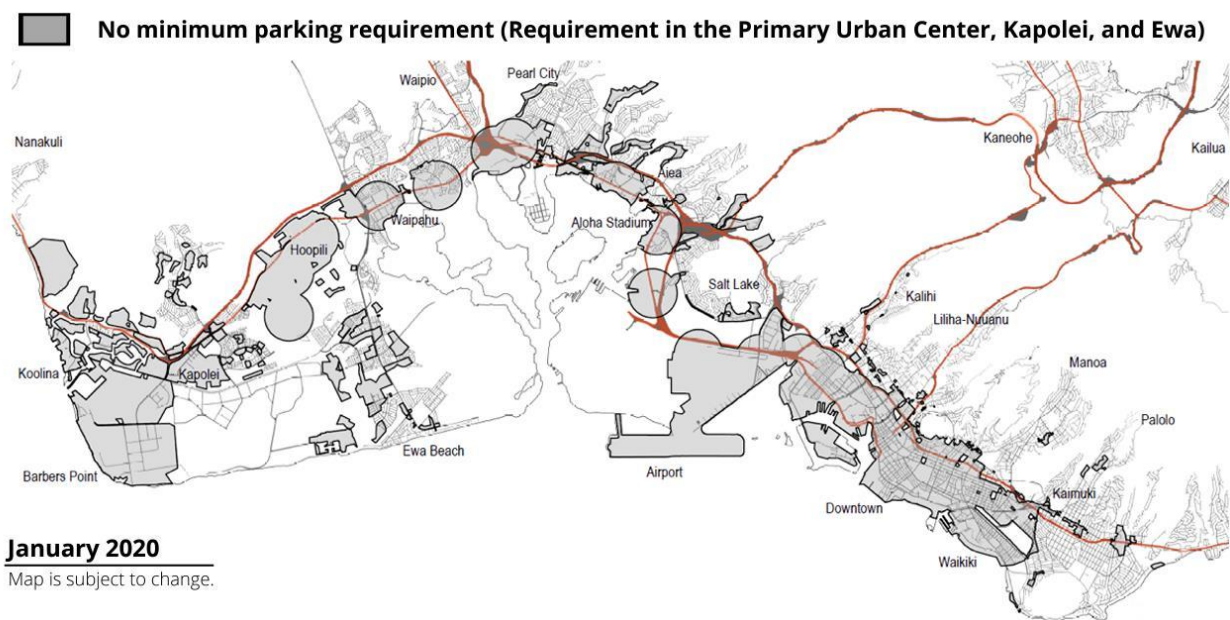
In 2020, the Honolulu City Council adopted Ordinance 20-41, which eliminates minimum parking requirements for new developments in Honolulu’s Primary Urban Center and in the TOD areas within a half-mile of a rail station (see Figure 19). The ordinance also newly allows joint-use developments outside of these areas to share

Honolulu Emissions Reduction Plan—Parking Framework

parking without obtaining a land-use permit and allows required parking and loading spaces to be provided off-site.

Ordinance 20-41 demonstrates Honolulu’s commitment to reducing automobile dependency and accommodating clean and healthy transportation options, such as walking, bicycling, and taking transit. In areas where minimum parking requirements still exist, the ordinance creates incentives for reducing parking demand through sustainable transportation. For example, one car share space reduces the number of required automobile spaces by three, four bike additional bike parking or bike share spaces reduce the number of required automobile spaces by one, and unbundling at least 50 percent of parking spaces exempts a development from minimum parking requirements completely.

Figure 19: Areas of Honolulu without Minimum Parking Requirements



Source: City and County of Honolulu, Parking Reform for a Resilient Oahu, 2021.

Honolulu Emissions Reduction Plan—Parking Framework

Honolulu Complete Streets Ordinance (Ordinance 12-15)

In 2012, the Honolulu City Council adopted a Complete Streets Ordinance. Section 14-18 of the municipal code requires that a multi-modal approach be considered in all planning documents and that new projects implement complete streets principles, which consist of the following:

- Improve safety
- Apply a context sensitive solution process that integrates community context and the surrounding environment, including land use
- Protect and promote accessibility and mobility for all
- Balance the needs and comfort of all modes and users
- Encourage consistent use of national industry best practice guidelines to select complete streets design elements
- Improve energy efficiency in travel and mitigate vehicle emissions by providing nonmotorized transportation options
- Encourage opportunities for physical activity and recognize the health benefits of an active lifestyle
- Recognize complete streets as a long-term investment that can save money over time
- Build partnerships with stakeholders and organizations statewide
- Incorporate trees and landscaping as integral components of complete streets

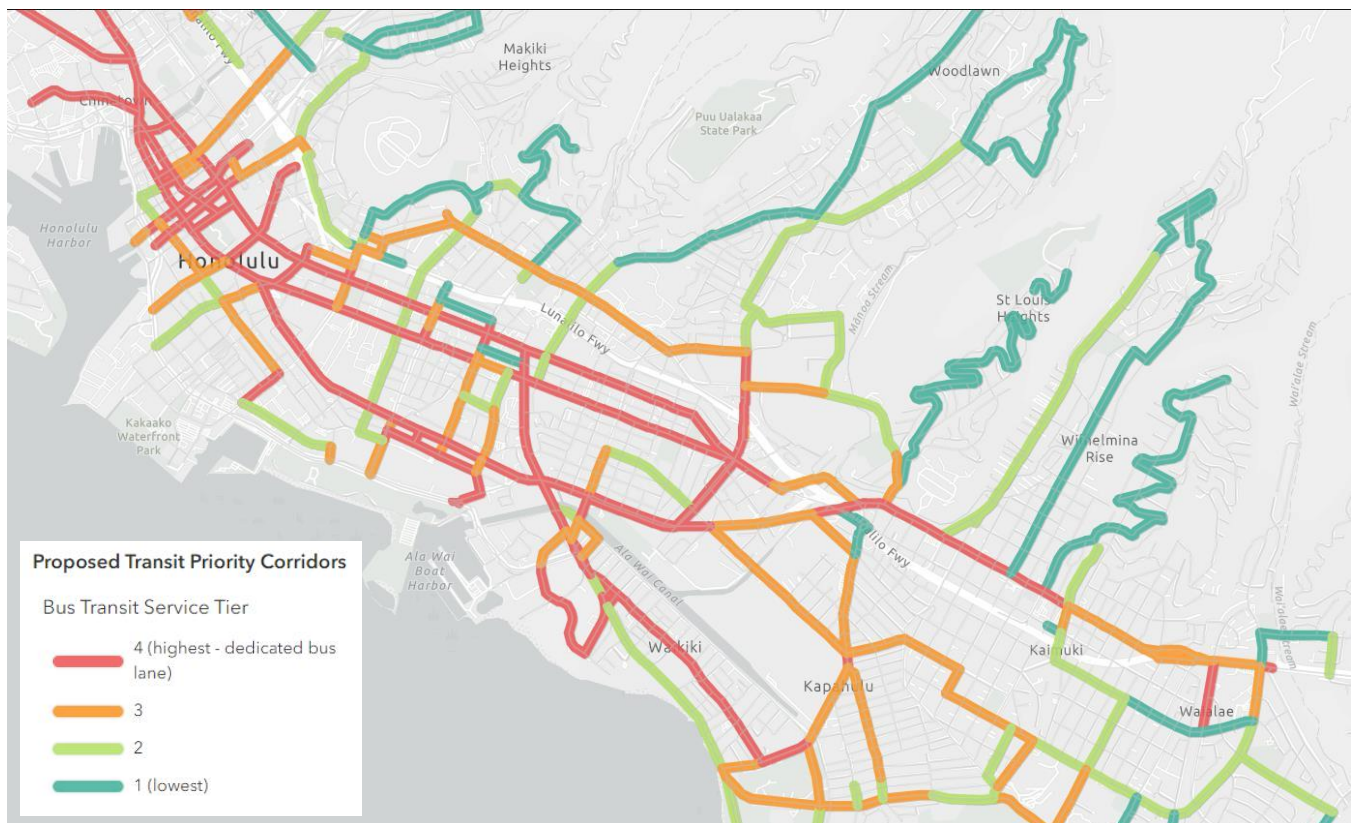
The Complete Streets Ordinance reflects an understanding of street space as a valuable public resource for the community, which can be managed in a way that promotes the Honolulu’s sustainability goals.

Honolulu Emissions Reduction Plan—Parking Framework

Existing Multimodal Transportation Options

Honolulu is served by local public transit (TheBus and TheHandi-Van) and a 20-mile, 21-station commuter rail system (HART). People can use the HOLO card to pay for transit, and low-income households are eligible for a reduced rate. There are plans to further improve public transit by providing additional transit priority corridors throughout the primary urban center, including creating dedicated bus lanes (see Figure 20).

Figure 20: Proposed Transit Priority Corridors in Urban Honolulu

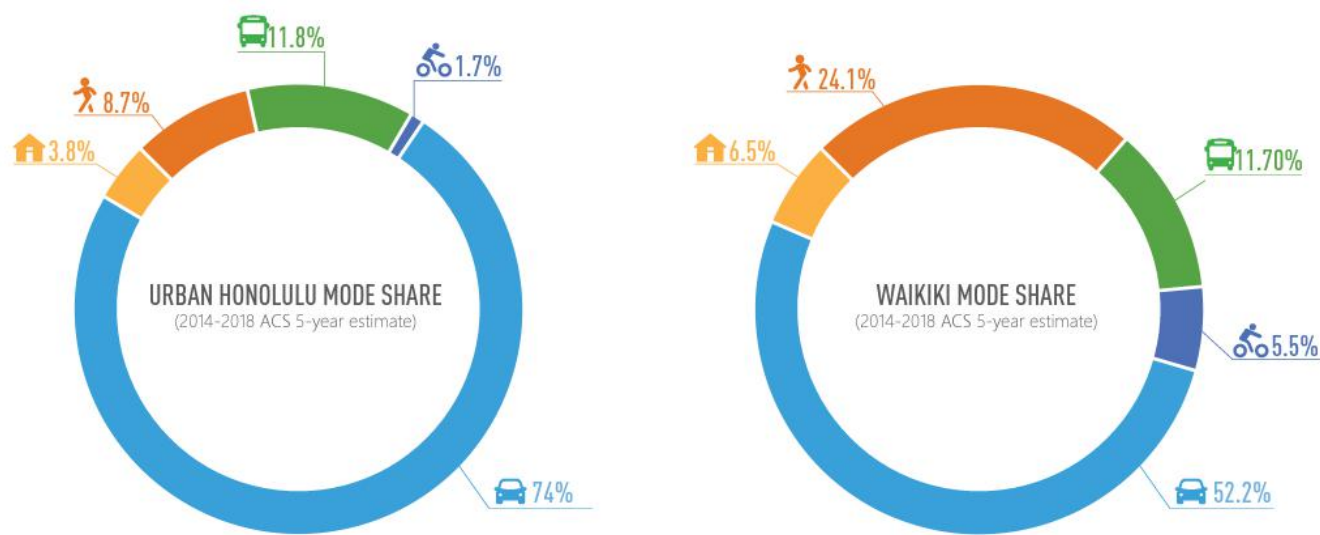


The City of Honolulu has also helped launch an affordable bikeshare system called Biki, which has bike share stations in the public right-of-way throughout the downtown area. According to the 2019 Oahu Bike Update, Biki has experienced sustained ridership growth since its launch in 2017 and is already among the most popular bikeshare systems in the nation.

Honolulu Emissions Reduction Plan—Parking Framework

The ability to get around urban Honolulu by means other than a private vehicle is reflected by the area’s commute mode splits, which, when compared to national averages, show that a relatively high share of people travel by walking, biking, and transit (see Figure 21). These numbers represent an urban transportation system that is already relatively accommodating to sustainable transportation but also still has significant room for progress.

Figure 21: Commute Mode Shares in Urban Honolulu and Waikiki



Source: Oahu Pedestrian Plan, 2022.

CCH Goals and Guiding Principles

The City and County of Honolulu has done extensive public outreach to inform the development of the planning documents highlighted above, including the General Plan, the Climate Action Plan, the TOD plans, the Pedestrian Plan, the Bike Plan Update, and the TDM Plan. These plans set forth a consistent vision for Honolulu, and their broad goals can be used to develop guiding principles with which to evaluate potential parking pricing models.

The following guiding principles for parking management are based on well-established CCH goals. Honolulu's parking management framework should be designed to promote the three elements of a sustainable place:

1) Environmental protection

- Reduce GHG emissions from cruising for parking by ensuring at least some spaces are available
- Reduce GHG emissions from SOV travel by shifting mode share toward more sustainable modes
- Consider the program's ability to enhance sustainable multimodal transportation options

2) Economic health

- Consider the needs of local businesses
- Consider the impact on CCH resources, including technology and administrative costs, and the long-term ability of the program to support itself financially

3) Social equity

- Consider access needs for travelers with limited physical mobility and limited financial resources
- Consider the user experience for all potential users of the system
- Consider the program's ability to generate revenue to enhance affordable transportation options

Pricing Models and Technology Review

The first section of this report developed a general framework of how parking and parking management affect greenhouse gas emissions and highlighted ways of reducing two possible sources of emissions: cruising and SOV trips. The existing conditions section revealed high parking demand and high utilization rates throughout the study area, confirming that Honolulu could use parking management to reduce GHG emissions from both of these sources.

This section explores options for managing public parking and reducing GHG emissions through pricing. It presents a holistic review of the costs and benefits of each strategy from multiple perspectives, including how each strategy would be expected to impact City and County administration resources, local businesses, community access, and social equity. It also considers how some strategies may be more flexible and adaptable than others or require greater investments in technology and monitoring. The models analyzed include:

- Demand-based pricing
- Tier-based pricing
- Blanket price increases
- Cordon pricing

1. Demand-based Pricing

Demand-based pricing is a strategy meant to use parking resources as efficiently as possible. It involves raising or lowering prices by location, such as by targeting 85 percent occupancy on every block face for on-street parking and 90 percent occupancy for larger parking lots and structures. Demand-based pricing can account for demand by location and by time of day—with higher fees for popular areas and during peak hours.

Honolulu Emissions Reduction Plan—Parking Framework

Factors to Consider

- **Cruising GHG impact:** One key strength of demand-based pricing is its potential to substantially reduce Vehicle Miles Traveled (VMT) generated by drivers “cruising” for available parking. When rates are set to create at least one or two open spaces per block face or several open spaces per off-street facility during peak hours, drivers will be able to find a parking space near their destination almost immediately.
- **SOV trip GHG impact:** If parking demand is high enough that prices generally increase with demand-based pricing, the price increases can make solo vehicle travel less attractive. People may be more likely to carpool to split the fee, or take transit, bike, or walk to their destination. Prompting a shift to more sustainable travel modes will decrease GHG emissions. On the other hand, if any areas charging for on-street parking are observed to have such low demand that prices decrease, this could also increase the attractiveness of SOV travel and increase emissions. Furthermore, if perceptions of parking scarcity currently stop some people from making SOV trips, once they expect convenient parking to be available near their destination, they may be more likely to drive and park.
- **Access impact:** Demand-based pricing is meant to maximize access, ensuring that parking resources are used as efficiently as possible. By design, parking will be highly utilized, meaning many people will be able to drive and park. High prices will help discourage long-term parking in areas of high demand, and those spaces will turn over all day, freeing them up for customers. When people anticipate finding convenient parking wherever they want to go, this can increase access as well, as drivers may be more likely to take trips to popular areas even when they have limited time available to search for parking or walk a long way to their destination. Because demand-based pricing lowers prices in areas where demand is low, this can increase access for travelers with limited financial resources to pay for parking.
- **Equity impact:** Demand-based pricing helps keep spaces open on each block face, and those with limited physical mobility may be especially likely to appreciate the option to park close to their destinations. Demand based

Honolulu Emissions Reduction Plan—Parking Framework

pricing also lowers the cost of pricing in areas with less demand. People with limited financial resources or who do not want to pay higher parking rates in prime areas will need to park on the periphery and walk to their destination, unless discounted parking rates are available to income-eligible drivers. It is also possible to use any additional revenue generated from demand-based parking to fund multimodal mobility improvements. Because lower-income individuals are less likely to drive alone and more likely to use other modes, demand-based pricing can result in a net benefit for low-income communities overall.

- **Impact on local businesses:** Demand-based pricing supports local businesses. The high occupancy goal ensures parking spaces turnover, and that more people can access each area. The fact that open parking spaces will be available on each block means that potential customers who are in a hurry will not be dissuaded from patronizing shops, restaurants, or professional services businesses due to lack of parking. Those who are most willing to pay for parking may also be the most likely to spend money at these local establishments.
- **User-friendliness:** The user-friendliness of this approach depends partly on how clearly the possible parking options are conveyed to users. Ideally, drivers would know the cost of parking on any given street before pulling up to the space. The more frequently prices change—either from hour to hour, month to month, or street to street—the more complicated it becomes for drivers to understand their options, even as these frequent changes increase the efficiency of the system. Pricing by zone rather than by individual street and setting rates based on peak hour demand and maintaining the same hourly rate throughout the day could simplify the user experience. As technology advances, a demand-based pricing program could benefit from using underground space sensors, cameras, or in dashboard systems to display available parking spaces and their hourly rates on a cell phone app. For now, many cities with demand-based pricing simply provide a map on the city website with streets and public lots color-coded based on their hourly rates.
- **Adaptability:** Curb space is no longer limited to just parking, and many cities are dedicating space for micro-mobility, parklets, commercial deliveries and

Honolulu Emissions Reduction Plan—Parking Framework

passenger drop-off areas. Demand-based pricing can help cities transition right-of-way space toward these emerging curb uses, as the program is designed around an occupancy percentage goal that is more about efficiency than about incentivizing one any one use over another. These alternative uses of the curb space could simply be charged market rate fees based on parking demand, or they may be offered lower rates in an effort to support other city goals. Regardless of whether additional programs developed for alternative uses, demand-based pricing for available parking can work efficiently as one component of a larger curb management framework.

- **Impact on CCH resources:** The resources required to implement demand-based prices depends on how often and for what size areas the parking rate adjustments are made.
 - **Technology costs:** If there is high demand in unmetered areas, demand-based pricing would require investment in additional smart parking meters. Basic technology would be required to virtually display parking rates that are regularly updated. It is possible to monitor and collect parking occupancy data with underground sensors; however, this technology is not necessarily required to implement demand-based pricing, and given the limited lifecycle of sensor technology, many cities prefer to have staff members conduct periodic occupancy counts or use meter transaction data. The City and County of Honolulu already has experience using occupancy data for rate adjustments in off-street facilities with attendants.
 - **Administration time required:** The paid parking area would likely need to expand if there is high demand in unmetered areas, which might require dedicating additional resources to enforcement.

To adjust rates, If CCH did not initially invest in vehicle sensor technology, staff time would be required, either to analyze IPS meter transaction data or to conduct occupancy counts. Counts and rate adjustments might be done on a quarterly, semiannual, or annual basis. The amount of time required for rate adjustments would depend on the level of analysis conducted—whether adjustments were made by individual block face or by a larger area, and

Honolulu Emissions Reduction Plan—Parking Framework

whether parking rates were set to manage peak demand hours or to offer different rates for different hours of the day.

Alignment with CCH Guiding Principles and Goals

- **Environmental protection:** A major strength of demand-based pricing is its ability to reduce superfluous vehicle travel generated by drivers circling to find parking. If parking demand causes prices to increase in busy areas, some people will park further away and walk to their destinations, and others traveling to those areas may find it more convenient and cost-effective to carpool, take transit, walk, or bike instead of driving, further reducing vehicle travel and emissions. However, if demand-based pricing ever results in lower prices for some areas, this could also make driving more attractive and increase vehicle travel.

In the short-term, demand-based pricing could be expected to benefit the environment by greatly reducing emissions from cruising for parking and slightly reducing single occupancy vehicle (SOV) mode share. In the long-term, demand-based pricing is a management strategy that complements other goals—allowing the transportation system to continue working smoothly even if Honolulu chooses to reduce its parking footprint and repurpose land for other uses.

- **Economic health:** The strategy's ability to continually maintain availability also benefits local business owners, as parking space turnover will ensure that more customers have access to each space per day. Also, because one or two spaces should be available on each block, parking is more convenient for potential customers who choose to drive and pay for parking. Another strength of demand-based pricing is its ability to generate revenue by targeting high occupancies. When parking demand is as high as has been observed in Honolulu, curb space becomes a valuable financial asset for the public.

Honolulu Emissions Reduction Plan—Parking Framework

In the long-term, demand-based pricing may not only cover the cost of additional meters, administration, and enforcement, but also generate additional revenue, which the City could use for streetscape or access improvements to further enhance the appeal and economic vitality of the area.

- **Social equity:** Demand-based pricing helps keep spaces open on each block face, and those with limited physical mobility may be especially likely to appreciate the option to park close to their destinations. Demand-based pricing does not prohibit CCH from providing transportation subsidies, but it will remove any existing “subsidies” of artificially low parking prices currently available to all drivers and could open opportunities for targeted subsidies that better support individuals with financial need or align with environmental goals. Boulder’s EcoPass and Portland’s Transportation Wallet provide examples of targeted transportation subsidies funded by parking revenue. It is also possible to offer discounted parking rates for income-eligible drivers.

Demand-based pricing without targeted subsidies in place may present a small hardship for some vehicle owners in the short-term, as they may park in less expensive areas on the periphery and need to walk further to their destinations. In the long-term, demand-based parking management will allow for increased focus and investment in more affordable travel options such as walking, biking, and transit, which will allow households to save money by owning fewer vehicles.

Decision Points

- **Frequency of updates:** Rates may be adjusted quarterly, biannually, annually, or biennially. The more frequently rates are adjusted, the more effective the program will be in achieving its target occupancy goals. If rates are too low to manage demand on a block, and the increment of adjustment is small, it may take several cycles of updates before reaching the price that achieves 85 percent utilization. The benefits to updating rates less frequently are greater consistency for users and less administrative burden for staff.

Honolulu Emissions Reduction Plan—Parking Framework

When utilization data is collected by hand, it may be impractical to adjust rates too often, given the large number of City streets where observations must take place. Annual updates may allow for a cyclical plan that focuses on one area at a time. In the future, new technology may allow for real-time price changes based on actual utilization rates at any given time, but in the short-term, updates will require CCH staff to make periodic observations and input any subsequent price changes into the system.

- **Basing rates on peak hours vs. changing throughout the day:** Basing daily rates on peak hour demand and keeping the same rate throughout the day creates simplicity and predictability for parkers. On the other hand, charging higher rates during typical peak demand periods, such as during the early afternoon or the dinner hour, and lower rates throughout the rest of the day, could potentially increase the efficiency of the system. Changing hourly rates for different times of day requires a thorough understanding of the peak hours for each area.
- **Zones vs. individual block segments:** Demand-based pricing could adjust rates on every block face, every block, or larger zones. The larger the area of analysis, the easier it is for administrators to input price updates. When pricing is consistent throughout an area, this can also increase user-friendliness. However, if the area of analysis is too large, the pricing program may become ineffective if the highest demand streets still have high occupancies that cause drivers to cruise for parking. Zones may be preferred if all streets within a zone have roughly the same demand, while pricing by individual block segments is preferred when there is greater variation in demand.
- **Increment of price changes:** Small price changes, such as twenty-five cents per hour, create less of a shock to drivers and will shift demand more gradually. Smaller increments may mean it takes longer for the system to find the correct price. Larger increments of change may create more of a shock for drivers but may also help the system find the correct price more quickly. An ideal system might include multiple increments of change depending on how far a location's utilization is from the goal; for example, increasing the hourly rate by 25 cents if peak occupancy is observed to be above 85 percent, and increasing by 50 cents if it is above 95 percent.

Honolulu Emissions Reduction Plan—Parking Framework

- **Target utilization range:** Demand-based pricing usually involves increasing prices where utilization is above 85 percent; it also involves lowering prices where occupancy is low. To implement demand-based pricing, a city must establish a lower end (such as 60 or 70 percent) of the optimal occupancy range. A lower low end can ease administration by creating a larger target range that requires fewer price updates. A lower low end can also keep prices slightly higher, advancing both revenue generation and greenhouse gas reduction goals. A higher low end, on the other hand, helps to maximize access.

Demand-Based Pricing in San Francisco

San Francisco, California first began implementing demand-based pricing through a pilot program called *SFpark* in 2011. The primary purpose of the program was to improve parking availability; other outcomes evaluated included the effect on parking rates, parking search times, the average number of citations per meter, daily greenhouse gas emissions, daily vehicle miles traveled, transit speed, parking revenue, and sales tax revenue.

Results:

A program evaluation conducted in 2014 found the following:⁷

- **Availability increased:** The amount of time that blocks achieved the target parking occupancy rate increased by 31% in pilot areas.
- **Average rates decreased:** On average, the hourly rate at meters decreased by 11 cents from \$2.69 to \$2.58, and average hourly rates at SFpark garages decreased by 42 cents from \$3.45 to \$3.03.
- **Parking revenues increased:** Although average rates decreased, revenue increased by approximately \$1.9 million per year, due to higher utilization in low demand areas and higher pricing in high-demand areas. (A December 2017

⁷ SFpark Pilot Project Evaluation, 2014.

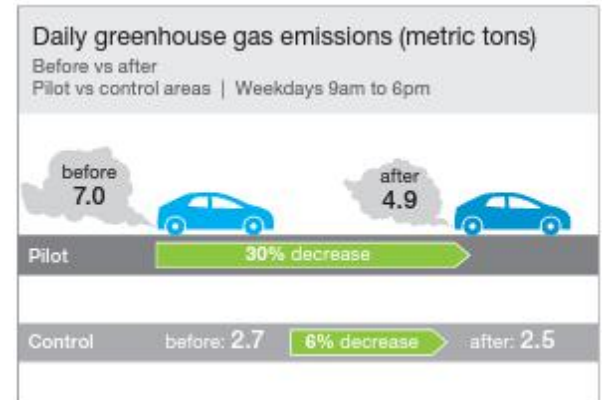
https://www.sfmta.com/sites/default/files/reports-and-documents/2018/08/sfpark_pilot_project_evaluation.pdf

Honolulu Emissions Reduction Plan—Parking Framework

update revealed that only for the .04% of highest-demand meters did the updated prices reach \$7 per hour.)

- **Parking citations decreased:** The SFMTA gave 23% fewer parking meter-related citations per meter than before the pilot. The new system made it easier to pay and allowed the City to eliminate time limits.
- **Parking search times decreased:** There was a 43% decrease in the average amount of time a driver spent looking for parking, from 11 minutes and 36 seconds before SFpark to 6 minutes and 36 seconds after.
- **VMT decreased:** As a result of less circling, pilot areas saw a 30% decrease in VMT, from 8,134 miles per day in 2011 to 5,721 miles per day by 2013.
- **GHG emissions decreased:** In the pilot areas, greenhouse gas emissions decreased from 7 metric tons per day in 2011 to 4.9 metric tons per day by 2013 (see Figure 22).
- **Transit speeds increased:** Double parking decreased by 22 percent in pilot areas due to improved availability, and in the corridors where double parking decreased, average transit speeds increased from 6.4 to 6.6 miles per hour.
- **Sales tax revenue increased:** Demand-based pricing improved access to neighborhood commercial districts. Pilot area sales tax revenue rose by 22% compared to a 15% increase in the rest of the City.
- **New meters made a difference:** In areas with observed demand but without meters, parking was too full 90% of the time prior to meter installation. After installing meters, this dropped to just 15% of the time.

Figure 22: GHG emissions decrease in



Source: SFpark Pilot Project Evaluation, 2014.

Honolulu Emissions Reduction Plan—Parking Framework

Implementation:

- **Data collection:** Initially, the City collected on-street data from in-ground sensors, which required the demarcation of individual curb parking spaces.⁸ Sensor data could be compared with payment data to evaluate compliance. However, the underground sensor technology at the time was found to be expensive and to have a short life cycle, so when the sensors reached the end of their life cycle, the City shifted to using adjusted payment data as a proxy for occupancy. This was found to correctly reflect occupancy data approximately 70 percent of the time.⁹ For garages, data was collected from loop counters, daily in-person car counts, and payment records.
- **Data management:** San Francisco subcontracted with IT professionals and spent resources to develop a robust data processing warehouse and management system that could be run and updated in-house (see Figure 23). The system provided reports of deviations from usual activity levels so that staff can identify meters in need of repair or replacement. The City generated business intelligence reports to track and analyze the number and share of rate adjustments in each direction, payment compliance rates, transit public speeds, and average parking occupancy by hour on each block.
- **Real-time data feed:** San Francisco generated a real-time data feed, which provided parking availability and price information at no cost to app developers.

⁸ SFpark Technical Manual, 2014.

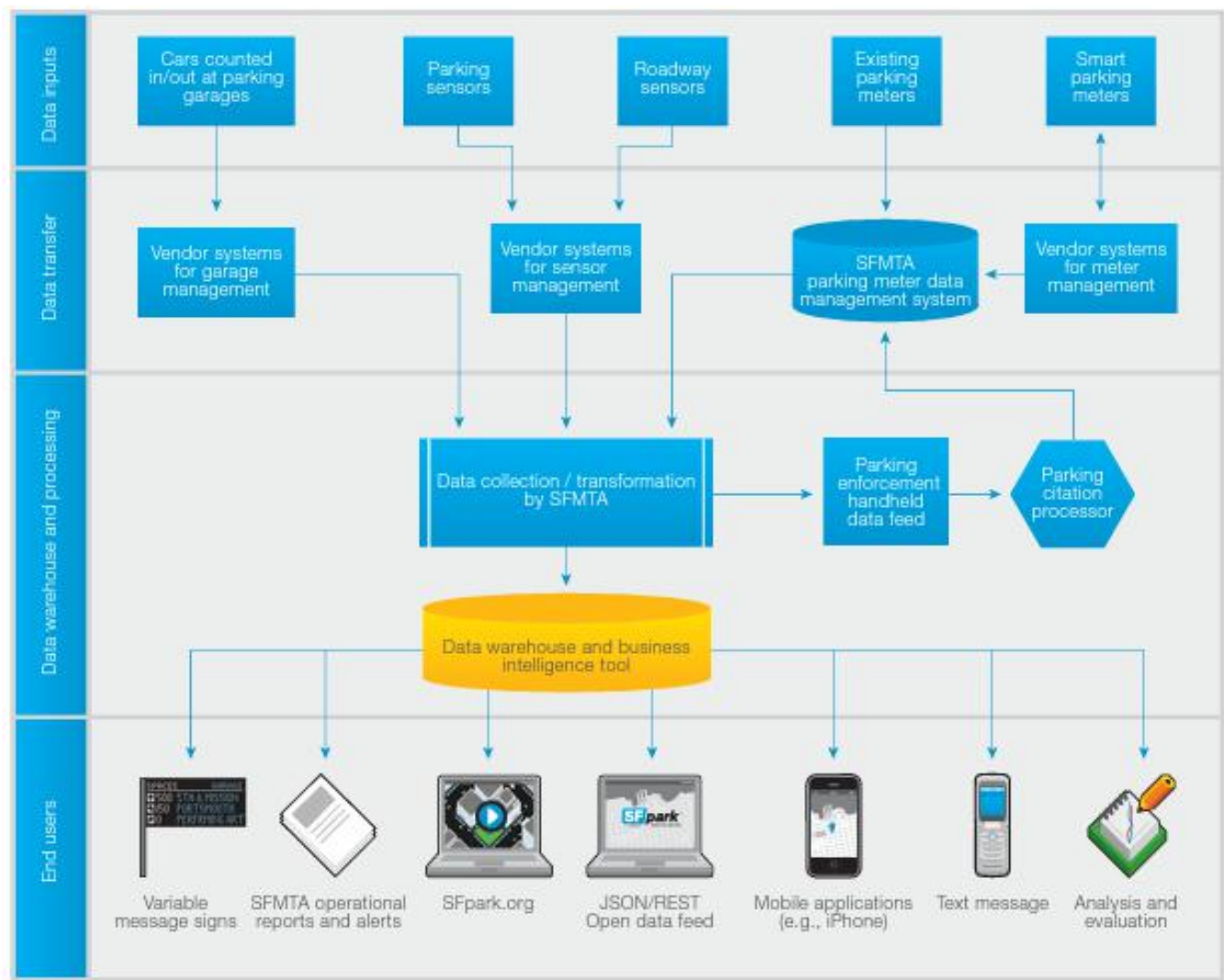
https://www.sfmta.com/sites/default/files/reports-and-documents/2018/05/sfpark_tech_manual_web.pdf

⁹ Demisch, 2015. Transportation Research Board.

<https://www.itskrs.its.dot.gov/its/benecost.nsf/ID/479404fdaf62b0c785257fbf006b29db>

Honolulu Emissions Reduction Plan—Parking Framework

Figure 23: SFpark Data Management Overview



Source: SFpark Technical Manual, 2014.

Honolulu Emissions Reduction Plan—Parking Framework

- **Smart meters:** The parking meters used in *SFpark* accepted credit card payments, transmit payment data (for all payment methods) to a central server in real-time, and allowed new rates and display information to be programmed and deployed remotely.
- **Rate adjustments:** San Francisco adjusted meter rates on each block approximately every quarter. Rate adjustments were based on occupancy categories, as follows:
 - **80–100% occupancy:** increase rate by \$0.25 per hour
 - **60–80% occupancy:** no change in rate
 - **30–60% occupancy:** decrease rate by \$0.25 per hour
 - **Below 30% occupancy:** decrease rate by \$0.50 per hour
- **Varied rates by time and day:** Parking demand varies throughout the day, so San Francisco fine-tuned its parking system to charge different rates at different times of the day, with three time of day categories:
 - 9am–12pm
 - 12pm–3pm
 - 3pm–6pm

Prices further vary according to whether it is a weekday or weekend day.

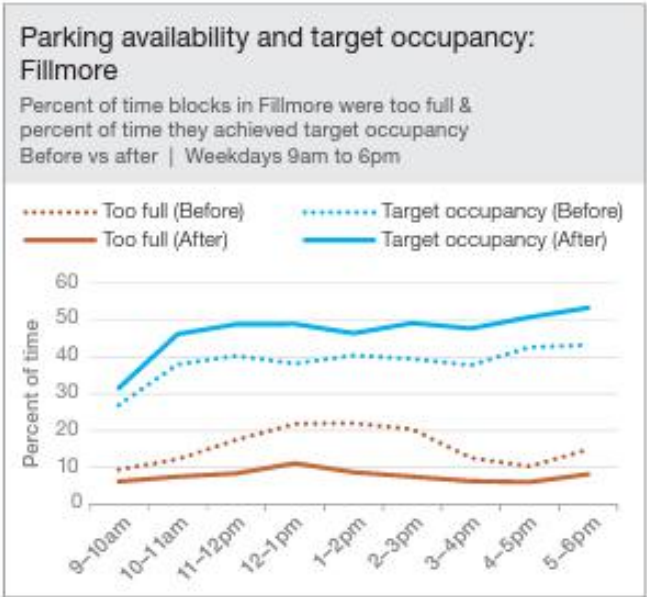
- **Garage wayfinding:** Off-street rates decreased, likely in part because the City installed new static wayfinding signs so people could locate public parking garages in the area.

Honolulu Emissions Reduction Plan—Parking Framework

Sample Area Case Study:

The results from the Fillmore area of San Francisco illustrates the progress made toward the goals that the demand-based pricing program was created to address. Fillmore is more affluent north of Geary Boulevard and less affluent to the south. Before the pilot, parking rates were \$2 in all areas. North of Geary Boulevard had over 90 percent occupancy at all times, while streets south of Geary Boulevard always had available parking. After a series of demand-based rate adjustments, prices increased up to \$8.75 on some streets north of Geary, and were reduced to \$1 south of Geary. Now, far more street segments are meeting occupancy targets, showing that the \$2 per hour was never the right rate for any blocks and illustrating the benefits of pricing by block rather than using larger zones (see Figure 24).

Figure 24: Achievement of target occupancy rates before and after SFpark Pilot



Source: SFpark Pilot Project Evaluation, 2014.

Honolulu Emissions Reduction Plan—Parking Framework

2. Tier-based Pricing

Tier-based pricing is a strategy meant to support local businesses. It involves providing less expensive parking for the first hour or first few hours of stay, and more expensive parking thereafter. This encourages shorter stays and more rapid turnover of spaces, which effectively increases capacity and allows more people to drive and park. Tier-based pricing can be thought of as providing either a “discount” encouraging short-term parking and/or a “surcharge” discouraging long-term parking. It also promotes moving long-term parkers to less expensive off-street parking, which better utilizes those facilities.

Factors to Consider

- **Cruising GHG impact:** Tiered parking shifts the allocation of spaces away from longer-term parkers and toward those staying for a shorter time. If the base rate is set at the appropriate price and there is nearby off-street longer-term parking available at a less expensive rate, tiered pricing should decrease on-street long term parking stays, which promotes parking turnover. Because cruising is based on overall availability, tier-based pricing alone would not directly affect the cruising GHG impact. If the lowest pricing tier was low enough that occupancy rates remained high, cruising would still occur.
- **SOV trip GHG impact:** Prioritizing short-term parking can increase capacity and the number of vehicle trips, potentially increasing GHG emissions. If perceptions of parking scarcity currently stop some people from making short trips by vehicle, once they expect convenient parking at an affordable rate to be available near their destination, they may be more likely to drive and park.
- **Access impact:** Discouraging long-term parking can free up more parking spaces, which increases the total number of people able to drive and park to access local destinations. Tier-based pricing provides access to more drivers—some of whom may have otherwise traveled by an alternative mode, and others of whom may have otherwise chosen not to make the trip at all.
- **Equity impact:** Increasing the rates for long-term parking stays reduces the number of people able to afford to leave their vehicles parked for long periods

Honolulu Emissions Reduction Plan—Parking Framework

of time, freeing up more spaces to offer at the lowest pricing tier. This shift in allocation away from long-term parking will make short-term parking more affordable to more people. The impact on those with limited physical mobility will still hinge on overall availability and ability to pay.

- **Impact on local businesses:** Local businesses are the primary beneficiaries of tier-based pricing. Without tier-based pricing in place, businesses might lose out on potential customers, or might offer to cover parking costs for their customers through a parking validation program. Tier-based pricing effectively subsidizes the first few hours of parking. This can help attract customers at the margin, who would be unwilling to pay the regular market rate but are attracted by the discount at the lowest tier.
- **User-friendliness:** Tier-based pricing adds an additional layer of complexity to parking pricing. Users with flexible schedules may simply leave sooner to avoid paying the rates at higher tiers; users planning to stay for a longer time will have more information to absorb and consider when deciding whether to park somewhere or look for another space. Tier-based pricing is most user-friendly when parking options designed for longer-term stays also exist and are conveyed with clear signage and wayfinding. Additionally, a tier-based pricing program requires pay-by-plate technology, and first time users may find the process of paying for parking more time-consuming.
- **Adaptability:** Tier-based pricing is meant to increase the number of vehicles able to access each space, by offering lower prices for shorter stays. At one extreme would be passenger pick-ups and drop-offs, so by extension, this strategy might allow free use of the curb for passenger loading and unloading. Curb uses such as bike or scooter share hubs could also align with this strategy's goal of increasing customer access. A larger curb management framework might designate different priorities for different areas of the city, and tier-based pricing is an option especially well-suited for busy commercial areas.
- **Impact on CCH resources:** A tier-based pricing program is more of a one-time investment than an ongoing expense. However, it would also require new technology, and the choice of technology could affect the efficiency of ongoing parking enforcement.

Honolulu Emissions Reduction Plan—Parking Framework

- **Technology costs:** Traditional single space meters simply display whether or not a space has been paid for and do not require the user to input their license plate. Tier-based pricing, however, requires pay-by-plate technology, so that parking enforcement officers know not only whether a space has been paid for, but how long a particular vehicle has occupied the space. Pay-by-plate can be done by phone or at multi-space meters.
- **Administration time required:** The shift to pay-by-plate technology would shift enforcement practices. Parking enforcement will be slightly more time-consuming if enforcement officers need to scan or enter every license plate to verify whether each vehicle has paid for parking. If multi-space meters are used and require drivers to display proof of parking, this creates an additional burden for users but may ease the efficiency of enforcement. Aside from enforcement time, implementing tier-based pricing would simply require a one-time investment in setting up the program. If the program had performance indicator goals for the share of spaces used for short-term vs. long-term parking, periodic monitoring would also be necessary to adjust the price differential between each tier. However, the more general goal of prioritizing short-term parking could still be achieved without spending staff time on monitoring or analysis.

Alignment with CCH Guiding Principles and Goals

- **Environmental protection:** Tier-based pricing would not directly support environmental protection goals or reduce greenhouse gas emissions from vehicle travel. Prioritizing short-term parking stays could effectively increase parking capacity and potentially increase the number of vehicle trips.
- **Economic health:** Tier-based pricing can benefit local businesses by prioritizing short-term stays in a commercial area, potentially allowing more customers to come and go. If tier-based rates are effective in altering the behavior of most drivers, the pricing model may reduce revenue relative to stable hourly rates. If drivers do not alter their behavior substantially, the higher

Honolulu Emissions Reduction Plan—Parking Framework

rates for longer stays could increase the parking program's revenue. Relative to charging stable hourly rates, any potential revenue impact of tier-based pricing would probably not be large or predictable enough to factor into an evaluation of this pricing model.

The administration time needed for tier-based pricing would be minimal; where paid parking is already in place, the switch to tier-based pricing would require a one-time investment. Because tier-based pricing requires an enforcement officer to know not only whether a space has been paid, but also how long the vehicle has been parked, it requires investing in additional technology that ties payment to a vehicle's license plate.

- **Social equity:** Increasing the rates for long-term parking reduces the number of people able to afford to leave their vehicles parked for long periods of time, freeing up more spaces to offer at the lowest pricing tier. This shift in allocation away from long-term parking will make short-term parking more affordable to more people. The impact on those with limited physical mobility will still hinge on overall availability and ability to pay as determined by the actual rates set for each tier.

Decision Points

- **Pay-by-plate technology choice:** Technology that requires users to enter their license plate and pay by app requires the least investment and is most adaptable to new curb uses. This can also be convenient for people who park in an area regularly. However, requiring users to pay by app can present equity concerns for drivers without smartphones, as well as practical challenges for users with limited phone storage or battery life. Another pay-by-plate technology option is a multi-space pay station. Pay stations require greater investment and are less adaptable to new curb uses, but they may also be less likely to present challenges to drivers. Either payment method could be integrated with LPR enforcement.
- **Whether/how often to monitor performance by length of stay:** It may be that the goal of tier-based pricing is to achieve specific turnover targets, similar to

Honolulu Emissions Reduction Plan—Parking Framework

the targeted 85 percent occupancy threshold of demand-based pricing, rather than simply “more” short-term stays and “fewer” long-term stays. If the program establishes a goal, such as 70 percent of stays within the lowest pricing tier, periodic length-of-stay analysis or monitoring would be required, along with periodic price updates, gradually increasing the hourly rate of subsequent tiers as much as necessary to achieve turnover goals. On the other hand, an agency may set the hourly rates of subsequent tiers high enough that they consider the additional revenue generated by long-term parkers to offset the decrease in turnover. In this case, tier-based pricing would not require a monitoring plan.

- **Which areas to implement:** The goal of increasing turnover applies primarily to commercial areas where local business owners hope more customers will patronize their businesses. Parking program administrators interested in tier-based pricing should consult with economic development staff and local business owners to understand where discounted rates for short-term parking (or surcharges for long-term parking) may be beneficial.

Tier-Based Pricing in Sacramento

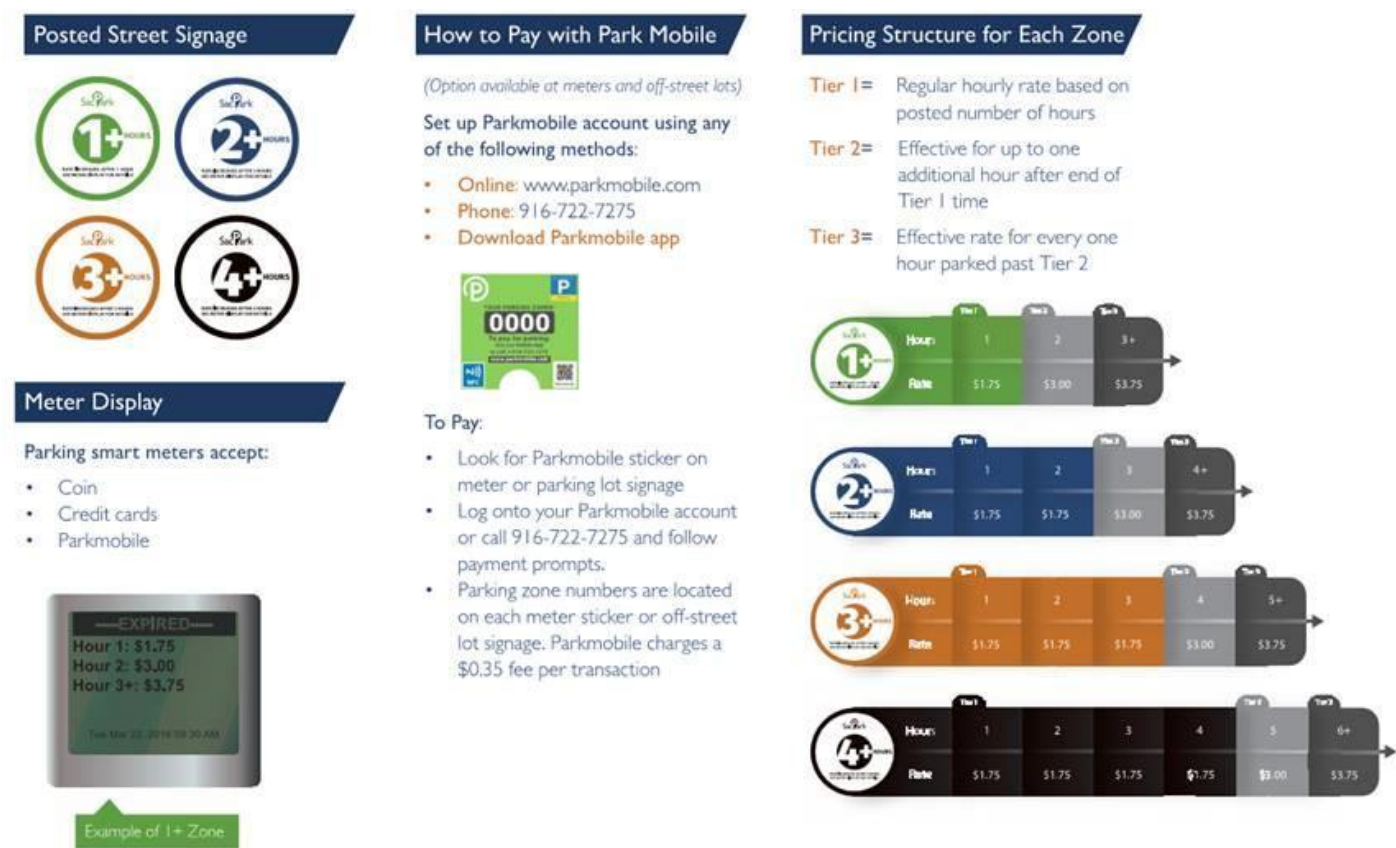
An example of a city with tier-based pricing for on-street parking is Sacramento, California. Sacramento combines tier-based pricing with demand-based pricing and has four zones with rates ranging from \$1.75 to \$3.75 per hour depending on location and length of stay. For example, in Zone 1, the base hourly meter rate is \$1.75, and increases to \$3.00 in the second hour, and \$3.75 per hour for three or more hours. The other three zones do not begin to increase the base rate until the third, fourth, or fifth hour of stay.

To enforce tier-based pricing, parking enforcement officers need to be able to identify how long a particular vehicle has been parked in a location, so Sacramento uses pay-by-plate technology. Its smart meters require users to input their license plate number. The meters accept coins, credit card, or in many locations, payment via Parkmobile through the app or by phone call. Users who use the Parkmobile app can save time because the app stores their license plate number, and users are also able to add additional time to the meter from their phones without returning to their

Honolulu Emissions Reduction Plan—Parking Framework

parking locations. The smart meters are integrated with enforcement devices that verify whether a vehicle has paid for its parking session. Figure 25 summarizes the tier-based pricing system in Sacramento.

Figure 25: Tiered On-Street Parking System Rates in Sacramento, CA



Source: City of Sacramento

Honolulu Emissions Reduction Plan—Parking Framework

3. Blanket Price Increases

Blanket increases in parking rates, enforcement hours, and paid parking areas is the strategy with the potential to maximally reduce greenhouse gas emissions. Increasing the cost of parking across the board will make driving and even vehicle ownership more expensive and incentivize people to rely more on sustainable modes of transportation. This pricing model decreases demand for parking by eventually allowing spaces to be repurposed for wider sidewalks, bike infrastructure, bus lanes, or other uses. However, while most effectively advancing climate goals, aggressive parking pricing expansions without consideration of access and occupancy could cause temporary hardships if some drivers perceive no alternative transportation options and as a result take fewer trips.

Factors to Consider

- **Cruising GHG impact:** Increasing the cost of parking will decrease demand, increasing the number of available spaces and reducing GHG emissions from cruising.
- **SOV trip GHG impact:** Increasing the cost of parking and expanding the paid parking area would make solo vehicle travel less attractive and boost the share of trips made by carpool, transit, walking, and biking, reducing GHG emissions from SOV travel.
- **Access impact:** Blanket price increases have the greatest potential to reduce greenhouse gas emissions but do not consider how space can be used most efficiently for the benefit of current users. Some people may respond to price increases by taking not only fewer vehicle trips, but fewer trips altogether. To increase the cost of parking without negatively affecting access and the vitality of the community, residents and visitors must feel that viable transportation alternatives are available.
- **Equity impact:** To the extent that price increases help keep spaces open on each block face, those with limited physical mobility may appreciate the option to park close to their destinations, as those with ADA placards will still be able to park for free in metered spaces. Higher prices for parking create a

Honolulu Emissions Reduction Plan—Parking Framework

greater burden for those with limited financial resources. Any parking fees represent a greater share of income for low-income individuals. For people working multiple part-time jobs just to make ends meet, it could be especially difficult to budget hours of additional travel time each week for biking or taking public transportation. However, another lens on equity might conclude that high prices are a net benefit for equity, as fees would be paid primarily by higher-income individual, while revenues could support public infrastructure and mobility improvements that would benefit everyone. It is also possible to offer parking discounts for low-income drivers.

- **Impact on local businesses:** The impact on local businesses can be multifold. Higher rates can benefit local businesses, if the higher rates create more availability and attract new customers who have the financial resources and willingness to pay for parking but would otherwise have gone elsewhere where parking was more convenient. On the other hand, higher rates could also harm local businesses if the cost is so high it prevents people from shopping or dining in an area and too many spaces go empty.
- **User-friendliness:** Increasing parking rates, the paid parking area, and enforcement hours across the board can be done in a simple way that does not create additional complexity for users. When parking rates, enforcement hours, and payment methods are consistent across areas, the system is predictable for users, and drivers will know what to expect.
- **Adaptability:** Lowering automobile parking demand increases opportunities to repurpose land for other uses, such as bus lanes, bike lanes, bike parking, shared bike and shooter stations, deliveries, parklets, and outdoor dining. Blanket price increases do not involve setting up new programs or technologies that would be wasteful to eliminate in the near future.
- Impact on CCH resources:
 - **Technology costs:** Parking rate increases based on reducing greenhouse gas emissions rather than increasing efficient use of space are simple to administer and do not rely on technology or analysis for monitoring the way demand-based pricing does. The only technology costs involved would be the cost of additional meters to expand the paid parking area.

Honolulu Emissions Reduction Plan—Parking Framework

- **Administration time required:** Increasing the paid parking area and hours of enforcement may require additional enforcement resources to be most effective, but the pricing model would not have any other ongoing administrative costs.

Alignment with CCH Guiding Principles and Goals

- **Environmental protection:** In the short-term, increasing the cost of parking and the area of enforcement promotes Honolulu’s environmental goals by reducing parking demand and encouraging mode shift. When parking costs are higher, this encourages people to carpool, take transit, walk, bike, or chain trips together. In the longer term, the reduction in parking demand that results from this strategy could further promote environmental protection goals by allowing space to be repurposed for greener uses and reducing Honolulu’s parking footprint.
- **Economic health:** The impact of blanket price increases on economic health depends on the amount of the increases and their effect on travel behavior. In areas with high parking demand, price increases will be more likely to also increase revenue. In areas with lower parking demand to begin with, price increases could result in fewer vehicle trips, potentially both decreasing both revenue and economic activity in an area.

Any reduction in economic activity, however, would likely be short-lived. In the longer-term, because blanket parking price increases would not reduce actual travel demand, price-sensitive travelers may eventually respond the changes by reducing their vehicle ownership, potentially investing in e-bikes, coordinating carpools, and learning how to use transit and bike share or other new mobility solutions that may emerge. As more people turn to sustainable transportation alternatives, these alternatives will become more efficient due to economies of scale, creating a virtuous cycle that results in more convenient and affordable travel options for all residents and visitors.

Honolulu Emissions Reduction Plan—Parking Framework

Blanket price increases also require less ongoing administration than demand-based rate adjustments. The pricing model could support itself financially while keeping more CCH staff time available for other project work.

- **Social equity:** In the short term, blanket price increases, without an initiative to provide discounts for income-eligible individuals, could present a hardship for lower-income travelers, who may struggle to find room in their budgets to cover increased parking costs, or who may find themselves too busy to explore alternative modes that would increase the total amount of time they spend traveling. People who have made vehicle ownership decisions based on current affordability of parking may perceive rapid price increases made solely for environmental reasons to be insensitive and unfair.

In the longer term, blanket price increases should result in a more equitable transportation system that prioritizes travel that is both more sustainable and more affordable to all users. When fewer people own private vehicles, and those who own them pay high parking fees that help fund improvements for environmentally friendly alternatives, this can gradually reduce the disparities between vehicle-owners and non-vehicle owners.

Decision Points

- **Rate increase amounts:** If price increases are not based on demand, but rather on the goal of encouraging sustainable travel, higher rate increases will be more effective in affecting mode share. Doubling or tripling hourly rates could greatly reduce parking demand but may present a hardship for many people. Because people have already calculated expected parking costs into their vehicle ownership decisions, rates that increase too much, too quickly, may be perceived as unfair by the public. A program of blanket rate increases should account for this and increase gradually and on a predictable schedule, balancing the public desire for low-cost parking with the emissions reduction and mode shift potential of higher rates.
- **Paid parking area increases:** Like increasing rates, increasing the paid parking area can help encourage people to travel by more sustainable modes.

Honolulu Emissions Reduction Plan—Parking Framework

Increasing the paid parking area can also prevent GHG emissions due to cruising for free parking. Implementing paid parking throughout the City would maximally reduce GHG emissions, while more limited expansions could keep options open for people willing to park in less convenient areas and walk to save money. Options include increasing the paid parking area throughout the Primary Urban Center, or in all transit-oriented development areas.

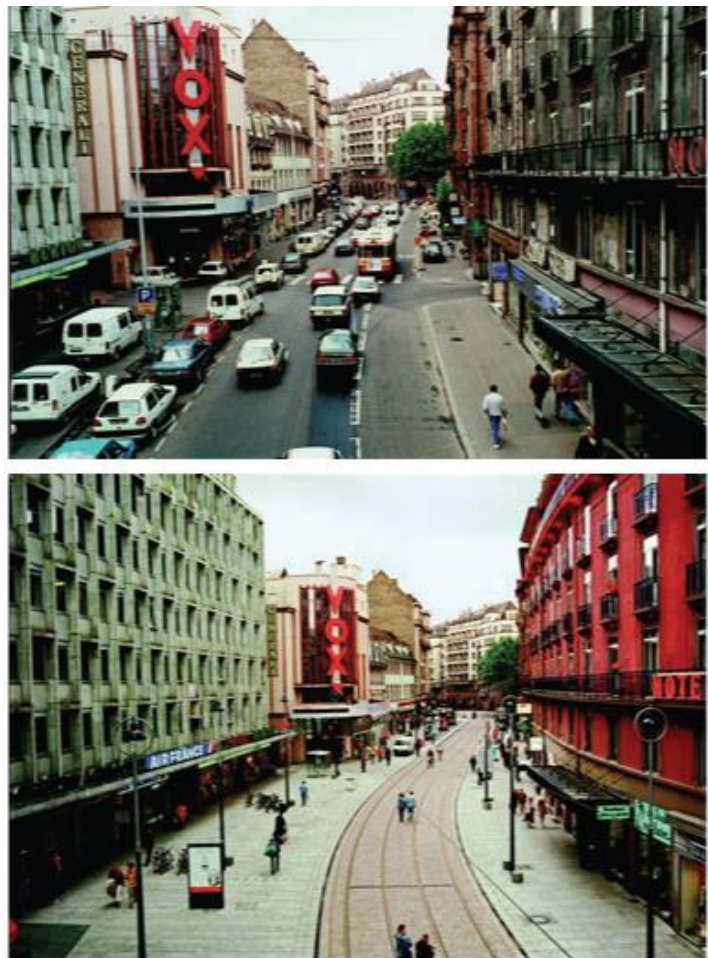
- **Enforcement hours increases:** When enforcement is limited to the daytime hours, the opportunity to park for free on the street might encourage vehicle ownership among households who might otherwise choose to make do with fewer vehicles. Expanding enforcement hours requires additional staff time, but can help achieve emissions reduction goals, reduce parking demand, and eventually increase opportunities to repurpose public land for other uses that advance community goals.

Honolulu Emissions Reduction Plan—Parking Framework

Blanket Price Increases in Strasbourg, France

While most pricing models used in the United States are created with the purpose of increasing economic efficiency and improving access to available parking, it is also possible to use parking prices in pursuit of goals for improving sustainability and quality of life. For example, Strasbourg, France has used parking policy to reduce vehicle use and promote walking, biking, and public transit. The pricing scheme is designed so that inner-city curbside parking is the most expensive and the peripheral public off-street lots are the least expensive, which encourages people to park on the outskirts of the City and take transit to the center. In addition, Strasbourg expanded its paid parking area by 2,500 spaces between 2007 and 2008, and a walking survey focused on the inner city revealed that there was an 11.5 percent increase in walking that year. Following that successful result, in 2010, the pay-and-display zone was increased by another 5,600 spots. These changes were done in conjunction with improvements to public transit (see Figure 26) and active transportation infrastructure (see Figure 27).

Figure 26: Strasbourg's Grand Rue Before and After Tram Implementation



Source: ITDP, Europe's Parking U-Turn, 2011.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 27: Curbside Bike Lane in Strasbourg



Source: ITDP, Europe’s Parking U-Turn, 2011.

Strasbourg’s goal of becoming more walkable also involved raising crosswalks, widening sidewalks, and beautifying public streets with street trees and furniture, and its goal of becoming more bicycle friendly also involved providing space for free secure bicycle storage at its public parking garages. Street parking in the inner city was replaced with park and ride lots near tram stations on the City outskirts.

As Strasbourg worked to implement these changes, the City also ran several communications campaigns about sustainable transportation. The “Ecomobilité” campaign challenged car dependence with active transportation posters and brochures throughout the city. The “Priority to our Quality of Life” campaign

included public discussions and pamphlets explaining the reasoning for the expansion of the paid parking area (see Figure 28).

Honolulu Emissions Reduction Plan—Parking Framework

Figure 28: “Priority to our Quality of Life” Outreach Materials Accompanying Strasbourg’s Paid Parking Expansion



Source: ITDP, Europe’s Parking U-Turn, 2011.

Honolulu Emissions Reduction Plan—Parking Framework

Cordon Pricing

Cordon pricing is similar to tolling, charging drivers to enter a city center or busy area during certain hours. It can support many of the same goals as parking pricing: reducing greenhouse gas emissions, improving air quality, and generating revenue to improve sustainable mobility options. Several international cities¹⁰ have implemented cordon pricing, with encouraging results, including:

- **London:** 31% decrease in auto trips, 33% increase in bus trips and in bike trips
- **Stockholm:** 18–20% decrease in auto trips, ~50% increase in transit use, \$155 million yearly revenue

The City and County of Honolulu’s role in vehicle registration provides an opportunity for simplified implementation relative to what other cities would face, as CCH can easily access the license plate data necessary to administer the program. It is also possible to create a means-based program, with discounts, tax rebates, or exemptions for low-income residents or employees.

Factors to Consider

- **Cruising GHG impact:** Cordon pricing could reduce the total number of vehicles entering busy areas, reducing overall parking demand and decreasing GHG emissions from cruising.
- **SOV trip GHG impact:** Increasing the cost of driving in the most congested areas would make solo vehicle travel less attractive and boost the share of trips made by carpool, transit, walking, and biking, reducing GHG emissions from SOV travel.

Figure 29: Cordon Pricing Sign



Source: UCLA ITS, 2022.

¹⁰ https://www.portland.gov/sites/default/files/2021/poem_workingdraft_cordonmemo_clean.pdf

Honolulu Emissions Reduction Plan—Parking Framework

- **Access impact:** Cordon pricing can boost transit by generating additional revenue and reducing vehicle congestion, thereby improving bus speed and frequency for those who rely on public transportation. Because cordon pricing usually surrounds a dense area with alternative transportation options available, the potential negative impacts on access are relatively minimal.
- **Equity impact:** Cordon pricing charges drivers and usually dedicates the revenue to improve public transit. Because drivers tend to be more affluent than non-drivers, cordon pricing may benefit lower-income individuals overall. It also improves local air quality, reducing inequities generated by the current system in which non-drivers must still breathe in air pollution they did not generate. Furthermore, since cordon pricing is tied to license plates, it is possible for a cordon pricing program to offer discounts, tax refunds, or exemptions for low-income residents or employees.
- **Impact on local businesses:** The impact on local businesses can be multifold. Reduced congestion can benefit businesses by increasing the ease of access for potential customers or delivery drivers. Cordon pricing may increase the number of people who enter the cordoned area by sustainable modes, but it may also have the potential to divert some trips to other areas.
- **User-friendliness:** Cordon pricing linked to vehicle license plates is even more user-friendly than charging for parking, as cordon charges can occur automatically upon entry.
- **Adaptability:** Cordon pricing is relatively adaptable, as the boundaries of the paid parking area can be changed. It is also possible to create variable pricing, where rates differ by time of day, or dynamic pricing, where rates differ according to real-time congestion levels.
- **Impact on CCH resources:**
 - **Technology costs:** CCH does not have any tolling infrastructure, so cordon pricing represents a significant initial investment. However, cordon pricing could pay for itself overtime depending on rates and demand and potentially create a valuable source of revenue going into the future.
 - **Administration time required:** Starting a cordon pricing program would require additional study, staff time, and innovation at the onset. Once

Honolulu Emissions Reduction Plan—Parking Framework

the program was established, any administrative costs would easily be covered by program revenue.

Alignment with CCH Guiding Principles and Goals

- **Environmental protection:** Cordon pricing substantially decreases automobile trips into busy urban centers and increases the number of trips made by biking or transit. The reduction in SOV travel reduces greenhouse gas emissions and improves local air quality.
- **Economic health:** Cordon pricing reduces the economic inefficiencies caused by traffic congestion. Initial implementation of the system could be somewhat costly, but in the long run, it may generate substantial revenue for the City and County of Honolulu.
- **Social equity:** Cordon pricing reduces inequity by reducing the negative environmental externalities that drivers impose on others. Reduced congestion can also make bus travel more efficient, reducing the disadvantages experienced by travelers who rely on public transit. Since cordon pricing is tied to license plates, it is possible for a cordon pricing program to offer discounts, tax refunds, or exemptions for low-income residents or employees.

Honolulu Emissions Reduction Plan—Parking Framework

Decision Points

- **Area and cost:** A cordon pricing plan must include area boundaries and locations for LPR technology to register vehicle license plates. A large cordon area and high cost of entry may better achieve mode share goals, at the cost of potentially preventing some trips altogether. A smaller area and cost may result less impact on mode share given the fixed costs of setting up the program, but would soften the program's impact on the public and still allow for updates based on monitoring and evaluation.
- **Type of pricing:** Dynamic pricing would change the cost of entering the cordoned area based on real-time congestion levels. This would help ensure the program achieves its goals of reducing traffic and congestion without limiting access more than intended, but it would provide the public with less predictability. Variable pricing could change the cost of entering the cordoned area based on the time of day, with the same price schedule each day. This would be more user-friendly and predictable to the public, but less efficient at achieving optimal level of vehicle traffic.
- **Means-based pricing:** Discounts for low-income drivers could soften any hardships created by cordon pricing, but would also somewhat compromise the program's goal of altering travel choices. Tax refunds based on income could allow for a stronger impact on travel behavior while also still working to reduce social inequities. Targeted exemptions for residents or employees could help overcome potential political resistance.
- **Synergy with parking enforcement:** If CCH were to link the payment process for cordon pricing to vehicle license plates and registrations, it could be possible to increase the user-friendliness and efficiency of the system by requiring the same method of payment for parking fees, cordon pricing payments, and fines. License plate payment data could also provide CCH with a wealth of travel behavior information to inform future transportation analyses, programs, and investments.

Evaluation Matrix and Scoring

This section develops a high-level evaluation matrix for scoring the degree to which each model discussed above would advance the City and County of Honolulu’s goals. The methodology begins by assigning equal weight of 100 possible points to each of the three elements of sustainability, and then lists subgoals under each category, with higher weights assigned to subgoals that are associated with larger impacts, that account for greater time periods, or that apply to more people (see Table 2). For more detail regarding the individual subcategory scores, refer to Appendix C.

This scoring shows how each model has unique strengths and weaknesses. For example, blanket price increases score highest on environmental protection, but lower on social equity. Tier-based pricing scores highest on economic health, but low on environmental protection. Cordon pricing scores well on subgoals that relate to the future, but ends up with a lower score due to higher initial implementation costs and fewer immediate benefits related to social equity. It is important to note, however, that there can be substantial variations between individual programs within each pricing model, which could potentially enhance the benefits of one model or mitigate the negative impacts of another. These pricing models are not mutually exclusive, and features of each model could potentially complement one another.

Ultimately, demand-based parking pricing resulted in the highest overall score based on the categories and subgoals in this evaluation matrix, highlighting its potential to balance environmental goals, economic health, and social equity, as well as its potential to balance short-term needs and long-term community vision. If the City and County of Honolulu moves forward with implementing demand-based pricing, or any of the pricing models discussed, it would represent significant progress compared with the status quo, which leads to high emissions, inefficient land use, reduced economic vitality, reduced revenue potential, minimal benefits to travelers with limited physical mobility, and high disparities between driving and more sustainable modes. Regardless of which model is chosen, parking management and pricing can help Honolulu become more environmentally friendly, economically vibrant, and accessible to all.

Honolulu Emissions Reduction Plan—Parking Framework

Table 2: Pricing Model Evaluation Matrix

Environmental Protection	Points Available	Demand-based Pricing Score	Tier-based Pricing Score	Blanket Price Increases Score	Cordon Pricing Score	Status Quo
Reduces cruising GHG	20	20	0	10	10	0
Facilitates repurposing land for greener uses	20	10	0	20	10	0
Reduces SOV travel GHG	60	30	0	60	60	0
Environmental Protection Subtotal	100	60	0	90	80	0
Economic Health	Points Available	Demand-based Pricing Score	Tier-based Pricing Score	Blanket Price Increases Score	Cordon Pricing Score	Status Quo
Avoids negative short-term impact to local business and economic vitality	20	20	20	0	10	5
Creates positive long-term impact on local business and economic vitality	30	25	30	20	30	0
Initial investment of CCH resources	20	10	5	15	0	20
Ongoing CCH resources required and ability to generate revenue	30	20	25	20	30	10
Economic Health Subtotal	100	75	80	55	70	35
Social Equity	Points Available	Demand-based Pricing Score	Tier-based Pricing Score	Blanket Price Increases Score	Cordon Pricing Score	Status Quo
Beneficial impact on travelers with limited physical mobility	30	30	0	20	0	0
Avoids negatively impacting travelers with limited financial resources	35	25	25	0	0	20
Potential to reduce disparities between drivers and those who use other modes	35	25	10	35	35	0
Social Equity Subtotal	100	80	35	55	35	20
TOTAL SCORE	300	215	115	200	185	55

Source: Walker Consultants, 2022. Points are approximate based on research and assumptions.

Honolulu Emissions Reduction Plan—Parking Framework

Potential for a Hybrid Approach

It is possible to create a pricing program that combines features of multiple pricing approaches to strike the best balance between a program that accommodates short-term needs and one that rapidly advances Honolulu’s longer-term strategic vision. This section briefly introduces several possibilities:

Demand-based + tier-based hybrid: Demand-based pricing could be implemented throughout the entire City and County of Honolulu, with the available option of layering tier-based pricing on top of the demand-based pricing in commercial areas at the request of local business owners. The lowest-priced tier might begin at a certain base rate, with higher-priced tiers for longer stays. When street parking occupancy is observed to be above 80 percent, the rates at each tier could increase, and if occupancy falls below 60 percent, or some similar established threshold, the rates at each tier could decrease.

Demand-based + blanket price increases: One hybrid model might include a blanket expansion of the paid parking area to cover all streets within a certain area, such as the Primary Urban Center or the transit-oriented development areas. Base rates could be set for all street parking, and periodic rate adjustments could be made only on streets where observations reveal sufficiently high demand. Such blanket price increases could be more acceptable in areas with more alternatives available, and including the demand-based rate increases will ensure parking availability is maintained in all areas and emissions reductions from cruising as well as from reducing SOV travel are achieved.

Another option for incorporating blanket price increases involves raising the “price floor” for all paid parking areas to a level that may be higher than necessary to achieve the minimum level of availability.

Parking pricing + cordon pricing: In the future, CCH may wish to explore potential integration of parking pricing and cordon pricing. For example, payment could be linked to vehicle license plate, and the same device used to pay to enter a cordoned area could also be scanned to pay for street parking or enter an off-street facility.

Honolulu Emissions Reduction Plan—Parking Framework

Summary Comparison of Parking Pricing Models

Each pricing model analyzed above—demand-based pricing, tier-based pricing, and blanket price increases—has a different strategic focus. Demand-based pricing seeks to maximize efficiency and support business, tier-based pricing seeks to reduce long-term parking in the most convenient spots, promote turnover, and support businesses, and blanket price increases prioritize climate goals. Table 3, below, provides an overview of the comparative benefits and challenges of each individual approach to pricing parking that was discussed in the previous sections.

Selecting a parking pricing model or developing a hybrid approach involves understanding the local context in the City and County of Honolulu, including strategic goals and priorities, administrative capabilities and resources, and current and planned sustainable transportation options available to residents. Combining features from each of the three models may help CCH balance climate goals, access and equity goals, economic development goals, and other practical considerations. Table 2, above, shows how each parking pricing strategy supports each priority.

The next section incorporates features from each of the three approaches to parking pricing and outlines implementation guidelines that address the various decision points involved in framework development.

Honolulu Emissions Reduction Plan—Parking Framework

Table 3: Parking Pricing Model Comparison Chart

	Demand-Based Pricing	Tier-Based Pricing	Blanket Price Increases
Cruising GHG impact			
SOV Trip GHG impact			
Access impact			
Equity impact			
Impact on local businesses			
User-friendliness			
Adaptability to future needs and curb uses			
Impact on CCH resources			
Impact on economic vitality and sustainability			

Source: Walker Consultants, 2022.

Implementation Guidelines

Demand-based pricing emerged as the most promising pricing model for CCH. It is also possible to layer tier-based pricing on top of the demand-based model, and to establish a higher price floor for existing meters, more closely aligned with market rates. Any subsequent price increases or meter installations will be based on utilization observations, with the goal of improving user-friendliness and optimizing efficient access, rather than aggressively discouraging vehicle trips. This section outlines the considerations and decision points for setting up a demand-based pricing system and establishes implementation guidelines. Implementation includes:

- Choosing a level of analysis (i.e., block face, block, or larger zones)
- Setting initial rates
 - Determining whether prices will also vary by the time of day and/or day of the week
 - Developing income-eligible discounts
 - Establishing pricing tiers based on length of stay
- Establishing guidelines for price adjustments
- Developing an ongoing process for monitoring utilization and adjusting prices
 - Data collection method
 - Frequency of price updates
- Planning for program expansion
 - Streets adjacent to metered streets
 - Streets in TOD areas
 - Streets adjacent to curb parking repurposed for other uses
 - Curbs regulated for commercial delivery or passenger pick-ups
 - By request
- Designing a data management system
- Conducting financial analysis and planning how revenue will be used
- Developing a method of communicating prices to the public
- Establishing an enforcement strategy
- Measuring performance
- Establishing legal authority for the program

Honolulu Emissions Reduction Plan—Parking Framework

Choosing a Level of Analysis

Demand-based pricing case studies have shown that demand can vary significantly even from one block to another. Because the success of the model depends on maintaining one or two open spaces per block face, occupancy rates should also be analyzed at the individual block level, rather than at the level of larger zones. In general, it should usually be sufficient to group meters on both sides of a block together when calculating utilization rates, and this will make it easier to develop maps communicating prices to the public. However, exceptions may be made if observations reveal some blocks where demand is much higher on one side of the street than the other; in these cases, each side of the street can be analyzed and updated separately.

Setting Initial Rates

Time of day and day of week considerations: For ease of implementation and public acceptance, initial pricing for each street or off-street facility should be set at the same base rate citywide (with the new floor, see page 56). Rates should be set based on peak-hour demand counts conducted on a typical weekday or weekend day. The observations conducted by CCH staff did not reveal large enough differences in occupancy between weekdays and weekends to warrant different rates for different days of the week. Similarly, the observations did not reveal regular enough hourly demand patterns to warrant setting hourly rates for street parking that fluctuate according to time of day. Keeping a consistent rate allows for easier program implementation for staff and results in greater legibility and predictability for drivers who frequently park in an area. A sufficiently high price floor can help ensure continued availability almost as effectively as truly dynamic real-time price updates would, while also supporting climate and sustainable mobility goals and resulting in greater predictability for drivers.

Honolulu Emissions Reduction Plan—Parking Framework

Low-income discounts: As Honolulu enables parking payment via the HOLO card, there is an opportunity to create parking discounts for income-eligible individuals. It is recommended that individuals approved for HOLO card's Low Income Transit Fare Program also receive a 50 percent discount off regular parking rates when paying with their HOLO card (see Figure 30).

Pricing tiers based on length-of-stay: Tiered pricing should be implemented for street parking only, in order to encourage turnover of prime spaces and nudge longer-term parkers to park in off-street facilities. For the sake of simplicity and program legibility for users, tier-based pricing should be implemented equally on all metered streets. The first tier rate should be the initial rate currently in effect and apply for the first two hours of parking. The second tier hourly rate should be \$1 more than the first tier and apply to all subsequent hours. When the first tier rate is updated based on demand observations, the second tier rate should be updated in equal increment.

Figure 30: HOLO Card



Source: City and County of Honolulu, 2023.

Establishing Guidelines for Price Adjustment

The ideal occupancy varies slightly for street parking and off-street facilities. For off-street, there are enough spaces that a 90 percent utilization target is sufficient to ensure availability of at least a few spaces. A single block of street parking, however, will have fewer total spaces, especially as more spaces are regulated for commercial delivery or passenger pickup and drop-off zones, so setting the target utilization slightly lower, such as at 80 percent, may be necessary to maintain a minimum of availability. It is recommended that prices be increased whenever utilization exceeds these levels. Demand-based pricing also involves lowering rates in areas with low utilization. This provides options for price-sensitive individuals willing to park further from their destination and walk, and it helps ensure public space dedicated to parking facilitates as much access as possible. A price increment of \$0.25 is small enough to allow gradual adjustment for users and large enough to arrive at target occupancy

Honolulu Emissions Reduction Plan—Parking Framework

rates relatively quickly. Given these considerations, the following peak hour occupancy thresholds are recommended to guide price adjustments:

Off-street facilities:

- 90–100% occupancy: increase rate by \$0.25 (but not above the established price ceiling)
- 60–90% occupancy: no change
- Below 60% occupancy: decrease rate by \$0.25 (but not below the established price floor)

Street parking:

- 80–100% occupancy: increase rates for both tiers by \$0.25 (but not above the established price ceiling)
- 60–80% occupancy: no change
- Below 60% occupancy: decrease rates (for both tiers) by \$0.25 (but not below the established price floor)

Price ceiling and floor: The price ceiling should be set at \$8 per hour, slightly above market rate and tied to the consumer price index, to allow the system to continue to function effectively in all areas even if market conditions fluctuate with time. In addition, a price floor should be set at \$4 per hour, which can support sustainability goals and while also helping manage any new demand on lower-demand streets caused by the price adjustments on higher demand streets.

Developing an Ongoing Process for Monitoring Utilization and Adjusting Prices

Data collection method: As discussed earlier, IPS meter revenue data did not correlate closely enough to CCH staff’s in-person occupancy observations to be considered an accurate reflection of demand. Therefore, it is recommended that utilization of paid spaces be monitored by analyzing single space sensor data. CCH is currently in the process of purchasing sensors. Using sensor data will ensure price adjustments can be made based on the actual peak demand at a location, rather than

Honolulu Emissions Reduction Plan—Parking Framework

on average peak demand hours. Additionally, if using single space sensors to determine occupancy rates, in-person observations should also be conducted periodically in the paid areas to verify sensor data and identify any potential complications.

Frequency of price updates: Updates can occur quarterly at first and annually if occupancy rates are found to remain stable within the target zone.

Planning for Program Expansion

Implementing demand-based pricing also requires a methodology for monitoring non-enforcement hours and unmetered areas to ascertain when and where occupancy rates may be exceeding the recommended thresholds. In these cases, hours should be expanded, or new meters should be installed to help manage demand.

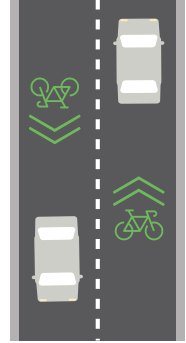
Enforcement hours can be evaluated by analyzing sensor occupancy data. Unmetered streets do not have sensor data, so in-person occupancy observations should be conducted during peak hours (between 6pm–8pm) on typical weekday or weekend evenings. If observations must be done in person, selected blocks can be divided into monitoring zones, and observations can be done on different days for each zone for ease of scheduling. Each zone should be monitored and updated quarterly initially, and updates may become less frequent later on if prices are found to stabilize with time.

It is not feasible to collect quarterly occupancy data on every unmetered city street, but the following may be considered priority areas for regular monitoring:

- **Streets adjacent to metered streets:** It makes sense to monitor parking utilization on streets adjacent to metered streets because staff will already be in the area monitoring the metered streets, and meters are likely to increase demand for parking in nearby unpriced areas.

Honolulu Emissions Reduction Plan—Parking Framework

- **Streets in transit-oriented development (TOD) areas:** As there are no minimum parking requirements for new developments in TOD areas, these busy neighborhoods may experience higher demands for unpriced street parking. To prevent cruising for parking and preserve air quality in these neighborhoods, streets should also be monitored on at least an annual basis, and meters should be installed on streets where parking occupancy exceeds 80 percent.
- **Streets adjacent to curb parking repurposed for other uses:** If plans for bike lanes, bus lanes, pedestrian walkways, public space, outdoor dining areas, commercial delivery zones, or pickup and drop-off zones result in the elimination of on-street parking spaces on a street, the surrounding streets should be monitored to ensure open street parking spaces are still available. On blocks where occupancy exceeds 80 percent, meters should be installed.
- **By request:** The program could also allow residents, business owners, and CCH staff to identify times or areas where finding street parking is a challenge and recommend staff monitor the area and consider a program expansion.



Designing a Data Management System

Another step necessary for a smooth implementation is designing a data management system. This could involve organizing meters into block segments and organizing block segments and adjacent areas into monitoring zones. Staff should be able to easily identify areas for price adjustments, make updates, and track the history of the program. The City and County of Honolulu may wish to subcontract with IT professionals to develop a data processing warehouse and more robust management system that could be run and updated in-house with capability to automatically generate business intelligence reports.

Planning the Use of Revenue

Initially, demand-based pricing may generate only enough revenue to fund the management, expansion, and enforcement of the program. However, other cities have found that demand-based pricing results in additional revenue, which could be

Honolulu Emissions Reduction Plan—Parking Framework

reinvested in sustainable transportation. The City and County of Honolulu may wish to engage the public to establish priorities for the specific use of additional parking revenue, such as improvements to active transportation infrastructure and public transit, sustainable transportation initiatives like Boulder’s EcoPass, parking cash-out programs, or subsidies for bikes or e-bikes.

Communicating Prices to the Public

For many residents and visitors, price is a factor when deciding where and whether to drive and park, so CCH should make pricing information available to the public online. This can be done via a color-coded map that allows users quickly visualize general parking costs throughout the entire City, as well as to click on or hover over

Figure 6: Tier-Based Pricing Signage in Sacramento



a specific block or off-street facility to see its hourly rate. CCH may also wish to include an additional map layer showing the blocks or facilities where prices recently increased or decreased. The City should also have clear, streamlined signage at the curb and meter. Figure 31 displays an example of signage used for tier-based pricing in Sacramento, CA. Off-street public parking facilities should also have clear signage, near the facility entrance, that can be easily updated as rates are adjusted based on utilization rates.

Source: City of Sacramento, 2023.

Establishing an Enforcement Strategy

Achieving availability goals is critical to the program’s popular acceptance and relies on regular enforcement. Demand-based pricing will likely increase the number of metered streets, which could potentially require additional enforcement resources. However, enforcement may also become more efficient and effective with the use of new technology.

Honolulu Emissions Reduction Plan—Parking Framework

Targeted enforcement: The City and County of Honolulu has plans to purchase single space sensors, which, in addition to providing peak occupancy data to guide price adjustments, can provide data in real-time, showing on a map which meter spaces are occupied but have not been paid for. Sensors can also help with the enforcement of tier-based pricing, by showing the length of time a vehicle has been parked in a space without moving. Honolulu may be able work with technology vendors to develop software that generates alerts or recommendations for targeted enforcement areas based on real-time sensor data. Another option is to analyze occupancy rates in an area alongside revenue to determine which locations could benefit from increased enforcement.

Increased citation fees: One strategy the City and County of Honolulu can use to increase compliance is increasing the citation fee for parking infractions. Most parking violations currently result in a \$35 fee, which, when enforcement is not guaranteed, may not be enough to dissuade some people from parking without paying, especially if the cost of parking increases. It is recommended that CCH increase the fee to \$63 (similar to that of many other cities) and also consider implementing graduated fines that increase if the same vehicle commits the same offense within a designated time period, such as two years. In addition to increasing the fee for expired meters, CCH should evaluate and consider updating the fees for other parking infractions, to avoid unintended consequences.

Measuring Performance

Honolulu can establish performance indicators to monitor the progress of the program over time. Some possible metrics of relevance include:

- The share of metered blocks within the target occupancy range during peak hours
- The share of off-street facilities within the target occupancy range during peak hours
- Average time spent looking for a space
- Average GHG emissions from parking search
- Average sales tax revenues of managed areas relative to economic trends
- New business investment



Honolulu Emissions Reduction Plan—Parking Framework

- Number of parking-related complaints received
- Gross annual parking revenue
- Net annual parking revenue reinvested in sustainable transportation projects and programs
- Annual citations given

Establishing Legal Authority for the Program

Article 22 of the Traffic Code currently includes strict parking meter zones, rates, and enforcement hours for on-street paid public parking. The zones, rates, and hours are too rigid and limited to allow demand-based pricing to function effectively. For the program to work, the code would need to be updated to allow the director of transportation services to adjust paid parking areas, rates, and hours based on occupancy levels. The code could also establish the ability to implement price increments for tier-based pricing, as well as the ability to develop low-income discounts.

Full implementation of demand-based pricing would require similar updates to Article 23, which governs public off-street facilities. The update would need to eliminate time limits for metered parking facilities and allow for rates that vary based on demand, rather than the fixed rates that are currently set in code for each off-street facility.



Some of the code updates to enable demand- and tier-based pricing for metered parking could be modeled after Section 15-23.2A, which already establishes demand-based rate adjustments, but only for attendant-operated public parking facilities. The code directs the director of transportation services to determine the occupancy rate of each attendant-operated facility on a semiannual basis, increasing rates when occupancy exceeds 90 percent, and decreasing rates if the occupancy rate decreases by over 20 percent from the previous period. Some of the specifications in Section 15-23.2A may be more rigid than would be ideal to maintain efficient and effective parking operations, and it is recommended that more flexibility be introduced to allow the director of transportation services to adjust base rates, any

Honolulu Emissions Reduction Plan—Parking Framework

additional rates or tiers deemed helpful to operations, and the hours of operation based on demand, but within an established price floor and ceiling.

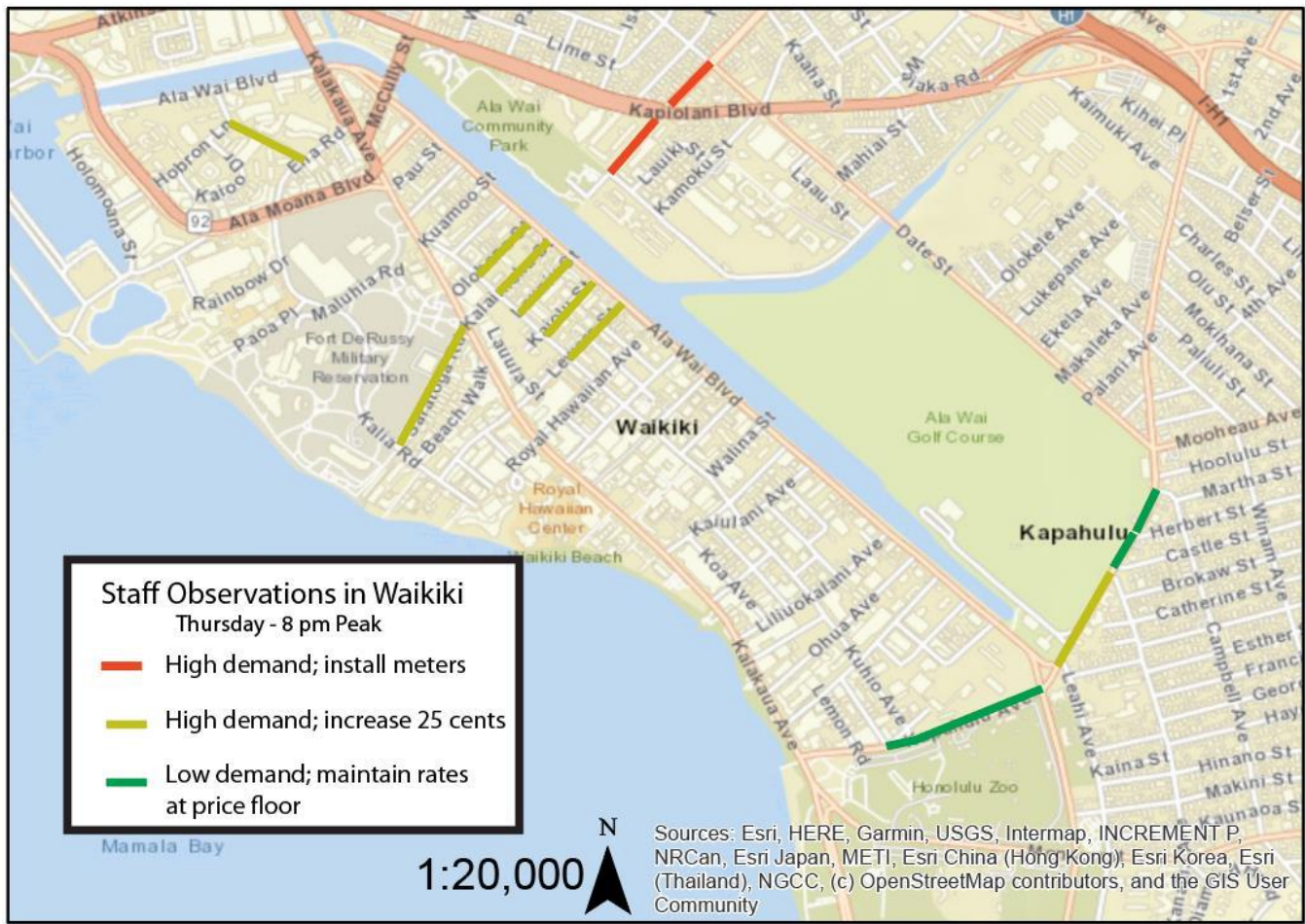
Street Parking Pricing Implementation for Sample Area

The following example explains how this pricing strategy would be implemented if the observations described below had been made after the new price floor of \$4.00 per hour had already been in place for at least three months. CCH staff collected occupancy data for 14 sample blocks in the Waikiki Avenue (see Figure 32). During peak hours, eight metered blocks exceeded the recommended occupancy threshold of 80 percent. On these blocks, rates should be increased 25 cents per hour. Four metered blocks along Kapahulu Avenue did not meet the threshold for a price increase, so their rates should be kept at the price floor. Two unmetered blocks along University Avenue had utilization rates of 100 percent; meters should be installed on these blocks, with prices starting at the floor and potentially increasing gradually until occupancy falls below 80 percent.

These are just a sample, and not the only metered streets in the Waikiki area. Ongoing peak hour monitoring should cover all metered streets as well as unmetered streets on adjacent blocks, public off-street facilities, and anywhere high demand has been identified. It may also be beneficial to monitor outside of the designated enforcement hours to determine whether enforcement hours should also be expanded.

Honolulu Emissions Reduction Plan—Parking Framework

Figure 32: Staff Observations and Associated Recommendations for Sampled Streets in Waikiki Area



Source: Walker Consultants, 2023.

Honolulu Emissions Reduction Plan—Parking Framework

Appendix A: Meter Locations

IPS Meter Locations*		Coin Meter Locations
Waimanu St	Amana St	S. King St
Pensacola St	Sheridan St	Aulike St
Rycroft St	S. Beretania St	Kuulei Rd
Young St	Victoria St	Maluniu Ave
Piikoi St	Kinau St	Kainehe St
Kaheka St	Ward Ave	Puniu St
Kalakaua Ave	Queen St	Kihapai St
Kamakee St	South St	Hoolai St
S. King St	Emily St	Aala St
Lunalilo St	Kawaiahao St	Aala Pl
Mission Lane	Hale-Makai St	N. Kukui St
University Ave	HPD Garage	Uluniu St
Metcalf St	Alapai St	Uluniu Ave
Alakea St	Lauhala St	N. King St.
Kapahulu Ave	N. Kukui St	Kohou St
Queen Emma St	S. Kukui St	Pohukaina St
Paokalani Ave	Nuuanu Ave	Auahi St
Ohua Ave	Harbor Village Lot	Keawe St
Uluniu Ave	S Vineyard Blvd	Queen St
Walina St	Richards St	Cooke St
Kanekapolei St	Mililani St	Halekauwila St
Aloha Dr	Punchbowl St	Coral St
Seaside Ave	Palace Square Lot	Ilalo St
Nohonani St	Bishop St	Liliha St
Nahua St	Merchant St	School St
Royal Hawaiian Ave	Pali Hwy	N. School St
Lewers St	Fort St	N. Beretania St
Kaiolu St	Bethel St	Kamakee St
Launiu St	N. Pauahi St	Piikoi St
Olohana St	Maunakea St	Waialae Ave
Kalaimoku St	Marin St	Koko Head Ave
McCully St	Smith St	Twelfth Ave
Hobron Ln	N. Beretania St	Kinau St
Saratoga Rd	River St	Makiki St
Beach Walk		Lunalilo St
Makaloa St		Kapahulu Ave
Kanunu St		Kalakaua Ave
Poni St		
Liona St		
Keeaumoku St		
Ahana St		

*Highlighted cells were sample streets on which CCH staff collected occupancy data.

Honolulu Emissions Reduction Plan—Parking Framework

Appendix B: Parking Occupancy Observations

Inventory data						Weekday Utilization - Thursday 10/6/22								Weekend Utilization - Saturday 10/22/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
Waikiki		Cartwright Road	Kuhio Ave	W	-																
		Cartwright Road	Kuhio Ave	E	5	0%	40%	100%	80%	100%	100%	60%	20%	40%	80%	100%	100%	100%	80%		
		Kuhio Ave	Paki Ave	W	21	10%	5%	48%	19%	14%	29%	19%	24%	52%	86%	52%	38%	52%	62%		
		Kuhio Ave	Paki Ave	E	11	0%	0%	91%	27%	0%	0%	9%	9%	9%	91%	55%	36%	55%	36%		
	Kapahulu Ave	Ala Wai Blvd	Kanaina Ave	W	21	10%	19%	5%	10%	33%	38%	76%	5%	14%	33%	14%	19%	33%	90%		
		Ala Wai Blvd	Kanaina Ave	E	11	27%	27%	27%	45%	64%	100%	100%	27%	55%	45%	55%	45%	91%	100%		
		Kanaina Ave	Castle Street	W	-																
		Kanaina Ave	Castle Street	E	-																
		Castle Street	Herbert Street	W	15	7%	7%	13%	7%	20%	53%	73%	0%	0%	7%	13%	7%	47%	33%		
		Castle Street	Herbert Street	E	2	0%	0%	50%	50%	100%	100%	100%	50%	50%	100%	50%	50%	100%	50%		
		Herbert Street	Campbell Ave	W	1	0%	0%	0%	0%	0%	100%	0%	100%	100%	100%	100%	100%	100%	100%		
		Herbert Street	Campbell Ave	E	4	75%	0%	50%	75%	75%	100%	100%	0%	25%	100%	0%	75%	100%	100%		
	Lewers Street	Kuhio Ave	Ala Wai Blvd	W	3	67%	67%	100%	67%	100%	100%	100%	100%	67%	100%	100%	100%	100%	100%	100%	
		Kuhio Ave	Ala Wai Blvd	E	3	100%	67%	100%	67%	67%	67%	67%	33%	100%	33%	67%	100%	100%	100%		
	Launiu Street	Kuhio Ave	Ala Wai Blvd	W	10	50%	20%	30%	30%	60%	100%	100%	50%	30%	60%	30%	70%	100%	100%		
		Kuhio Ave	Ala Wai Blvd	E	17	59%	41%	41%	35%	65%	100%	94%	41%	29%	59%	47%	76%	100%	94%		
	Kaiolu Street	Kuhio Ave	Ala Wai Blvd	W	12	67%	25%	25%	33%	83%	92%	100%	50%	33%	58%	83%	100%	100%	100%		
		Kuhio Ave	Ala Wai Blvd	E	12	42%	25%	25%	67%	75%	100%	92%	58%	58%	83%	67%	100%	100%	100%		
	'Olohana Street	Kuhio Ave	Ala Wai Blvd	W	8	88%	25%	50%	100%	100%	100%	100%	38%	63%	50%	25%	75%	100%	100%		
		Kuhio Ave	Ala Wai Blvd	E	10	60%	60%	80%	80%	100%	100%	100%	80%	60%	90%	60%	80%	100%	90%		
	Kalaimoku Street	Kuhio Ave	Ala Wai Blvd	W	8	50%	38%	50%	63%	88%	100%	100%	38%	38%	13%	38%	50%	88%	88%		
		Kuhio Ave	Ala Wai Blvd	E	11	45%	55%	82%	64%	82%	100%	100%	45%	0%	36%	18%	36%	45%	100%		
		Kalia Road	Kalakaua Ave	E	-																
	Saratoga Road	Kalia Road	Kalakaua Ave	W	13	77%	85%	100%	92%	100%	100%	100%	77%	100%	100%	100%	85%	100%	100%		
		Ena Road	Lipeepee Street	N	19	63%	89%	79%	68%	95%	95%	100%	63%	74%	79%	63%	74%	100%	100%		
	Hobron Lane	Ena Road	Lipeepee Street	S	16	56%	100%	94%	100%	94%	94%	94%	0%	88%	50%	69%	100%	94%	94%		
		Ala Wai Park	University Street	at Hihiiwai Street		96	32%	24%	38%	33%	70%	64%	16%	44%	85%	100%	91%	91%	41%	28%	
		Hihiiwai Street	Kapiolani Blvd	E	15	100%	100%	100%	80%	100%	93%	100%	100%	100%	100%	100%	100%	100%	100%		
		Hihiiwai Street	Kapiolani Blvd	W	12	50%	42%	42%	92%	92%	92%	100%	100%	100%	100%	100%	100%	100%	92%		
		Kapiolani Blvd	Date St	E	6	83%	83%	67%	67%	100%	100%	100%	100%	100%	117%	100%	100%	100%	100%		
	University Street	Kapiolani Blvd	Date St	W	7	71%	71%	86%	100%	100%	100%	100%	57%	86%	86%	86%	86%	86%	86%		
		Date St	S King Street	E	25	100%	92%	68%	68%	80%	88%	100%	84%	92%	96%	92%	88%	96%	84%		
		Date St	S King Street	W	18	94%	89%	89%	72%	83%	94%	100%	56%	67%	78%	67%	89%	78%	78%		

Honolulu Emissions Reduction Plan—Parking Framework

Inventory data						Weekday Utilization - Thursday 10/6/22								Weekend Utilization - Saturday 10/22/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
Chinatown	Smith Street	N King Street	N Hotel Street	W	7	86%	100%	100%	86%	100%	100%	86%	43%	100%	100%	100%	57%	100%	57%		
		N King Street	N Hotel Street	E	-																
		N Hotel Street	N Pauahi Street	W	5	40%	80%	100%	60%	80%	100%	100%	40%	80%	100%	80%	100%	100%	100%		
		N Hotel Street	N Pauahi Street	E	4	100%	100%	75%	75%	100%	100%	100%	0%	100%	100%	100%	100%	100%	75%		
		N Pauahi Street	N Beretania Street	W	8	13%	75%	75%	63%	88%	88%	63%	50%	63%	100%	50%	25%	100%	88%		
		N Pauahi Street	N Beretania Street	E	12	17%	42%	83%	33%	75%	100%	67%	25%	58%	75%	8%	25%	92%	92%		
	Nuuanu Ave	Merchant Street	King Street	W	6	33%	83%	83%	67%	100%	83%	50%	83%	100%	83%	67%	83%	100%	100%		
		Merchant Street	King Street	E	4	75%	100%	100%	100%	100%	75%	100%	75%	100%	75%	100%	100%	100%	100%		
		King Street	Hotel Street	W	7	71%	86%	86%	100%	100%	100%	57%	14%	100%	100%	86%	71%	100%	100%		
		King Street	Hotel Street	E	-																
		Hotel Street	Pauahi Street	W	-																
		Hotel Street	Pauahi Street	E	6	100%	83%	83%	100%	100%	100%	83%	33%	100%	83%	83%	83%	100%	100%		
		Pauahi Street	Chaplain Lane	W	6	50%	100%	117%	67%	83%	100%	100%	83%	100%	100%	100%	83%	100%	83%		
		Pauahi Street	Chaplain Lane	E	5	60%	100%	80%	100%	100%	100%	100%	20%	60%	80%	100%	120%	100%	120%		
		Chaplain Lane	Beretania Street	W	-																
		Chaplain Lane	Beretania Street	E	-																
		Beretania Street	Kukul St	W	7	71%	57%	14%	14%	14%	86%	86%	29%	29%	43%	43%	71%	100%	86%		
		Beretania Street	Kukul St	E	8	38%	88%	75%	13%	38%	100%	100%	25%	38%	50%	13%	63%	100%	100%		
		Kukul St	Vineyard Bl	W	-																
		Kukul St	Vineyard Bl	E	8	0%	38%	13%	50%	0%	13%	50%	0%	25%	25%	13%	75%	75%	100%		
	N Pauahi Street	Bethel Street	Nuuanu Ave	N	-																
		Bethel Street	Nuuanu Ave	S	3	67%	67%	100%	67%	100%	67%	100%	0%	0%	67%	33%	100%	67%	67%		
		Nuuanu Ave	Smith Street	N	7	43%	71%	86%	71%	100%	100%	100%	29%	43%	100%	43%	100%	100%	100%		
		Nuuanu Ave	Smith Street	S	6	50%	67%	100%	67%	83%	100%	67%	33%	67%	100%	83%	100%	100%	100%		
		Smith Street	Maunakea Street	N	2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	50%	100%	50%	100%		
		Smith Street	Maunakea Street	S	4	50%	100%	100%	75%	100%	75%	50%	100%	100%	100%	75%	100%	100%	100%		
Maunakea Street		River Street	N	-																	
Maunakea Street		River Street	S	5	80%	100%	100%	60%	0%	0%	0%	80%	80%	80%	40%	40%	80%	80%			
Richards Street	Haleka uwila Street	Queen Street	W	8	50%	63%	50%	25%	38%	63%	50%	50%	38%	13%	38%	38%	88%	50%			
	Haleka uwila Street	Queen Street	E	2																	
	Queen Street	Merchant Street	W	2	100%	50%	100%	100%	50%	50%	0%	50%	50%	100%	100%	50%	0%	0%			
	Queen Street	Merchant Street	E	-																	
	Merchant Street	S King Street	W	-																	
	Merchant Street	S King Street	E	-																	

Inventory data						Weekday Utilization - Thursday 10/6/22								Weekend Utilization - Saturday 10/22/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
Kanunu St	Kanunu St	Keeaumoku St	Kaheka St	N	16	63%	75%	25%	69%	63%	100%	88%	94%	63%	56%	50%	63%	100%	94%		
		Keeaumoku St	Kaheka St	S	14	21%	43%	21%	36%	86%	93%	100%	29%	50%	50%	21%	64%	100%	93%		
		Kaheka St	Kalakaua Ave	N	11	64%	64%	45%	55%	64%	91%	100%	64%	73%	64%	64%	73%	91%	100%		
		Kaheka St	Kalakaua Ave	S	6	17%	50%	67%	33%	100%	100%	83%	67%	83%	83%	50%	50%	83%	67%		

Honolulu Emissions Reduction Plan—Parking Framework

Inventory data						Weekday Utilization - Thursday 10/6/22								Weekend Utilization - Saturday 10/22/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
Civic Ctr	Halekauwila Street	Punchbowl Street	South Street	N	9	44%	67%	67%	56%	67%	67%	33%	33%	67%	44%	33%	56%	89%	78%		
		Punchbowl Street	South Street	S	12	33%	67%	67%	50%	50%	50%	25%	25%	100%	50%	42%	75%	67%	83%		
		South Street	Keawe Street	N	9	33%	67%	44%	33%	11%	78%	56%	56%	33%	33%	0%	11%	100%	89%		
		South Street	Keawe Street	S	4	25%	0%	0%	50%	0%	100%	100%	0%	0%	0%	0%	50%	75%	100%		
		Keawe Street	Coral Street	N	2	0%	0%	0%	0%	50%	100%	100%	50%	50%	150%	50%	50%	50%	50%		
		Keawe Street	Coral Street	S	8	50%	0%	13%	0%	13%	100%	100%	25%	38%	88%	75%	100%	88%	100%		
		Coral Street	Cooke Street	N	-																
		Coral Street	Cooke Street	S	7	71%	86%	86%	100%	100%	100%	100%	0%	14%	0%	57%	57%	71%	86%		
	Cooke Street	Ilalo Street	Ala Moana Bl	W	9	0%	11%	22%	11%	11%	22%	33%	0%	11%	11%	33%	33%	11%	0%		
		Ilalo Street	Ala Moana Bl	E	12	0%	17%	42%	8%	8%	0%	8%	8%	33%	33%	8%	17%	17%	25%		
		Ala Moana Bl	Auahi Street	W	-																
		Ala Moana Bl	Auahi Street	E	-																
		Auahi Street	Pohukaina Street	W	11	9%	18%	55%	9%	18%	100%	100%	18%	45%	45%	27%	73%	100%	100%		
		Auahi Street	Pohukaina Street	E	10	30%	40%	40%	10%	20%	100%	80%	70%	10%	60%	80%	80%	100%	100%		
		Pohukaina Street	Halekauwila Street	W	11	73%	55%	36%	82%	27%	100%	100%	45%	45%	55%	36%	27%	100%	100%		
		Pohukaina Street	Halekauwila Street	E	10	0%	20%	20%	60%	0%	100%	100%	40%	40%	50%	0%	0%	90%	0%		
		Halekauwila Street	Ilaniwai Street	W	2	100%	0%	50%	0%	0%	100%	100%	0%	100%	50%	0%	50%	0%	100%		
		Halekauwila Street	Ilaniwai Street	E	2	0%	50%	100%	100%	50%	100%	100%	100%	50%	100%	50%	100%	100%	100%		
		Ilaniwai Street	Queen Street	W	-																
		Ilaniwai Street	Queen Street	E	3	0%	100%	67%	67%	67%	100%	100%	67%	100%	67%	67%	67%	100%	100%		
		Queen Street	Kawalahao Street	W	-																
		Queen Street	Kawalahao Street	E	3	100%	67%	100%	100%	0%	100%	100%	33%	67%	33%	100%	67%	67%	67%		
		Kawalahao Street	Kapiolani Bl	W	-																
		Kawalahao Street	Kapiolani Bl	E	17	76%	88%	88%	94%	6%	59%	100%	71%	94%	94%	88%	71%	88%	100%		
		Kapiolani Bl	S King Street	W	-																
		Kapiolani Bl	S King Street	E	10	Road Construction during day						100%	Road Construction during day						20%		
		Pohukaina Street	Punchbowl Street	South Street	N	13	85%	100%	62%	92%	54%	100%	54%	38%	62%	54%	69%	77%	62%	77%	
			Punchbowl Street	South Street	S	-															
	South Street		Keawe Street	N	6	67%	83%	67%	83%	100%	83%	67%	33%	83%	83%	83%	83%	100%	83%		
	South Street		Keawe Street	S	2	50%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%		
	Keawe Street		Coral Street	N	7	14%	43%	14%	14%	29%	100%	86%	43%	43%	71%	86%	57%	71%	100%		
	Keawe Street		Coral Street	S	10	30%	20%	50%	90%	90%	100%	80%	50%	80%	90%	100%	80%	100%	90%		
	Coral Street		Cooke Street	N	8	0%	0%	0%	13%	0%	13%	0%	0%	13%	0%	0%	0%	100%	13%		
	Coral Street		Cooke Street	S	9	22%	44%	22%	22%	100%	100%	67%	56%	33%	22%	22%	56%	100%	100%		

Inventory data						Weekday Utilization - Thursday 10/6/22								Weekend Utilization - Saturday 10/22/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
S King Street	S King Street	Ward Avenue	Pensacola Street	N	30	10%	0%	3%	0%	0%	0%	100%	7%	0%	0%	3%	23%	50%	47%		
		Ward Avenue	Pensacola Street	S	-																
		Pensacola Street	Piikoi Street	N	6	17%	17%	33%	0%	0%	0%	100%	33%	83%	67%	17%	17%	100%	100%		
		Pensacola Street	Piikoi Street	S	6	0%	0%	33%	0%	0%	0%	100%	17%	100%	83%	0%	17%	50%	100%		
		Piikoi Street	Alder Street	N	2	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%	0%	50%		
		Piikoi Street	Alder Street	S	3	0%	0%	67%	0%	0%	0%	100%	0%	0%	33%	0%	0%	67%	33%		
		Alder Street	Birch Street	N	2	0%	0%	100%	0%	0%	0%	100%	0%	150%	50%	0%	0%	100%	100%		
		Alder Street	Birch Street	S	5	0%	80%	60%	80%	0%	0%	80%	0%	40%	40%	80%	20%	100%	80%		
		Birch Street	Cedar Street	N	4	50%	25%	75%	75%	0%	0%	75%	0%	25%	100%	100%	75%	100%	100%		
		Birch Street	Cedar Street	S	1	0%	100%	100%	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%		
		Cedar Street	Sheridan Street	N	3	100%	133%	133%	67%	0%	0%	100%	100%	100%	67%	100%	67%	100%	100%		
		Cedar Street	Sheridan Street	S	5	0%	0%	20%	0%	0%	0%	100%	40%	40%	80%	0%	20%	100%	100%		
		Sheridan Street	Ke'eaumoku Street	N	-																
		Sheridan Street	Ke'eaumoku Street	S	-																
		Ke'eaumoku Street	Kaheka Street	N	18	6%	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	33%	
		Ke'eaumoku Street	Kaheka Street	S	9	11%	33%	89%	44%	0%	44%	89%	0%	33%	56%	67%	22%	78%	100%		
		Kaheka Street	Kalakaua Ave	N	3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
		Kaheka Street	Kalakaua Ave	S	3	67%	0%	67%	67%	0%	0%	0%	67%	67%	67%	67%	33%	67%	67%		

Honolulu Emissions Reduction Plan—Parking Framework

Inventory data						Weekday Utilization - Thursday 10/6/22								Weekend Utilization - Saturday 10/22/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
Makiki	Piikoi Street	Lunalilo Street	Wilder Avenue	W	19	95%	95%	79%	89%	100%	100%	100%	79%	89%	100%	95%	95%	89%	79%		
		Lunalilo Street	Wilder Avenue	E	21	100%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	76%	100%	76%		
		Ward Street	Victoria St	N	7	71%	86%	86%	29%	14%	71%	100%	86%	86%	86%	100%	100%	100%	100%		
	Kinaiu Street	Ward Street	Victoria St	S	11	9%	36%	45%	18%	0%	0%	100%	18%	82%	91%	82%	45%	100%	73%		
		Victoria St	Pensacola Street	N	21	76%	81%	67%	33%	0%	81%	100%	81%	95%	95%	81%	95%	90%	100%		
		Victoria St	Pensacola Street	S	23	91%	87%	70%	39%	0%	83%	100%	91%	100%	96%	78%	78%	70%	100%		
		Pensacola Street	Piikoi Street	N	6	100%	83%	83%	83%	83%	100%	100%	83%	100%	83%	83%	100%	100%	133%		
		Pensacola Street	Piikoi Street	S	14	43%	57%	14%	36%	14%	71%	100%	86%	79%	79%	43%	71%	86%	86%		
		Piikoi Street	Ke'eaumoku Street	N	15	100%	87%	93%	80%	80%	80%	93%	100%	87%	100%	93%	93%	93%	93%		
Piikoi Street	Ke'eaumoku Street	S	23	100%	87%	91%	78%	83%	87%	100%	83%	70%	65%	65%	83%	70%	91%				
Kalihi	Kaili Street	N King Street	Beckley Street	W	-																
		N King Street	Beckley Street	E	15	100%	100%	100%	93%	93%	93%	100%	93%	93%	100%	93%	93%	93%	93%		
	Gulick Avenue	N King Street	Beckley Street	W	12	42%	67%	100%	100%	100%	100%	100%	92%	100%	133%	100%	100%	100%	100%		
		N King Street	Beckley Street	E	11	100%	82%	55%	27%	27%	100%	100%	100%	100%	136%	100%	100%	100%	100%		
	Mokauea Street	Dillingham Blvd	N King Street	W	17	29%	65%	71%	94%	100%	82%	88%	100%	82%	76%	71%	100%	65%	88%		
		Dillingham Blvd	N King Street	E	14	86%	79%	50%	21%	93%	100%	100%	100%	143%	136%	100%	100%	100%	100%		
	Kaumuali Street	Puuhale Road	Kalihi Street	N	18	100%	94%	100%	100%	94%	100%	89%	78%	72%	83%	94%	83%	100%	94%		
		Puuhale Road	Kalihi Street	S	15	53%	67%	67%	73%	80%	100%	100%	87%	80%	87%	80%	93%	100%	100%		

Inventory data						Weekday Utilization - Wednesday 2/8/23								Weekday Utilization - Saturday 2/4/22							
Area	Street	Beginning Point	Ending Point	Side of Road	Parking Spaces	8am	10am	12pm	2pm	4pm	6pm	8pm	8am	10am	12pm	2pm	4pm	6pm	8pm		
Kailua	Uluniu St	Oneawa St	Aarona Pl	N	13	77%	100%	92%	77%	92%	100%	85%	46%	100%	85%	54%	62%	92%	92%		
		Oneawa St	Aarona Pl	S	15	53%	93%	80%	67%	73%	100%	93%	13%	80%	80%	60%	60%	73%	67%		
		Aarona Pl	Aulike St	N	-																
		Aarona Pl	Aulike St	S	-																
		Aulike St	Maluniu Ave	N	12	50%	100%	75%	92%	92%	67%	50%	58%	67%	92%	83%	92%	42%	92%		
	Maluniu Ave	Aulike St	Maluniu Ave	S	12	75%	100%	92%	92%	83%	83%	92%	83%	92%	92%	100%	83%	100%	67%		
		Uluniu St	Kuulei Rd	E	13	8%	62%	77%	54%	62%	62%	85%	0%	23%	23%	31%	31%	62%	100%		
		Uluniu St	Kuulei Rd	W	6	0%	100%	100%	100%	83%	83%	83%	17%	67%	67%	83%	83%	67%	100%		
	Aulike St	Uluniu St	Kuulei Rd	E	10	40%	70%	70%	50%	60%	60%	50%	80%	80%	40%	40%	90%	100%	80%		
		Uluniu St	Kuulei Rd	W	9	56%	100%	78%	44%	56%	78%	44%	78%	89%	78%	67%	67%	100%	78%		
	Kuulei Rd	N Kainalu Dr	Maluniu Ave	N	2*	50%	0%	50%	100%	50%	50%	50%	100%	100%	100%	100%	100%	50%	50%		
		N Kainalu Dr	Maluniu Ave	S	10*	60%	70%	60%	70%	30%	30%	20%	70%	70%	50%	40%	30%	20%	10%		
		Maluniu Ave	Aulike St	N	9	33%	89%	56%	33%	33%	56%	100%	22%	56%	56%	56%	33%	89%	100%		
		Maluniu Ave	Aulike St	S	10	20%	70%	30%	30%	10%	0%	10%	20%	30%	40%	70%	30%	40%	20%		
		Aulike St	Oneawa St / Kailua Rd	N	9	33%	89%	89%	11%	0%	56%	56%	100%	89%	78%	33%	33%	67%	100%		
	Kihapai St	Aulike St	Oneawa St / Kailua Rd	S	4	0%	100%	75%	75%	50%	25%	50%	75%	100%	100%	100%	100%	0%	0%		
		Kainehe St	Hoolai St	N	4	50%	100%	100%	75%	100%	50%	100%	50%	100%	100%	100%	50%	50%	75%		
		Kainehe St	Hoolai St	S	7	71%	100%	100%	57%	57%	71%	100%	57%	100%	86%	71%	43%	57%	71%		
		Hoolai St	Oneawa St	N	8	38%	63%	50%	75%	75%	63%	75%	50%	88%	38%	100%	100%	25%	88%		
		Hoolai St	Oneawa St	S	3	67%	67%	100%	100%	67%	0%	100%	33%	100%	100%	100%	67%	33%	100%		
	Kainehe St	Kihapai St	Kailua Rd	E	8	50%	100%	88%	63%	75%	88%	100%	38%	100%	100%	100%	38%	88%	100%		
		Kihapai St	Kailua Rd	W	10	30%	90%	90%	70%	90%	90%	100%	30%	100%	0%	60%	60%	50%	30%		
	Hoolai St	Kihapai St	Kailua Rd	E	12	83%	75%	58%	58%	50%	83%	83%	92%	100%	25%	25%	42%	92%			
		Kihapai St	Kailua Rd	W	7	86%	100%	86%	29%	57%	71%	100%	29%	100%	86%	86%	57%	43%	86%		
	Puniu St	Kainehe St	Hoolai St	N	6	33%	100%	83%	67%	50%	50%	83%	50%	83%	100%	67%	83%	100%	100%		
		Kainehe St	Hoolai St	S	5	60%	100%	100%	80%	100%	100%	100%	80%	100%	100%	80%	100%	100%	100%		
	Municipal Lot	Covered (Senior Apts)	Upper Level		38	66%	92%	95%	92%	79%	47%	53%	74%	89%	74%	58%	47%	63%	76%		
		Covered (Senior Apts)	Lower Level		107	21%	57%	63%	58%	60%	36%	18%	29%	50%	39%	35%	27%	13%	8%		
	Hekili St	Open Air			145	53%	99%	88%	95%	95%	50%	43%	59%	80%	70%	65%	42%	42%	39%		
		Hamakua Dr	Hahani St	N	26*	100%	100%	96%	85%	62%	42%	23%	65%	73%	88%	73%	62%	46%	46%		
	Hamakua Dr	Hamakua Dr	Hahani St	S	21*	100%	100%	100%	90%	81%	48%	48%	52%	95%	90%	76%	76%	43%	33%		
		Kailua Rd	Hekili St	N	-																
		Kailua Rd	Hekili St	S	-																
		Hekili St	Hahani St	N	18*	100%	100%	100%	100%	100%	100%	83%	89%	100%	72%	83%	94%	83%	61%		
	Kailua Rd	Hekili St	Hahani St	S	20*	95%	95%	95%	60%	90%	95%	95%	75%	100%	90%	65%	80%	70%	45%		
		Kuulei Rd	Hahani St	N	11*	91%	82%	91%	82%	73%	36%	18%	91%	100%	73%	64%	27%	0%	18%		
		Kuulei Rd	Hahani St	S	-																

Appendix C: Pricing Model Evaluation Matrix Scoring Explanation

The scoring methodology for the Pricing Model Evaluation Matrix begins by assigning equal weight of 100 possible points to each of the three elements of sustainability, and then lists subgoals under each category, with higher weights or “points available” assigned to subgoals that are associated with larger impacts, that account for greater time periods, or that apply to more people. This appendix provides additional detail regarding the reasoning behind the weight assigned to each subcategory and the value assigned to each of the three pricing models relative to one another.

Environmental Protection

- **Reduces cruising GHG:** This subcategory was assigned 20 points. Even though reducing cruising emissions are a significant source of greenhouse gas emissions, and reducing these emissions is a long-term benefit, cruising represents only a share of total VMT. Demand-based pricing received the full score for this subcategory, since the model centers around maintaining parking availability. Blanket price increases received half of the available points, since the price increases would be likely to increase availability and reduce cruising in some areas, but without the demand focus, cruising may still occur in areas of especially high demand. Cordon pricing received half of the available points for a similar reason; managing the number of vehicles would reduce demand overall, but there could still be localized hot spots. Tier-based pricing received zero points because on its own, the strategy revolves around turnover, rather than availability. Availability and cruising would still depend on the price of parking at the lowest tier.
- **Facilitates repurposing land for greener uses:** This subcategory was assigned only 20 points because while repurposing land for greener uses (e.g., pedestrian walkways, bike and bus lanes, natural landscaping, or urban gardens) can be a very impactful long-term environmental strategy, simply

Honolulu Emissions Reduction Plan—Parking Framework

making it easier to bring about change provides no guarantee change will actually occur. Blanket price increases received the full score for this subcategory because the strategy does not revolve around vehicle access or revenue concerns, but rather uses pricing to gradually reduce car dependency and Honolulu's parking footprint, reclaiming public space for more sustainable land uses. Demand-based pricing received half the available points for this subcategory. Demand-based pricing will not reduce parking demand and free up land on its own; however, it can ensure the parking system continues functioning smoothly should other initiatives be implemented to repurpose curb space in some areas. Cordon pricing received half the available points, because it does have some potential to reduce parking demand, but this is not the goal of the strategy. Tier-based pricing received zero points because the strategy seeks to increase parking turnover, rather than reduce the need for parking.

- **Reduces SOV travel GHG:** This subcategory was assigned 60 points because it represents such a large and quantifiable source of greenhouse gas emissions. Blanket price increases and cordon pricing received the maximum score for reducing SOV travel. With blanket price increases, more people will carpool and gradually choose to walk, bike, or ride transit, eventually creating a more active pedestrian culture and a larger user base of transit users, allowing for more frequent service and further attracting riders. Cordon pricing can be used in a similar way, with a focus on reducing vehicle trips and emissions and shifting travel behavior. Demand-based pricing received half of the available points because it is possible that parking demand will increase prices enough to shift some people's travel behavior, even though this is not the explicit purpose of the strategy. Tier-based pricing received zero points, because prioritizing short-term parking effectively increases capacity, which would *increase* the number of vehicle trips if the lowest tier were maintained below market rate and turnover were increased.

Honolulu Emissions Reduction Plan—Parking Framework

Economic Health

- **Avoids negative short-term impact to local business and economic vitality:**
This category was assigned 20 points because it represents only the short-term impact of each model. Tier-based pricing received the maximum score, because charging more for longer stays is designed to increase turnover and allow more customer access, and there is no reason to expect any negative impact. Demand-based pricing also received the maximum score; this model similarly avoids a negative short-term impact because the pricing manages demand only enough to maintain one or two open spaces on each block, meaning the price ensures each block will still accommodate nearly its capacity of potential customers. Cordon pricing half of the available points because the effect on economic vitality is less certain and depends on the actual price point, which could either resemble demand-based pricing or blanket increases. A demand-based cordon charge would probably positively impact local businesses by reducing congestion just enough to make the area more accessible for drivers who most value access, while a very high cordon charge might be more effective at reducing emissions but dissuade many customers from visiting. Blanket price increases received zero points because the prices would potentially result in underutilized curb space in many areas. The status quo received five points because unavailable street parking also creates negative impact, but over-utilized parking still allows more customer access than under-utilized parking.
- **Creates positive long-term impact on local business and economic vitality:**
This category was assigned 30 points because it represents a longer-term impact. Tier-based pricing received the maximum score because increasing turnover allows more customers (or customers who are less price sensitive and may also be likely to spend more money supporting local businesses) to access the curb in any given time period. Demand-based pricing received nearly the maximum score, but not as high a score as tier-based pricing because maintaining curb availability ensures customers making short trips are able to find a space, but unlike tier-based pricing, the model does not focus on

Honolulu Emissions Reduction Plan—Parking Framework

cycling through as many parkers as possible within a given time frame. Cordon pricing received the maximum score because reducing congestion not only benefits existing businesses, but in the long-term, the efficiency of the transportation system also has the potential to attract new businesses. Blanket price increases received a lower score for potentially allowing underutilized curb space for periods of time, but still received twenty points relative to the status quo, because over the long-term, high parking costs could be expected to reduce vehicle ownership rates and shift more travel to transit, resulting in greater service frequency, more efficient use of space, and greater access.

- **Initial investment of CCH resources:** This category was assigned 20 points because it represents a one-time expense. In this case, the status quo was the baseline and received the full 20 points relative to the other categories since it would not require investment in additional technology or staff time. Blanket price increases received 15 points, because it could require additional meters, but would not require much staff time to implement. Demand-based pricing received 10 points, because it could require the purchase of additional meters to expand into areas of high demand, as well as staff time to determine which areas would benefit from initial price adjustments. Tier-based pricing received 10 points because proper implementation would require investment in pay-by-plate technology to identify how long a specific vehicle had occupied a space. It could also require additional enforcement resources, since enforcement officers could not discern whether the vehicle was parked in violation simply from looking at whether a space was occupied, and the meter had been paid. Cordon pricing received zero points because implementation would require significant study and staff time, as well as the purchase of new technology.
- **Ongoing CCH resources required and ability to generate revenue:** This category was assigned 30 points because it represents fiscal sustainability over the long-term. In this case, cordon pricing received the highest score, because once the system was running, enforcement could be automated through license plate reader technology, and any price adjustments could be

Honolulu Emissions Reduction Plan—Parking Framework

done consistently for all entry points into the cordoned area rather than analyzed on a block-by-block basis. Revenue could be high, especially relative to the ongoing resources required. Tier-based pricing received the second highest score, because as a stand-alone strategy, it doesn't require block-by-block analysis either, so staff resources needed for implementation would be minimal, and the potential for revenue could increase as some people pay the higher tiers. Enforcement would not require any additional resources beyond the status quo once the necessary technology was purchased. Demand-based pricing received 20 points, because block-by-block analysis with regular updates could be somewhat labor intensive, either conducting in-person occupancy counts or analyzing IPS meter data on each street, updating prices, and communicating the information to the public. The potential for revenue generation is high, however, because the strategy optimizes the utilization of parking spaces. Blanket price increases received 20 points, but for opposite reasoning: CCH resource investment would be lower, but so would the potential for revenue, as many parking spaces that might otherwise generate revenue could go empty. The status quo received 10 points because it still requires some staff resources to maintain operations and generates some revenue.

Social Equity

- **Beneficial impact on travelers with limited physical mobility:** This subcategory was assigned 30 points within the social equity category because travelers with limited physical mobility are important to consider, but they may also be less likely to drive alone, so in some cases their needs could also be accommodated by pick-up and drop-off zones. Demand-based pricing received the full 30 points, as this strategy is most likely to result in available parking conveniently located near any destination. Blanket price increases received 20 points, because this strategy would also be more likely to result in additional availability for those who need it most. Tier-based pricing and

Honolulu Emissions Reduction Plan—Parking Framework

cordon pricing would not necessarily increase parking availability, so these strategies received zero points, as did the status quo.

- **Avoids negatively impacting travelers with limited financial resources:** This category was assigned 35 points because it represents a significant portion of the population, many of whom have already made important life decisions (e.g., where to live, where to work, and whether to own a vehicle) based on the assumption that the status quo for the transportation system would continue as usual. Point assignments for each pricing model are sensitive to whether impacts are considered in the short-term or long-term and to whether income-eligible discounted pricing is available. This analysis assumes demand-based and tier-based pricing revenue is reinvested in sustainable transportation alternatives, and that income-eligible discounts are in place. Demand-based pricing received 25 points given these considerations. Tier-based pricing also received 25 points, because it could be considered as providing an additional discount for short-term parkers who might otherwise have decided not to visit an area due to the cost of parking. The status quo received 20 points as the baseline circumstances. Blanket price increases and cordon pricing could create a temporary hardship for travelers with limited financial resources, so these each received zero points, although there would also be potential to implement discounted rates for these strategies. They would also benefit those with limited resources in the longer term, as more travelers would likely switch to walking, biking, and public transit, and the transportation system would respond to this increase in travel with improved service frequency and facilities, but this is accounted for in the subsequent subcategory.
- **Potential to reduce disparities between drivers and those who use other modes:** This subcategory was assigned 35 possible points, partly because data has shown that those without vehicles are most likely to belong to the very lowest income categories, and partly because of the feedback loop by which reducing the disparity between drivers and non-drivers can increase the number of non-drivers, which can result in system improvements that further

Honolulu Emissions Reduction Plan—Parking Framework

encourage people to rely on sustainable transportation. Blanket price increases and cordon pricing received the full 35 points because they have the greatest potential to increase the cost of driving relative to other modes. Reducing driving and congestion would also improve transit operations, or even create space for bus only lanes, further reducing travel time disparities. Demand-based pricing received 25 points based on the assumption that the system would generate additional revenue, which could be reinvested in sustainable transportation, or initiatives like Boulder’s EcoPass. Tier-based pricing received 10 points relative to the status quo, because it could also slightly increase revenues, and also because increasing the cost of long-term parking decreases the disparity between drivers and non-drivers by reducing the affordability of long-term parking in convenient locations, a benefit previously available to drivers.



2024

ENERGY CONSERVATION AND EMISSIONS REDUCTION PLAN

*Department of Transportation Services
Fleet Transition Plan*

Introduction

Recognizing the imperative to reduce carbon emissions, the City and County of Honolulu (City) has committed to transitioning TheBus to zero-emission technologies by 2040. To comprehensively understand the long-term financial and environmental impacts of converting TheBus to an electric fleet, the City analyzed energy consumption scenarios to determine overall cost differentials and energy efficiency. To understand the cost implications, a total cost of ownership (TCO) analysis and a vehicle energy efficiency (VEE) analysis were conducted to determine the effects of electrifying TheBus fleet through 2040. Ultimately, this analysis determined that transitioning TheBus' 463 diesel buses to battery-electric buses, and constructing the accompanying charging infrastructure, can ultimately cost the City nearly an additional \$53.2 million over the next 28 years, when compared against the operation of a similar Diesel fleet.¹ Excluding one-time purchases like chargers and vehicles, the greatest financial benefit to the City is found in the recurring operational savings of an all-electric fleet where this analysis found that Honolulu can save up to \$135.6 million on fuel and maintenance costs over the same 28-year time period. Based on current operations, by 2040, it is expected that an all-electric fleet will require over 33 million kilowatt hours (kWh) of electricity annually. The transition from a diesel-powered bus fleet to an all-electric bus fleet will help to keep TheBus services affordable and will lower greenhouse gas (GHG) and NOx emissions, which in turn can improve health outcomes.

Key Assumptions

Key assumptions and data sources that were used in the TCO and VEE analysis include the following:

- **Vehicle Pricing, TCO:** The model uses manufacturer-suggested retail prices (MSRPs) for electric vehicles (EVs) where available. When MSRP pricing is unavailable, the model uses average pricing based on vehicle and fuel data in Argonne National Laboratory's (ANL) Alternative Fuel Life Cycle Environmental and Economic Transportation (AFLEET) Tool², ICF's *Comparison of Medium- and Heavy-Duty Technologies in California* report for the California Electric

¹ TCO includes the \$275.9 million estimate from the City for charging infrastructure and the \$45.9 million received from the Federal Transit Authority. Total reflects projected capital, fuel, and maintenance costs and utilizes the off-peak electrical rate.

² <https://afleet.es.anl.gov/>

Transportation Coalition (“CalETC report”)³, and ICF’s proprietary library of over 600 EV models. To accommodate a more fiscally conservative forecasting scenario, vehicle pricing was escalated annually using the aggregate of projected Light-Duty vehicle cost trends taken from the U.S. Energy Information Administration’s (EIA) 2023 Annual Energy Outlook (AEO) report.⁴ The model assumed all vehicles are owned and not leased.

- **Fuel, TCO and VEE:** Both analyses relied on the fleet provided fuel prices of \$4.50 per gallon of diesel which is based on data and recommendations provided by TheBus. The TCO model determines the average annual fuel use for each vehicle based on its average annual mileage and average fuel economy (miles per gallon), and then multiplies the fuel use value by the price per unit of fuel. ICF uses annual mileage and fuel efficiency assumptions by vehicle and fuel type from the AFLEET Tool and ICF’s CalETC report. The model escalates gasoline and diesel prices annually using projections from the AEO Reference Case for Transportation Gasoline and Diesel pricing.⁵
- **Maintenance, TCO:** Existing fleet maintenance costs were estimates using the AFLEET Tool dollar-per-mile assumptions by vehicle and fuel type. For diesel and electric transit buses, this equates to a \$1.00/mile and \$0.6/mile maintenance costs, respectively. Maintenance costs were escalated 2.2% annually based on the AFLEET average across 2019–2029.
- **Electricity Pricing, TCO and VEE:** Both analyses use Hawaiian Electric Company’s (HECO) proposed the E-Bus-P Rates (Docket #2023-0457), which assumes an off-peak effective rate of \$0.2868150 per kWh (10 pm – 5 pm) and an on-peak effective rate of \$0.6499227 per kWh (5 pm – 10 pm). For the TCO analysis only, the rates were escalated annually using projections from the U.S. EIA’s 2023 AEO Reference Case for Electricity. The VEE analysis factored in the proposed E-Bus-P rate also factored in the cost of the demand charge of \$4 per kW. Demand is determined by the maximum average load in kW during any fifteen-minute period as indicated by a demand meter each month. For the VEE analysis, a conservative estimate for demand assumes that all chargers are being utilized at the same time, therefore the monthly demand charge would be \$4 x (113 chargers x 150 kW), or \$67,800. Annually, demand charges would cost the City \$796,650.

³ CalETC report data is private. A summary report for policymakers is accessible here: https://caletc.com/assets/files/Summary-for-Policymakers_FINAL.pdf.

⁴ https://www.eia.gov/outlooks/aeo/tables_ref.php

⁵ https://www.eia.gov/outlooks/aeo/tables_ref.php

- **Vehicle Replacements, TCO and VEE:** ICF staggered the retirement timeframe based on the vehicle's mileage.
- **Vehicle Lifespan, TCO:** A 12-year vehicle lifespan was used for transit buses based on ANL's AFLEET tool.
- **Timeframe, TCO and VEE:** This analysis focuses on vehicle replacements for 2024 through 2040, with TCO calculations extending out across the 12-year vehicle lifespans to 2051.
- **Electric Articulated and Non-Articulated Bus Efficiency, VEE:** The average vehicle efficiency for electric non-articulated and articulated transit buses is 160 kWh per 100 miles.
- **Discount Rate, TCO:** 5% was used for NPV calculations.
- **Vehicle Ranges, TCO:** The EV mileage ranges per charge were accounted for when recommending vehicle replacements. The analysis also considered the average minimum and maximum temperature range on O'ahu to assess the potential impact that temperatures can have on EV ranges. Given that the average minimum and maximum temperatures in O'ahu are within the optimal range⁶ for battery performance, there is no expected reduction in range due to the climate. For TheBus' current vehicles, the model divided each existing vehicle's annual mileage by 365 operational days per year to estimate the range required each day (as requested by TheBus).
- **EV Charger Ratios, TCO and VEE:** During discussions with TheBus, representatives shared their plans to install 89 150kW direct current fast chargers (DCFC) in charging depots and 24 450kW pantographs to support enroute charging. Following the recent results of a separate EVSE assessment conducted for TheBus, ICF incorporated the City's total estimated charging project cost of \$275.9 million into our assessment. The analysis does not account for the fleet's existing chargers. The EV charging equipment pricing assumptions and incentive program amounts applied in the analysis are detailed in the subsequent assumption points.
- **EV Charging Infrastructure Costs, TCO:** The assumed cost for the 150kW networked DCFC hardware used in this analysis was \$100,000/charger, derived from the CalETC report⁷ and the International Council on Clean Transportation's (ICCT) working paper, *Estimating EV Charging Infrastructure*

⁶ <https://www.geotab.com/blog/ev-range/>

⁷ CalETC report data is private. A summary report for policymakers is accessible here: https://caletc.com/assets/files/Summary-for-Policymakers_FINAL.pdf.

*Costs Across Major U.S. Metropolitan Areas.*⁸ The installation cost assumption for the 150kW DCFC equipment was scaled to \$2,341,593/charger to reflect the \$275.9 million price tag of Honolulu's separate EV charging infrastructure assessment. Based on information shared with ICF regarding this fleet charging project estimate, installation costs reflect the costs associated with designing, planning, and conceptualizing the fleet charging solutions needed to support a total capacity of 500 electric transit buses between 2023 and 2040. As an additional note on installation costs, Honolulu is responsible for utility side upgrades like transformers.

- **EV Charger Operation Costs, TCO:** The model accounts for a \$255/charger/year networking fee based the ANL AFLEET tool. Further, maintenance costs were assumed to be \$200/year/charger, with an annual escalation of 1.1%, based on data from Rocky Mountain Institute's *Reducing EV Charging Infrastructure Costs* report.⁹
- **Incentives, TCO:** TheBus secured \$45,950,005 in funding through the FTA Low-No Program for EVs or EVs and charging equipment, depending on the year (Fiscal Year 2020, 2022 and 2023). The funding was distributed over four fiscal years in accordance with the program's terms, which specify that program funds are in obligation for four fiscal years.

GHG and NOx Emissions Calculation

Key assumptions and data sources that were used in the GHG and NOx emissions modeling:

- **Diesel Emissions, TCO and VEE:** Default national lifecycle values were derived from ANL's 2023 Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model.¹⁰ The GREET model assumes a well-to-wheels emissions of 95941.78 carbon dioxide equivalent (CO₂e) in grams per million British thermal units (g/MMBtu) for diesel, which was converted to 0.012 CO₂e in metric tons per gallon (MT/gallon) of diesel. These values remain constant across the assessment timeframe.
- **NOx Emissions, TCO:** Unlike CO₂e emissions, NOx outputs were calculated exclusively as tailpipe emissions since their emittance is dependent on vehicle usage. NOx outputs for medium- and heavy-duty vehicles were sourced from the CalETC report and do not vary between manufacturing

⁸ <https://theicct.org/publication/estimating-electric-vehicle-charging-infrastructure-costs-across-major-u-s-metropolitan-areas/>

⁹ <https://rmi.org/wp-content/uploads/2020/01/RMI-EV-Charging-Infrastructure-Costs.pdf>

¹⁰ <https://greet.anl.gov/tools>

years. To calculate the NOx emissions, the corresponding output of g/mi is applied depending on vehicle type and manufacturing year. This value is then multiplied by the annual mileage and summed over the vehicle's lifespan.

- **Electricity Emissions, TCO:** Electrical emissions are sourced from the U.S. Environmental Protection Agency's Emissions & Generation Resource Integrated Database (eGRID) dataset by state.¹¹ The most recent eGrid dataset was used for the analysis: it's based on 2022 and was released January 30, 2024. The provided state annual CO2e total output emission rate, measured in CO2e pounds per megawatt-hour (lbs/MWh), this dataset is converted to CO2e megaton per kilowatt hour (MT/kWh). ICF also applied a transmission and distribution loss factor of 4.5%.¹²

Total Cost of Ownership Analysis

The TCO analysis comprehensively evaluates the various factors involved in electrifying TheBus. It compares the costs and emissions implications of transitioning to electric buses with the consequences of maintaining the status quo. This TCO analysis considers capital costs, charging infrastructure hardware costs, charging infrastructure installation costs, annual fuel costs, annual operations and maintenance costs, and potential EV or EV charger grants. The aspirational timeframe to transition TheBus' fleet from diesel-powered to electric-powered is 2024 to 2040.

There are 480 transit buses in TheBus fleet scheduled for retirement between 2024 and 2040, with 463 of them slated for conversion to battery electric transit buses. Currently, TheBus operates 17 electric transit buses—the first to be introduced in Honolulu—with funding support provided by the U.S. Department of Transportation Federal Transit Administration's (FTA) Low or No Emission Grant Program (Low-No Program). Notably, the TCO analysis also assumes a maximum lifespan of 12 years for transit buses. Consequently, the fleet TCO analysis extends to 2051 to account for the ongoing fuel and maintenance costs from the vehicles acquired as late as 2040. Figure 1 illustrates the phasing in of these buses as TheBus replaces its existing fleet.

¹¹ <https://www.epa.gov/egrid>

¹² <https://www.epa.gov/egrid/data-explorer>

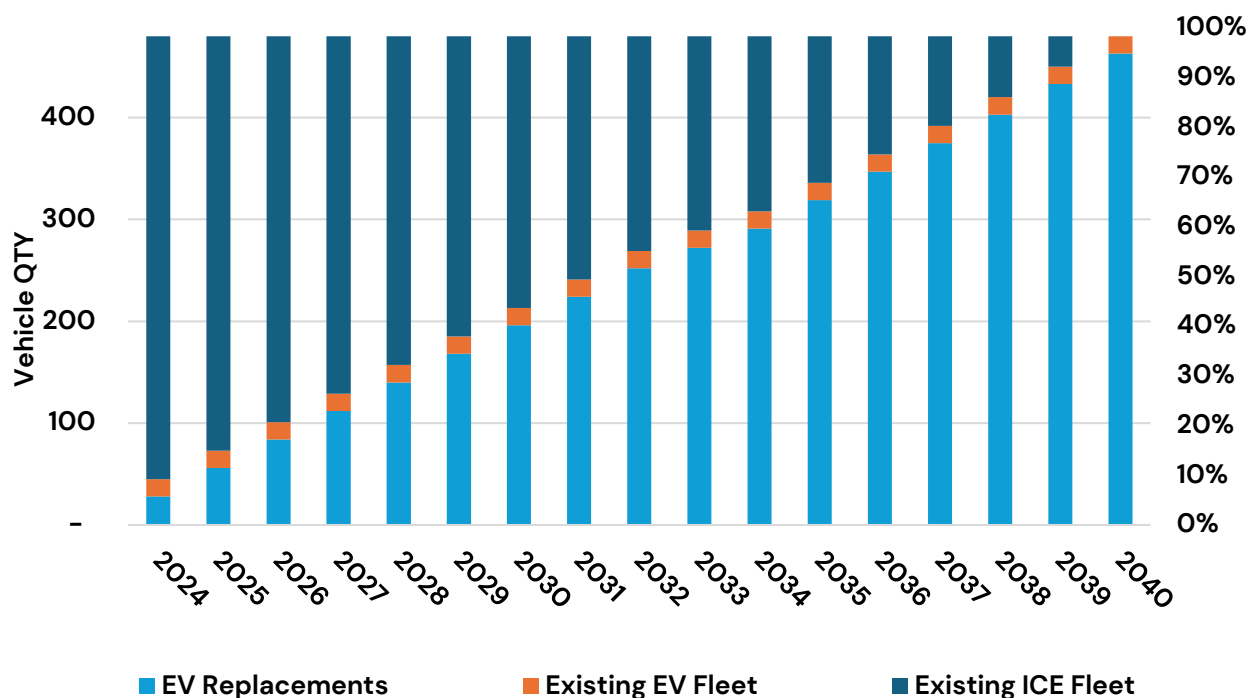


Figure 1. Recommended EV Replacement Timeline: Fuel Types

Transitioning 463 diesel buses to electric will result in a net present value (NPV) TCO differential, or incremental cost of conversion, of \$53,166,845 over the next 28 years (2024–2051), which accounts for the savings across the vehicles’ full lifespans. Notably, this figure is based on HECO’s off-peak electricity rates. Additionally, this analysis accounts for the EV and charging equipment incentives that TheBus secured as part of the FTA’s Low-No Program.¹³ In Fiscal Years 2020, 2022, and 2023, the City secured over \$45M in Low-No funding, which must be used within the four fiscal years of the grants being awarded. The team did not account for any future funding that the City may receive through later funding periods.

Tables 1a and 1b present the TCO differential, or the difference between replacing the existing fleet with EVs instead of Diesel units, across three electrical rate scenarios. These scenarios consider the costs of off-peak, on-peak, and the average

¹³ <https://www.transit.dot.gov/funding/grants/fiscal-year-2020-low-or-no-emission-low-no-bus-program-projects>; <https://www.transit.dot.gov/funding/grants/fy22-fta-bus-and-low-and-no-emission-grant-awards>; <https://www.transit.dot.gov/funding/grants/fy23-fta-bus-and-low-and-no-emission-grant-awards>

of the two for per-kWh-rates. Table 1a accounts for the Low-No Program funding that has already been obtained by the City, whereas Table 1b excludes federal subsidies. Up to charging the fleet exclusively during on-peak hours, TheBus can realize fuel savings when compared to the operation and fueling of similar Diesel units. Across these scenarios, the potential reduction in GHG emissions amounts to 625,870 metric tons (MT). These GHG savings are equivalent to removing 135,188 passenger vehicles from the road for one year.

Table 1a: TCO Comparison Scenarios with Federal Subsidies

Scenario Type	Incremental Capital Costs	Fuel Savings	Maintenance Savings	EVSE Costs	Federal Subsidies	Overall TCO Differential*
Off-Peak Rate	\$(45.3)	\$79.7	\$56.0	\$(184.1)	\$40.5	\$(53.2)
On-Peak Rate		\$(0.5)				\$(133.3)
Average Rate		\$39.6				\$(93.2)

Table 1b: TCO Comparison Scenarios without Federal Subsidies

Scenario Type	Incremental Capital Costs	Fuel Savings	Maintenance Savings	EVSE Costs	Federal Subsidies	Overall TCO Differential*
Off-Peak Rate	\$(45.3)	\$79.7	\$56.0	\$(184.1)	–	\$(93.7)
On-Peak Rate		\$(0.5)				\$(173.9)
Average Rate		\$39.6				\$(133.8)

* All component values have a Net Present Value discount rate of 5% applied. Final values may vary slightly from the sum of all preceding columns because of the rounding of totals.

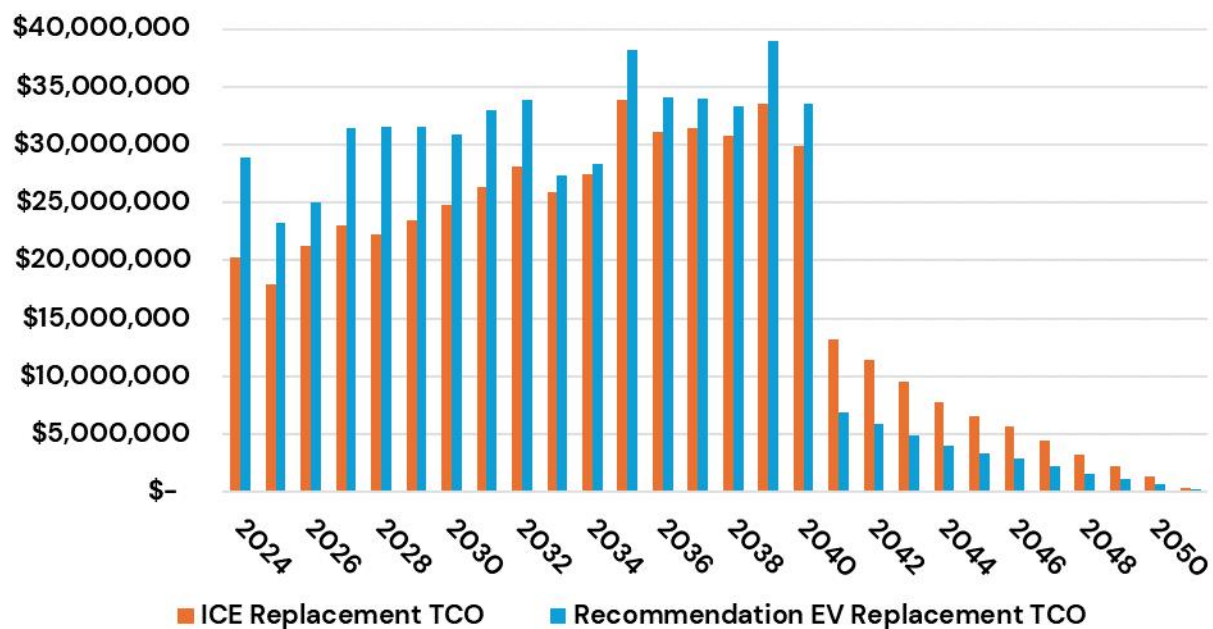
The previous portion of this memo details the analysis assumptions, specific vehicle recommendations, and financial and environmental impacts. Potential references and figures on TCO savings are based on the off-peak electricity rate¹⁴ and includes funding already secured by TheBus, unless otherwise specified.

¹⁴ HECO's Schedule P J off-peak rate is \$0.2868150/kWh per Docket #: 2023-0457

Summary Findings

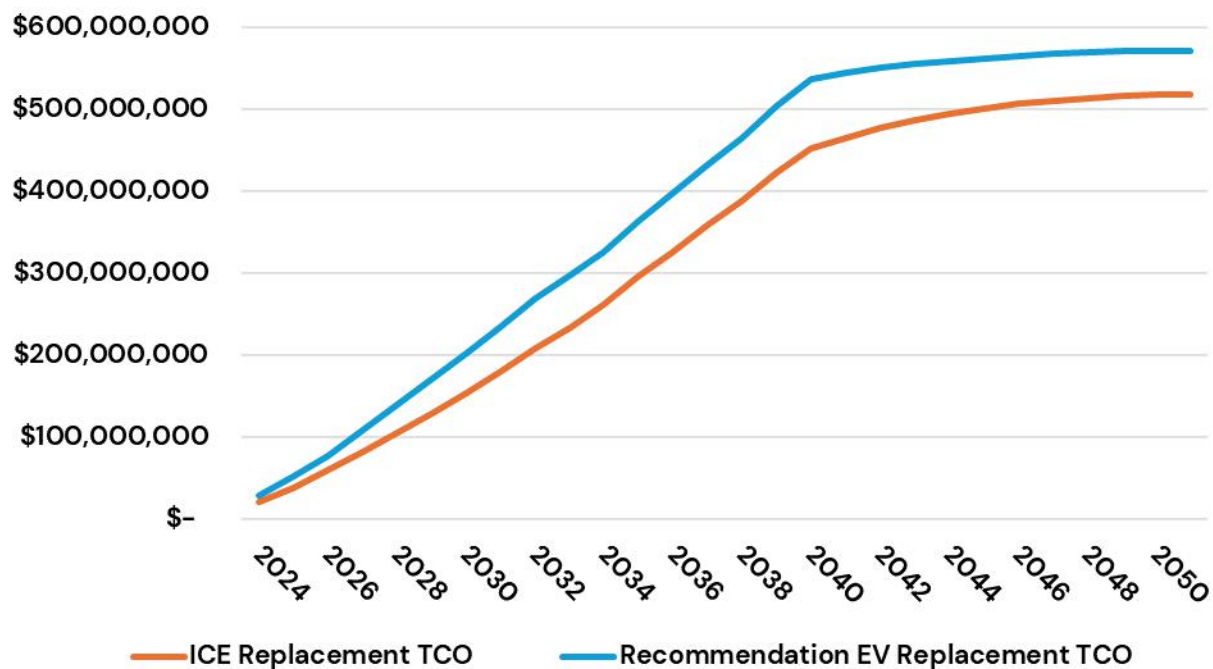
There are 480 transit buses in TheBus fleet that are scheduled for retirement between 2024 and 2040, and 463 of them will convert to battery electric transit buses. Figure 2 below shows the TCO for the 463 recommended vehicles each year if they were replaced with conventional, diesel vehicles versus with the recommended EVs. This timeline is based on the fleet retirement schedule outline in Figure 1 above. Initial EV costs are high due to the associated cost of charging infrastructure and the upfront capital cost of units. However, the reduced operational costs of EVs results in the annual cost of ICE units being more than EV units starting in 2041, as seen in Figure 2. The last EV replacement purchase is scheduled for 2040 so this transition to a lower annual operational cost for the all-electric fleet is the result of EVs having comparatively lower fuel and maintenance costs than their Diesel equivalents. Subsequent generations of EVs have the potential to produce significantly greater financial savings due to the preexisting infrastructure encapsulated in this initial electrification transition cost. Note that the fleet TCO analysis extends to 2051 to account for the ongoing fuel and maintenance costs from the vehicles acquired as late as 2040. A comparison of the cumulative financial costs of operating either an all ICE or all EV replacement fleet is seen in Figure 3.

Figure 2. Fleet Recommended Replacements TCO Comparison – Annual



Key Takeaway: Starting in 2041, or after the purchase of the last bus replacement, the annual cost of operation is higher for an ICE fleet than for a fleet of Battery Electric buses. While EVs are becoming less expensive, the upfront charging cost associated with each EV replacement is heavily impacting initial cost parity.

Figure 3. Fleet Recommended Replacements TCO Comparison – Cumulative



Key Takeaway: While the incremental cost for EVs is high upfront, as noted by the divergence of the two fleet scenarios, the overall cost of fleet operations will gradually begin to approach that of an equivalent ICE fleet as operations continue. This progression is the result of the decreased operational costs of EVs, primarily comprised of lower fuel and maintenance costs.

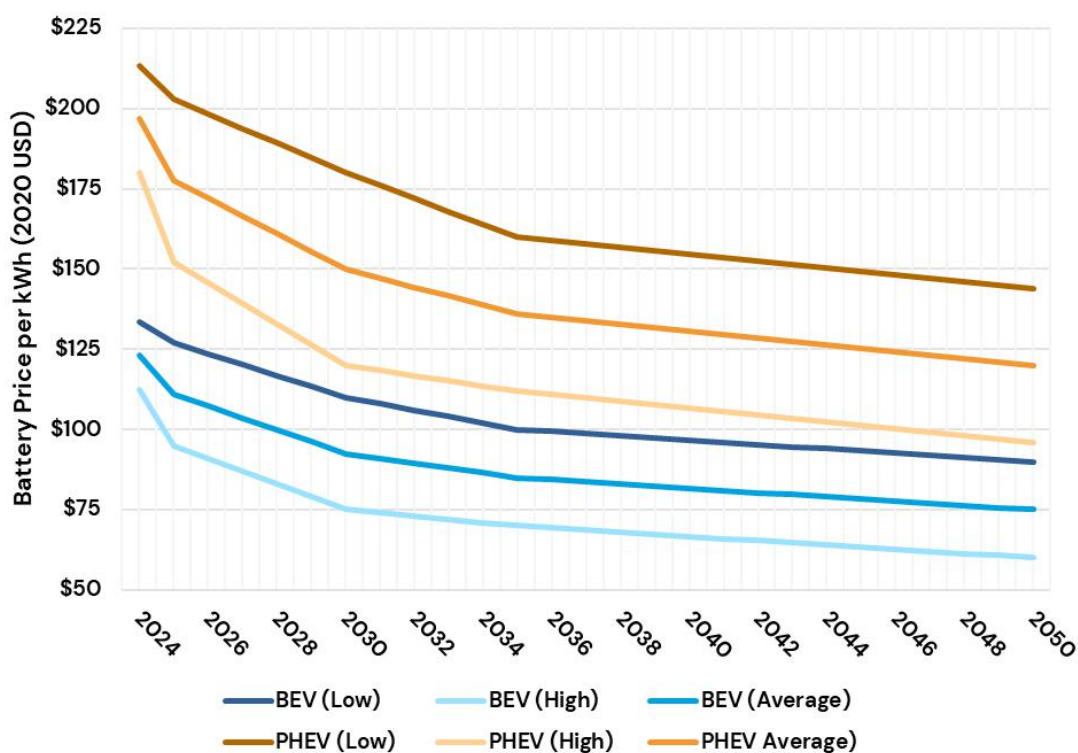
The financial and GHG emission impacts represent the difference between replacing the recommended vehicles with EVs compared to replacing them with ICE vehicles. The TCO used in the financial savings accounts for various factors, such as:

- Capital costs
- Annual fuel costs
- Annual vehicle operation & maintenance costs
- Charging infrastructure hardware costs
- Charging infrastructure installation costs
- Charging infrastructure maintenance and network costs
- Potential EV or EV charger incentives or grants

There are over 600 EV models in ICF's EV library, including over 30 electric transit buses. These vehicles were assessed across TheBus vehicle types and range requirements to compare TCOs and recommend replacement models. While our electric acquisition recommendations are based on the model with the lowest TCO

available that fits your fleet’s daily driving needs, there may be additional EV models within the same price range.¹⁵ For reference, the average cost of a non-articulated electric transit bus in the EV library is approximately \$810,000, whereas a diesel counterpart is assumed to have an average cost of \$500,000. Meanwhile, an electric articulated transit bus has an average cost of nearly \$1.4 million, while its diesel counterpart is approximately \$910,000. While our capital costs are escalated from assumptions tied to the EIA AEO, future technological innovations have the potential to greatly reduce the cost of EVs beyond current modelled trends. While not reflected in our outputs, Figure 4 depicts the anticipated cost of Lithium-Ion batteries for BEVs and PHEVs across three different scenarios of varying technological innovation, taken from ANL Transportation and Power Systems data.¹⁶

Figure 4. Projected Battery Costs for Battery- and Plug-in Hybrid EVs



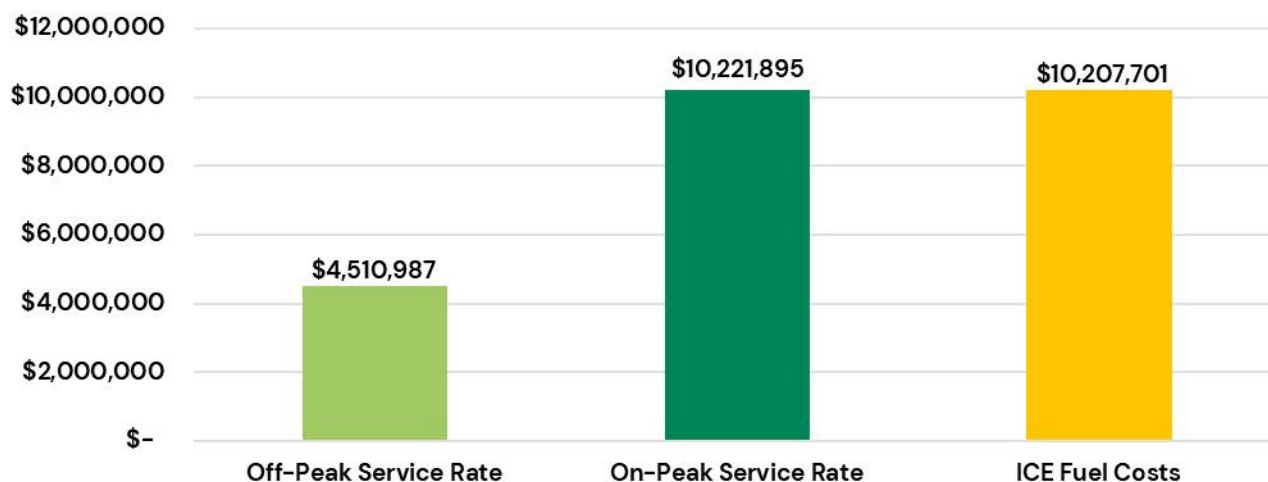
¹⁵ Considering TheBus vehicle types and range requirements, the following electric non-articulated buses were recommended to replace the current fleet: Arboc Equest CHARGE, ENC Axess EVO-BE, GreenPower Motor Company EV250 and EV350 All-Electric Transit Bus. For the electric articulated transit bus replacements, the New Flyer Xcelsior Charge models were suggested, with ranges of 153 miles and 230 miles. Based on feedback from TheBus, ICF did not recommend any replacements through BYD.

¹⁶ <https://www.anl.gov/taps>

Key Takeaway: The decrease in the per kWh cost of Lithium-Ion batteries for EVs is leading to an overall decrease in their capital cost. This model relies on a conservative estimate for the future price of EVs, tied to data from the EIA AEO, and does not account for more aggressive production scenarios or the adoption of new technological innovations.

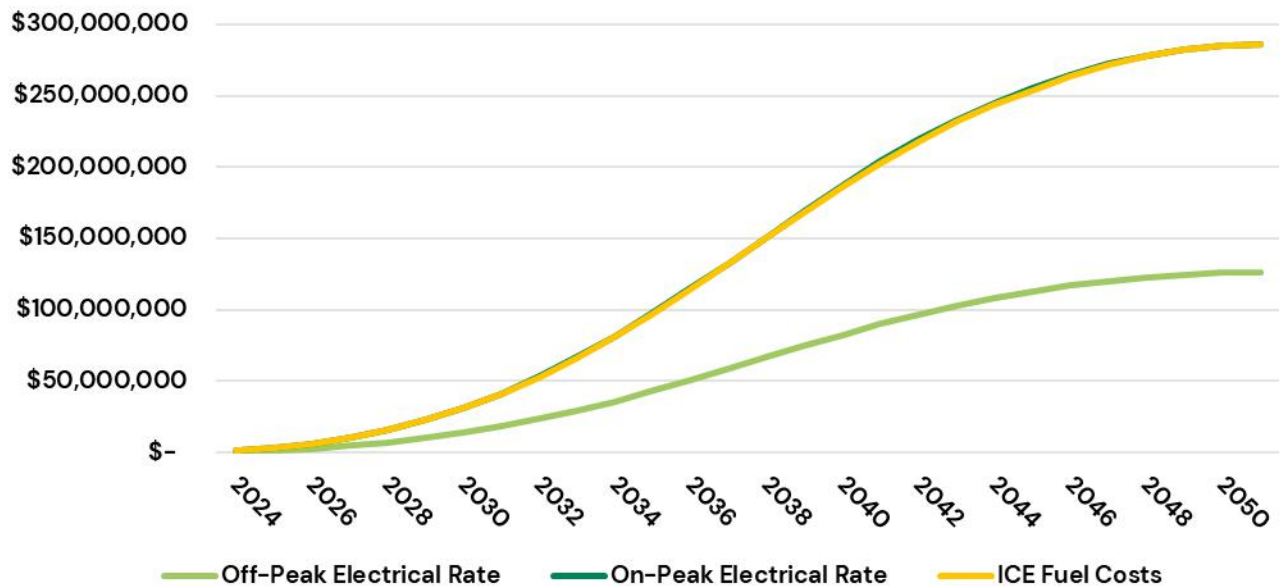
The greatest potential savings for the electric fleet are fuel costs. Looking at the Off-Peak electrical rate, the City can anticipate an annual average of \$5,696,714 in fuel savings over the TCO period of 2024 to 2051, as seen in Figure 5. At the Off-Peak rate, total fleet electrification should result in a cumulative differential of \$159,507,996 in fuel costs, which is equivalent to a net present value of \$79,684,889, as seen in Figure 6. To anticipate the pricing of fuel across the replacement fleet's complete operation, the provided starting rates were scaled using trends established in the EIA's 2023 AEO.

Figure 5. Fleet Average Annual Fuel Cost Comparison



Key Takeaway: Through utilizing the Off-Peak electrical rate, the City can save an annual average of \$5,696,714 in fuel costs. Conversely, exclusively utilizing the On-Peak electrical rate will cost the City an additional \$14,194 in annual fuel costs. Avoiding On-Peak electrical rates, when possible, will greatly increase annual fuel savings.

Figure 6. Fleet Cumulative Fuel Cost Comparison



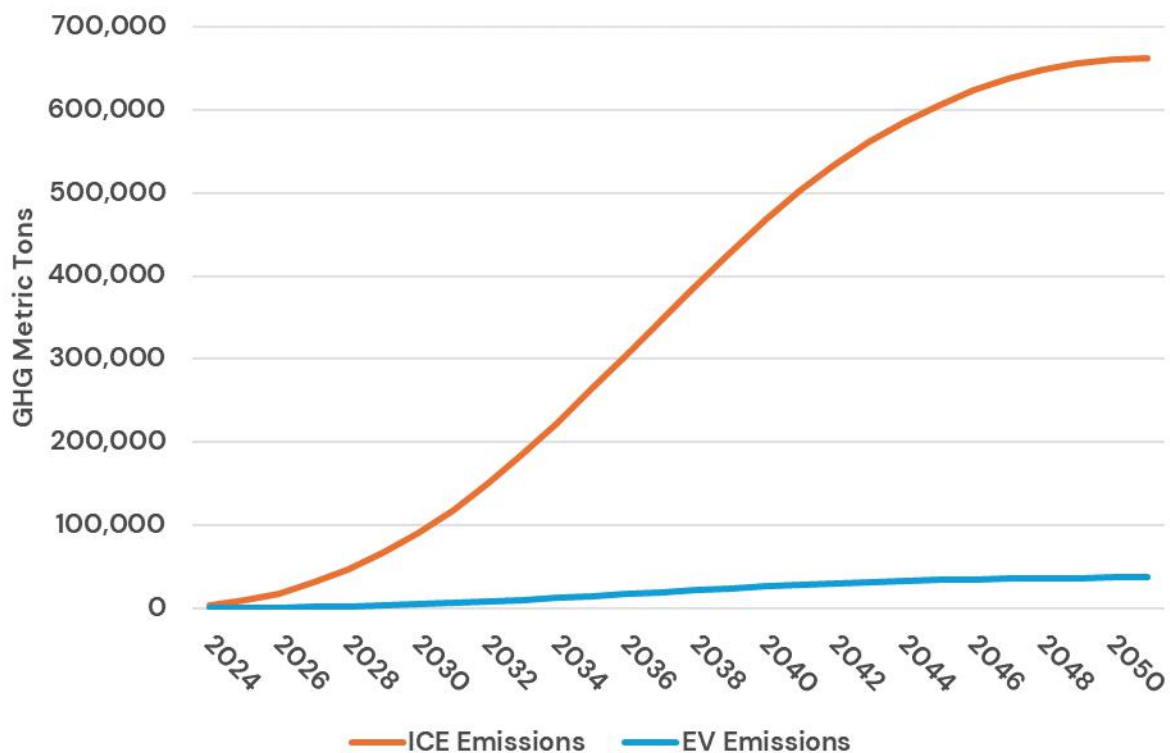
Key Takeaway: Over the next 28 years, the cumulative fuel savings for the City, when using the Off-Peak rate, will be \$159,507,996, which has a net present value of \$79,684,889. Relying on the On-Peak rate, the City will spend an additional \$397,423 on fuel costs over that same time period, which translates to a net present cost of \$423,952. As noted in Figure 5, planning charging around On- and Off-Peak windows can greatly reduce fleet fuel costs.

Based on the provided charging assessment data, TheBus fleet will use 295 DCFC cabinet-based ports at charging depots and 24 pantograph ports at enroute facilities to accommodate its newly acquired electric transit buses. This conservatively assumes a generalized four-to-one charger-to-vehicle ratio and does not account for any existing chargers at TheBus fleet facilities. This would result in a total EV charging infrastructure equipment and installation costs of \$275,900,000 for the fleet. Charging networking and maintenance costs would cost \$547,373 over the TCO timeframe.

From our analysis, converting 463 transit buses to electric equivalents is could reduce GHG emissions by 625,870 MT and NOx emissions by 68,969 pounds (lbs) over 28 years. The GHG emissions reductions are equivalent to removing 635,870 passenger vehicles from the road for one year or planting 10,326,826 trees. Figure 7 below illustrates the cumulative GHG emissions for ICE replacements compared to EV replacements. The GHG emissions included in this analysis account for both

tailpipe and source (fuel production) emissions, while the NOx emissions account for only tailpipe emission reductions.

Figure 7. Cumulative Fleet Green House Gas Emissions



Key Takeaway: The total emissions of operating an electric fleet will result in roughly 5.6% of the total emissions of operating an ICE fleet. While the production of an EV is typically more emission intensive than that of an ICE equivalent, the operational impact of an EV generally results a net-emission reduction.¹⁷

¹⁷ <https://www.epa.gov/greenvehicles/electric-vehicle-myths>

Vehicle Energy Efficiency Analysis

Building on the City and County of Honolulu's Fleet Transition Plan, this vehicle energy efficiency (VEE) analysis seeks to help DTS understand the long-term impacts of converting Honolulu's buses to an electric fleet. The VEE analysis determines the energy efficiency and total energy requirements of a fully electric bus fleet by 2040.

Vehicle Energy Efficiency Methodology

Annual Energy Requirements of Bus Fleet

DTS provided data for their entire fleet of buses, which included key information such as fuel economy, annual mileage, days used per week, and annual fuel consumption. To determine the annual energy requirement of each bus, ICF multiplied each bus's annual vehicle miles travelled by the assumed average transit bus efficiency (1.6 kWh per mile). For example, if a bus drove 40,653 miles annually, the annual energy requirement for that bus would be 65,044.8 kWh ($40,653 \times 1.6$ kWh).

Next, to determine the annual energy requirement that the whole bus fleet would require, ICF calculated the additional energy requirement for each bus based on the replacement schedule year. ICF then summed the year and years prior to determine the cumulative annual energy demand until 2040. For example, if 28 buses are scheduled to be replaced in 2025, the cumulative annual energy requirement estimate would include the 28 buses replaced in 2024 and the 28 buses replaced in 2025.

Fuel Use and Tailpipe Emissions

DTS provided annual fuel use data for their diesel buses. Based on this data, ICF determined the total gallons of fuel saved annually from replacing ICE buses with an electric bus. Tailpipe emissions reduction was determined by multiplying the annual fuel usage by the diesel emissions factor.

Annual Electricity Costs based on Energy Requirement

After determining the cumulative annual energy requirements, ICF used the on-peak and off-peak rates to estimate the electricity costs that DTS could expect from current fleet operations until 2040. There were three scenarios that ICF analyzed: 100% off-peak, 100% on-peak, 50% off-peak/50% on-peak (average rate). ICF

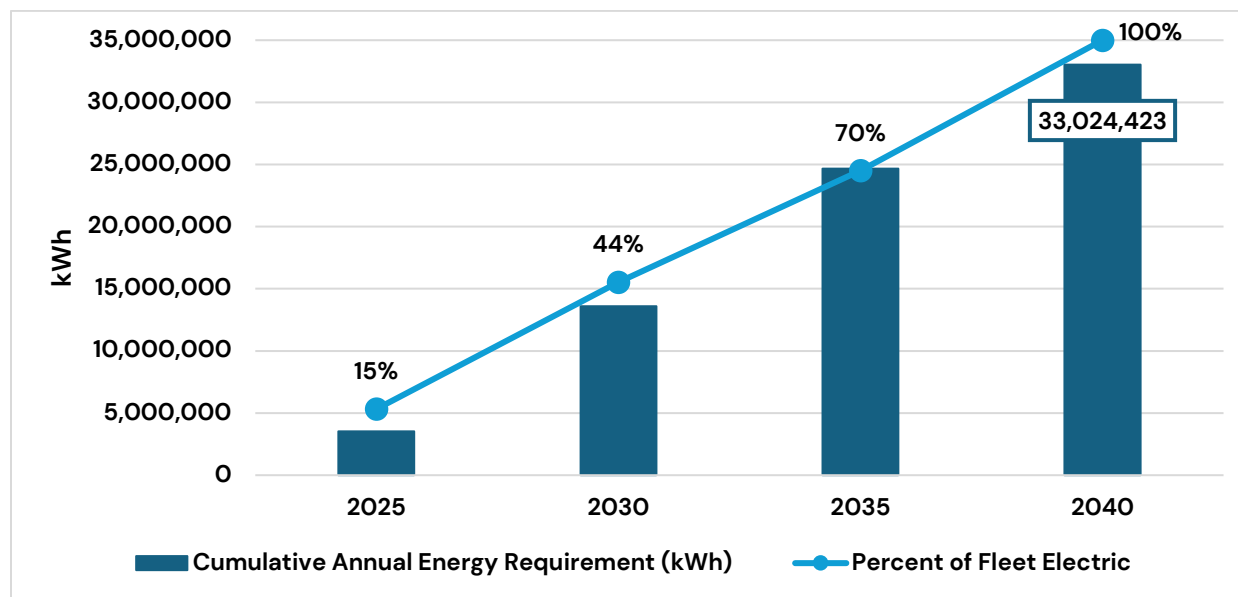
multiplied the cumulative annual energy requirement (kWh) by the proposed E-Bus P-Schedule Effective Rates for each scenario. Then, ICF added the proposed \$4/kW annual demand charge. For the three scenarios inclusive of the demand charges, the annual cost of electricity for 480 electric buses would cost \$22.3 million for the on-peak scenario; \$10.3 million for the off-peak scenario; and \$16.3 million for the average scenario.

Summary Findings

Energy Requirement

By 2040, an entirely electric fleet of buses will require over 33 million kWh of electricity to charge the fleet from depletion levels (based on annual VMT). With this energy requirement, the electric bus fleet is projected to use 0.5% of O‘ahu’s total energy production (based on 2021 data).¹⁸ Figure 8 illustrates the annual fleet energy requirement as the bus fleet electrifies in five-year intervals.

Figure 8. Annual Fleet Energy Requirement (kWh) Based on Annual VMT



Key Takeaway: The energy requirement posed by supporting an all-electric fleet for TheBus is expected to reach an annual demand of 33 million kWhs by 2040. The current retirement schedule of bus units is staggered such that the annual increase

¹⁸ <https://files.hawaii.gov/dbedt/economic/databook/db2022/section17.pdf>

is consistently distributed across this timeframe which should help with ensuring the grid is capable of supporting the additional posed demand.

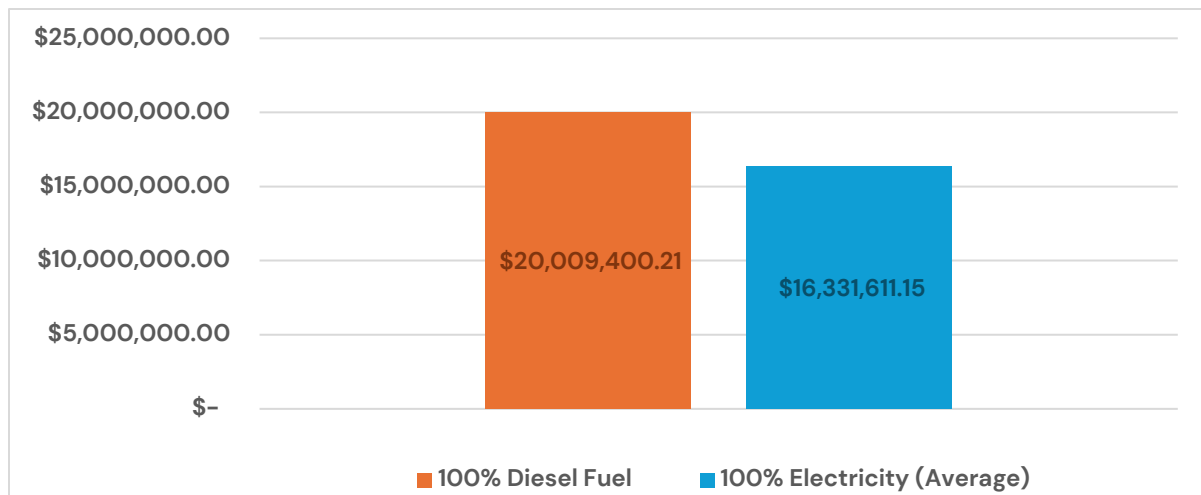
Fuel Use and Tailpipe Emissions Reduction

Using DTS provided data on each bus's annual diesel fuel consumption, ICF found the cumulative annual diesel fuel reduction based on the bus replacement schedule. By 2040, an all-electric fleet will reduce about 4.4 million gallons of diesel fuel consumption by the City. In turn, this will reduce 55,240 MT GHG tailpipe emissions, and 91,008 pounds of NOx tailpipe emissions.

Energy Cost Comparison

ICF compared the cost of 100 percent diesel fuel operations to 100 percent electric powered operations to determine the price difference. Based on City guidance, ICF assumed that a gallon of diesel would cost \$4.50 in 2040. ICF used HECO's proposed E-Bus P Rate to determine the cost of three different charging scenarios: 100 percent on-peak, 100 percent off-peak, and 50 percent on-peak and 50 percent off-peak (average cost). All scenarios include demand charges. ICF determined that, based off current bus fleet operations, in 2040, a 100% diesel powered fleet would cost the city about \$20 million. For the charging scenarios, ICF found that it would cost the city around \$22 million to charge 100 percent on-peak, around \$10 million for 100 percent off-peak, and around \$16 million for 50 percent on-peak and 50 percent off-peak charging. If the City wants to minimize its costs for powering its fleet, they should minimize on-peak charging time and maximize off-peak charging, while also being mindful of the power demand charges.

Figure 9. 2040 Annual Energy Cost Comparison – Diesel vs. Electricity (Average Cost)

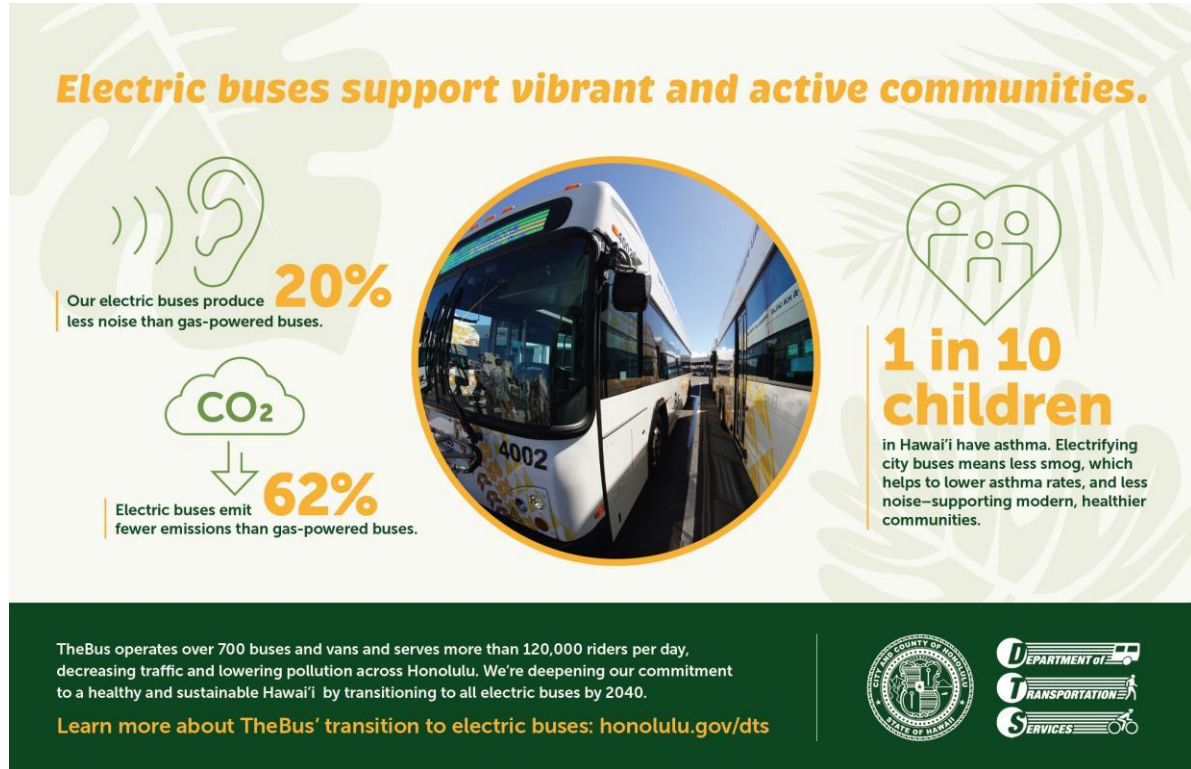


Key Takeaway: Applying the fuel cost of supporting an electric fleet with the average of the On-Peak and Off-Peak rates, operating an all-electric fleet should result in roughly \$4 million in savings annually. This translates to \$39.6 million projected fuel savings in the average rate scenario.

Infographics

To help DTS convey the benefits of transitioning TheBus fleet from ICE to BEB, ICF developed three public-facing infographics. These infographics can be used as advertisements on TheBus or at shelters, and are intended to provide talking points to DTS stakeholders and elected officials. To help support future presentations, ICF is also developing a basic PowerPoint (PPT) template, themed with the background images and colors from these infographic. This will include a cover slide and blank slides a few empty pages with options for content layout and recommended fonts/colors.

Infographic 1:



Infographic 2:

Electric buses combat climate change.

Electrifying city buses will remove the equivalent of **1,000** cars from the road each year.



28% of the energy for our electric buses comes from wind and solar power.



Increasing the use of **renewable energy**

helps Honolulu reduce our carbon footprint, combat climate change, and protect our island for the next generation.

TheBus operates over 700 buses and vans and serves more than 120,000 riders per day, decreasing traffic and lowering pollution across Honolulu. We're deepening our commitment to a healthy and sustainable Hawai'i by transitioning to all electric buses by 2040.

Learn more about TheBus' transition to electric buses: honolulu.gov/dts



Infographic 3:

Electric buses keep service affordable.



\$5.6 million

Average fuel costs DTS will save each year by transitioning to electric buses (2024-2040).

Since 2020, TheBus has used

\$42 million

in dedicated federal funds to purchase electric buses.



TheBus

is investing these savings to improve service and keep fares affordable.

TheBus operates over 700 buses and vans and serves more than 120,000 riders per day, decreasing traffic and lowering pollution across Honolulu. We're deepening our commitment to a healthy and sustainable Hawai'i by transitioning to all electric buses by 2040.

Learn more about TheBus' transition to electric buses: honolulu.gov/dts





2024

ENERGY CONSERVATION AND EMISSIONS REDUCTION PLAN

Capital Fleet Transition Plan – Phase II

Capital Fleet Transition Plan – Phase II

Introduction

The City and County of Honolulu (CCH) has an ambitious goal to achieve 100 percent renewable fuel use for ground transportation across the entire City fleet by 2035. Building off the Capital Fleet Transition Plan (CFTP) (2020), this memo aims to supply strategic support for the planning and deployment of charging infrastructure to support the electrification of the City's fleet. Through a series of workshops and analyses, ICF has identified barriers and opportunities related to fleet electrification and electric vehicle supply equipment (EVSE) installation.

This process began with department level electrification planning workshops, which provided further understanding of the specific needs and considerations of different departments. Next, analyses were conducted on 12 sites across the entire CCH fleet of vehicles to determine the minimum number of EV chargers required. This led to an analysis of existing infrastructure for EVSE and the grid upgrade requirements, along with a cost analysis. Finally, a pivotal aspect of this effort is the development of a phased planning and budgeting timeline. This strategic approach ensures a systematic and efficient process to planning and deploying charging infrastructure, thereby minimizing the costs associated with the fleet transition.

Department Level Electrification Planning Workshops

ICF held four department-level electrification planning workshops with the goal of better understanding operational needs, barriers to electrification, and how major divisions might approach electrification. Participating departments include the Department of Facilities Maintenance (DFM), Department of Parks and Recreation (DPR), Department of Environmental Services (ENV), and the Honolulu Police Department (HPD).

The workshops served as a platform to share information with managers and senior staff about the City's electrification goals, and to demonstrate how electrification may look for each department. It also provided a space for managers and senior

staff to discuss the department's operational considerations, which could be a barrier or opportunity for electrification. The information collected throughout these workshops enabled the ICF team to create custom EV infrastructure planning support based on the unique needs of each department. Based on the original CFTP analysis and the department level electrification workshops, the team identified customized strategies for each department to consider when designing its EV transition plan (Appendix A. Departmental Fleet Strategies

Table 1). For the full departmental strategies and next steps, please see Appendix A. Departmental Fleet Strategies

Table 1. Departmental Fleet Transition Strategies

KEY:		✓ - Suggested Strategy + - Implemented Strategy			
STRATEGY	DESCRIPTION	DFM	DPR	ENV	HPD
Establish annual department EV suitability review process	Although large-scale department EV replacement may not be possible immediately, the department should establish procedures to review EV suitability regularly and identify early electrification opportunities. The department EV suitability review should focus on whether the existing or upcoming EV models can support the current fleet operational/logistical needs. As part of this review, the department shall carefully consider duty cycles, and vehicle characteristics such as body type, function, fast charging capability, EV range, payload, and horsepower.	✓	✓	+	✓
Evaluate vehicle and infrastructure-as-a-service (VaaS and IaaS) options	VaaS and IaaS programs can present a valuable opportunity for departments to evaluate EVs' performance against existing ICE vehicles and to assess vehicle suitability with no significant upfront investment. Key factors to evaluate prior to launching pilot projects include vehicle type, models, daily usage, charging	✓	✓	✓	✓

KEY:		✓	- Suggested Strategy			
		+	- Implemented Strategy			
STRATEGY	DESCRIPTION	DFM	DPR	ENV	HPD	
	demands, vehicle and equipment useful life, maintenance and operation costs, vehicle and equipment downtime, and required staffing levels.					
Identify priority sites for EVSE installation and assess facility energy demand	Although the overall fleet electrification requires incremental steps, work on infrastructure and site development should begin immediately and before the vehicles are delivered to CCH. Departments should immediately start identifying facilities and vehicle dwelling sites that are suitable for early EV deployment and strategically plan the EV make-ready processes.	✓	✓	+	✓	
Explore opportunities to integrate off-grid renewable energy sources with charging infrastructure	Because renewable energy generation can be distributed and the generated electricity can be stored and discharged without the need for fuel deliveries, it also serves as a unique and reliable asset for grid resilience, which can help the facilities keep the power on during disruptions. Departments may consider installing solar panels or small-scale wind turbines along with battery energy storage systems (BESS) at individual sites to power EV charging if space allows.	✓	✓	✓		
Use telematics to better understand current fleet usage	To plan for EV transition and assess infrastructure charging demand and power need, all City departments need to fully understand the current fleet operation and characteristics, which includes, but not limited to, fleet composition, average and maximum daily usage, and fuel consumption. Telematics data can present a wealth of asset information that may facilitate fleet electrification process,	✓	✓	✓	✓	

KEY:		✓	- Suggested Strategy			
		+	- Implemented Strategy			
STRATEGY	DESCRIPTION	DFM	DPR	ENV	HPD	
	beyond what traditional fleet data (e.g., odometer) can provide.					
Establish a communication platform with other city departments and city leadership to share information and best practices	It is important to closely collaborate with other City departments and City leadership to establish an open platform to communicate barriers and difficulties encountered, share department fleet electrification experience and lessons learned, and help the City to adjust and establish new transportation electrification and climate goals moving forward.	✓	✓	+		
Prioritize EV replacements with cost-effective options	Fleet electrification needs to be conducted using a gradual and phased approach given the high upfront costs for equipment purchase and infrastructure installation. Therefore, the department should consider prioritizing replacement of vehicles that are presented with cost-effective EV replacement options.			✓		
Identify facility charging demand and load capacity in advance	Facility charging demand and load capacity needs can alter with many factors. By developing a comprehensive EVSE plan that addresses all charging demands at a facility can assist in identifying potential grid upgrade requirements early on.			✓		
Evaluate EV take-home policy options for officers	It is critical to consider possibilities of amending and updating the current department vehicle take-home policy. For instance, what EV models shall be eligible for inclusion in the current take-home vehicle list, how will electricity usage be reimbursed for EVs, and what additional				✓	

KEY:	✓	- Suggested Strategy			
	+	- Implemented Strategy			
STRATEGY	DESCRIPTION	DFM	DPR	ENV	HPD
	incentives can be offered to offset EV costs and home charging infrastructure and electrical upgrade.				

Minimizing the Quantity of EV Chargers Required

In order to electrify the City's fleet, it is essential to minimize the costs of EVSE and maximize operational efficiency. ICF developed EV infrastructure design methods that can be leveraged by various agencies as they plan for EV infrastructure deployment at their facilities. The methods are intended to serve as a high-level guide for determining charger specifications, infrastructure upgrade requirements, and cost estimates. For the full methodology, see Appendix B.

In tandem, ICF conducted an analysis of 12 sites (three sites per department) to determine charger specifications and find the minimum number of chargers required. Using data from current fleet operations, ICF analyzed the average vehicle miles travelled (VMT) to determine charging requirements, power demand, and charger specifications. Based on these findings, ICF identified a optimized scenario – the highest possible vehicle-to-charger ratio per vehicle class (light-duty vehicle or heavy-duty vehicle) – to determine the least number of chargers required per site based on operational and fleet data. The results of the analysis can be seen in *Table 2* below.

Table 2. Optimized Number of Chargers per Site

Dwell Site	Vehicle Class and Charger Specs	# of Vehicles	Optimized Ratio - # of Vehicles:Charger (by vehicle class)	# of Chargers
KUALOA MAINT YARD	LDV (12-15kW)	23	4 :1	6
	HDV (12-15 kW)	1	1 :1	1
EWA MAHIKO DIST PARK	HDV (DCFC 50 kW)	3	2 :1	2
	LDV (12-15 kW)	11	6 :1	2
KEEHI LAGOON PARK	HDV (L2 12-15 kW)	2	1 :1	2
	LDV (L2 6-8kW)	15	4 :1	4
WAIANAE MAINT YARD	LDV (L2 6-8 kW)	12	6 :1	2
BERETANIA NEIGHBORHOOD COMMUNITY CENTER	LDV (L2 8-11 kW)	14	5 :1	3
HALAWA ROAD	LDV (L2 12-15 kW)	83	4 :1	23
	HDV (DCFC 50 kW)	52	4 :1	13
BLDG KOKEA ST REPAIR & MAINT	LDV (L2 8-11 kW)	40	5 :1	8
ST-SWEEPING-SAND ISLAND	LDV (L2 3-6 kW)	2	2 :1	1
	HDV (DCFC 50 kW)	18	1 :1	14
PEARL CITY ROAD MAINT	LDV (8-11 kW)	13	11 :1	1
	HDV (DCFC 50 kW)	15	3 :1	5

Grid and Site Level Upgrades

Of the sites analyzed in the previous section, the City selected four sites to conduct a site-specific grid load capacity analysis. ICF coordinated with Hawaiian Electric Company (HECO) to collect relevant data and discuss relevant tools and methodologies that HECO previously developed to assess the upgrades needed when fleets are deploying to charge infrastructure. This analysis builds on earlier work done for the CFTP.

Using existing capacity ratings of the main electric panels at each facility, ICF compared the projected additional charging load to panel capacity, which yielded a rough determination of whether each panel is large enough to accommodate the projected EV charging, or if upgrades are necessary. If a site had a power demand over 10kW of the transformer size, ICF recommended a new transformer size and estimated the upgrade costs.

ICF assumed that the costs associated with distribution system upgrades for sites with overloads 10 kW and lower would be captured in the site-level EVSE installation. Furthermore, HECO could mitigate any site overloads below 10 kW by feeder reconfiguration, load balancing, and demand-side management measures. Therefore, calculating the cost of distribution upgrades separately for sites with relatively low overloads may result in overstated infrastructure costs. For this reason, sites with overloads of 10 kW and lower are not calculated.

If a site experienced an overload greater than 10 kW, ICF assumed that distribution system upgrades would be needed to add new power transfer capability. The distribution capacity upgrades ICF accounted for include new service transformer deployments and installation of 100 feet of new conductors and service drops. For service upgrades below 50 kW, ICF assumed that underground reconductors (repull or customer installed conduits) would be needed. For service upgrades greater than 50 kW, ICF assumed a new underground line (trench and installation) would be needed. The costs related to system upgrades were estimated using the Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas and Electric's

Unit Cost Guides because there were no unit costs available for Hawai‘i. The results of this analysis can be found in *Table 3. Grid Upgrade and Cost Analysis* below.

Table 3. Grid Upgrade and Cost Analysis

Dwell Site	Estimated Added Power Demand from EV Chargers (kW)	Total Site Billed Demand (kW)	Total Nighttime Peak Load Under Optimized Scenario	Site Service Transformer Capacity (kVA)	New Transformer Size Required (kVA)	Upgrade cost
WWM-CSM HALAWA	74.7	63.2	137.9	300	-	
HALAWA RD	99.6	200.3	299.9	300	-	
KUALOA MAINTENANCE YARD	33.3	25	58.3	25	50	\$30,178
BERETANIA NEIGHBORHOOD	6.7	0	6.7	150	-	

Results

Of the four sites that CCH selected only one site, Kualoa Maintenance Yard, needed a new transformer based on the additional power demand from EV chargers. The site’s power demand was 33.3 kW, which is more than 10 kW of overload for the current transformer. Therefore, it is recommended that Kualoa Maintenance Yard upgrades to a 50 kVa transformer to meet the additional demand. Since the upgrade requires more than 10 kW in power, the final cost estimate includes the cost of the transformer and costs to trench and install 100 feet of conduit. Although the total assumed nighttime peak demand is greater than 50 kW, it falls within the 10-kW overload allowance, which can be mitigated by HECO. However, it should be noted that the current available billing data does not specify when the current peak happens.

Phased Planning and Budgeting Timeline for City Fleet EV Infrastructure Development

Using the results of the charger analysis and grid upgrade requirements, ICF conducted a budgeting and planning timeline for EV infrastructure development. First, ICF established a vehicle replacement schedule by vehicle miles travelled to determine each site's charger installation schedule. The charger installation schedule for each site is depicted in Figures 1 – 4 below.

Based on the collective charger installation schedules for the four sites, ICF conducted a cost analysis for annual infrastructure costs for each site, which is highlighted in

Figure 5. EVSE costs include hardware and installation cost estimates provided by the Office of Climate Change, Sustainability, and Resiliency (CCSR). The CCSR currently has an estimate of 7715.23 \$/kW for the total EVSE costs, with 30% for design and engineering, and 70% for construction. A 3% year-over-year cost reduction was assumed between now and 2030, consistent with findings from the International Council on Clean Transportation (ICCT).¹ By 2035, ICF estimates that the total costs associated with installing EVSE and charging equipment will be over \$12 million across the four sites based on current costs estimations. However, it is noteworthy that the unit price for charger is not linear, and the current value may be an overestimate. For example, as reported by the Hawai'i Energy², the total project costs to build L2 chargers vary between \$3,000 – \$68,145, while in the current analysis, a single L2 charger installation would cost \$46,291 – \$146,589. For DCFC

¹ https://theicct.org/wp-content/uploads/2021/06/ICCT_EV_Charging_Cost_20190813.pdf

² <https://hawaiienergy.com/wp-content/uploads/evcs-summary-sheet.pdf>

chargers, Hawai'i Energy reported a range of \$38,157 – \$281,120 and our analysis indicates the cheapest DCFC charger with 50 kW output level would cost \$385,761.

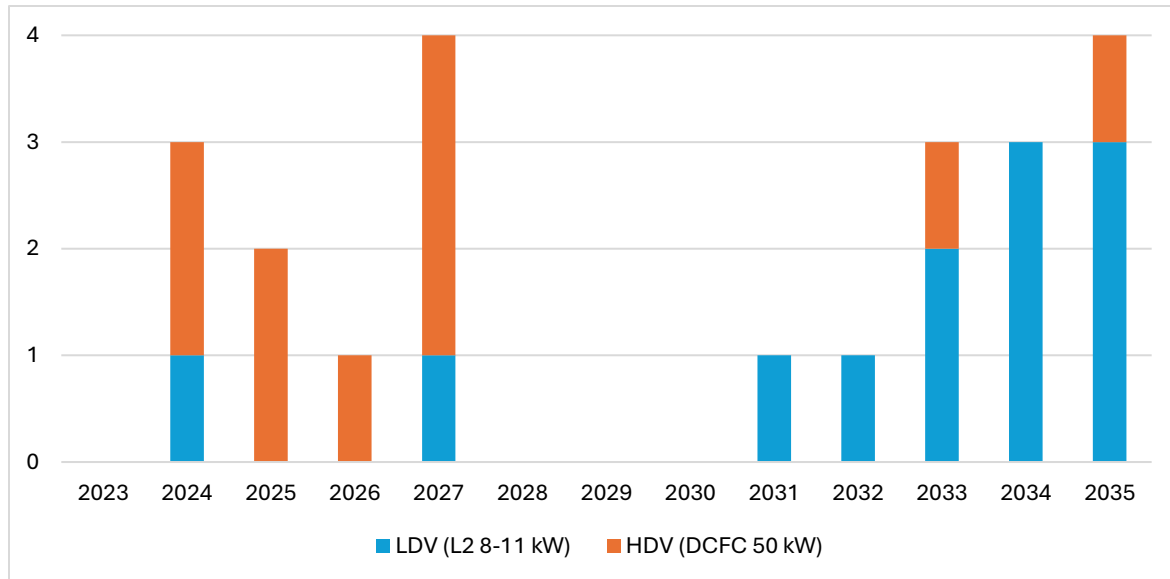


Figure 2. Charger Installation Schedule for Halawa Road

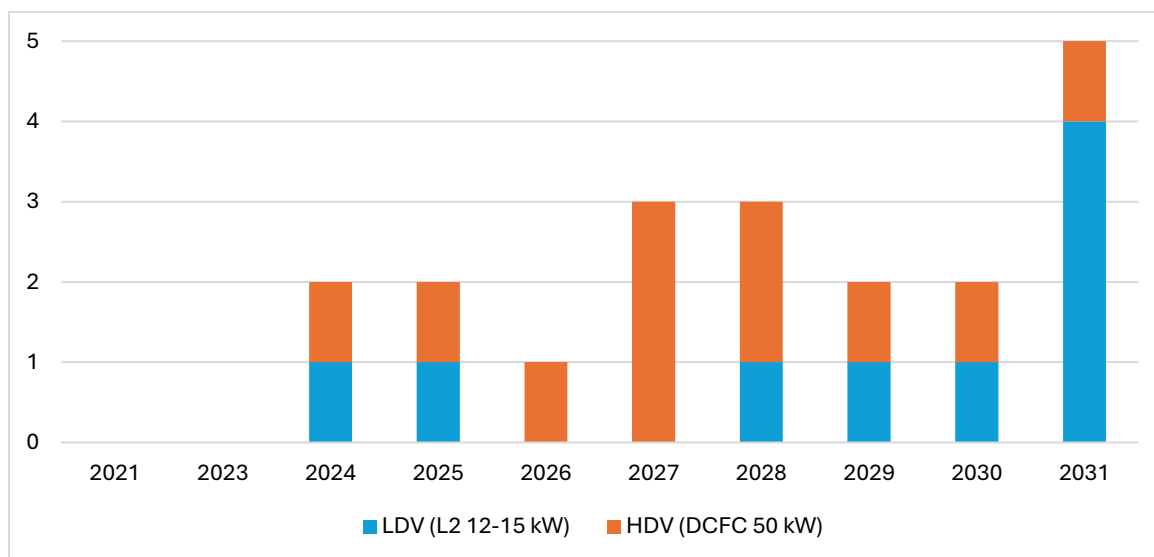


Figure 3. Charger Installation Schedule for Kualoa Maintenance Yard

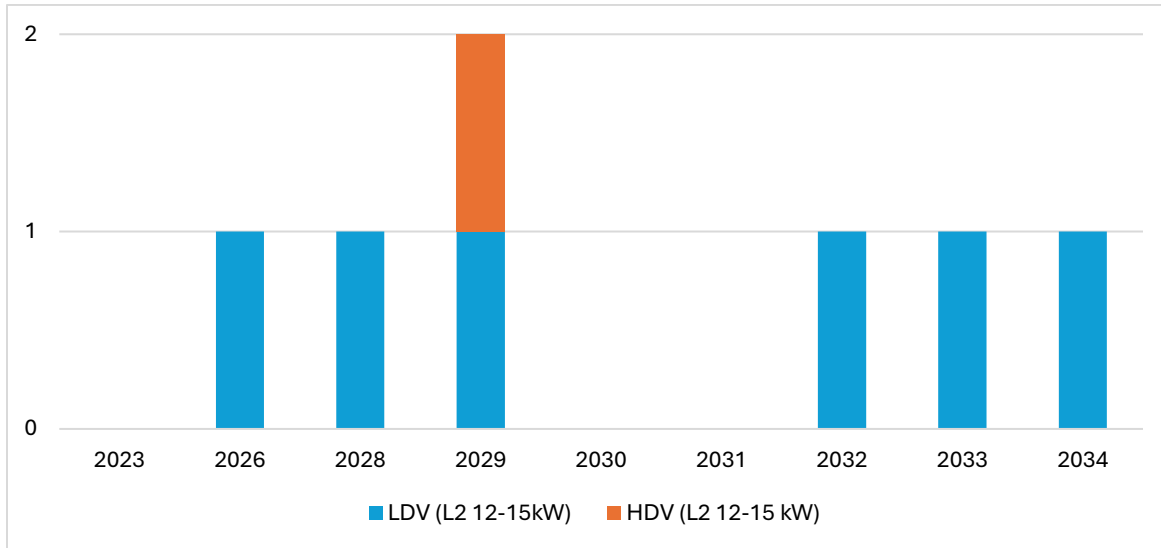


Figure 4. Charger Installation Schedule for Beretania Neighborhood Community Center

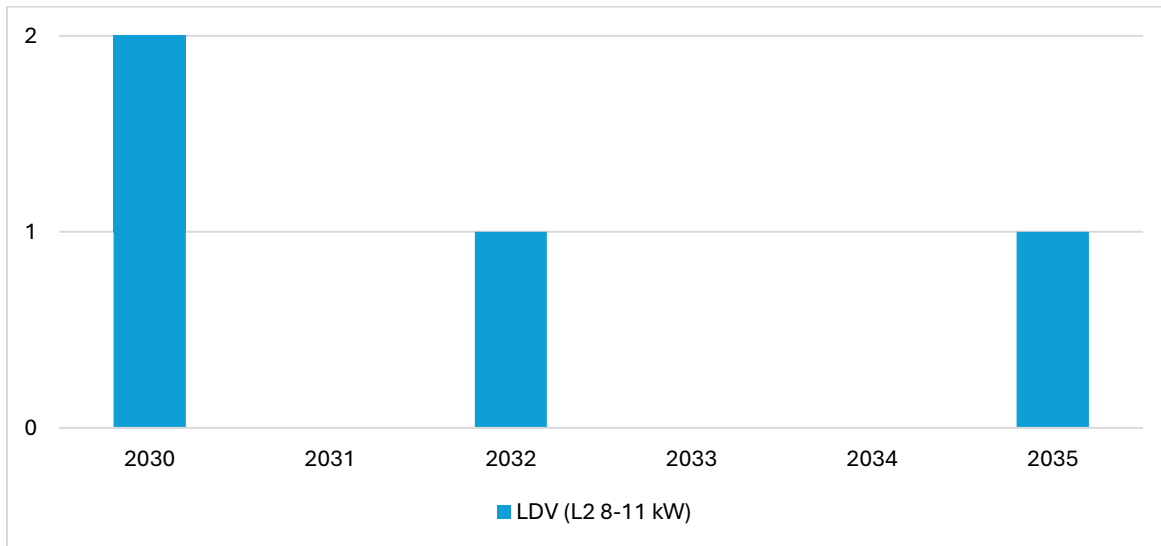
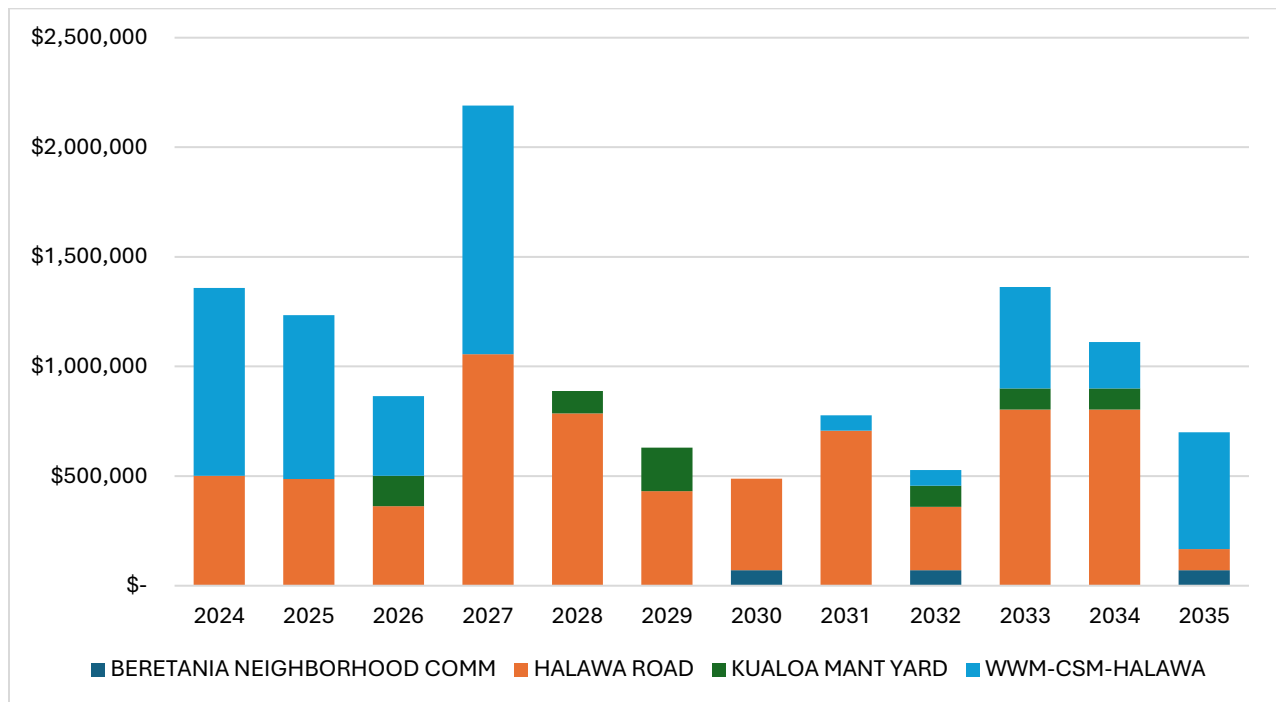
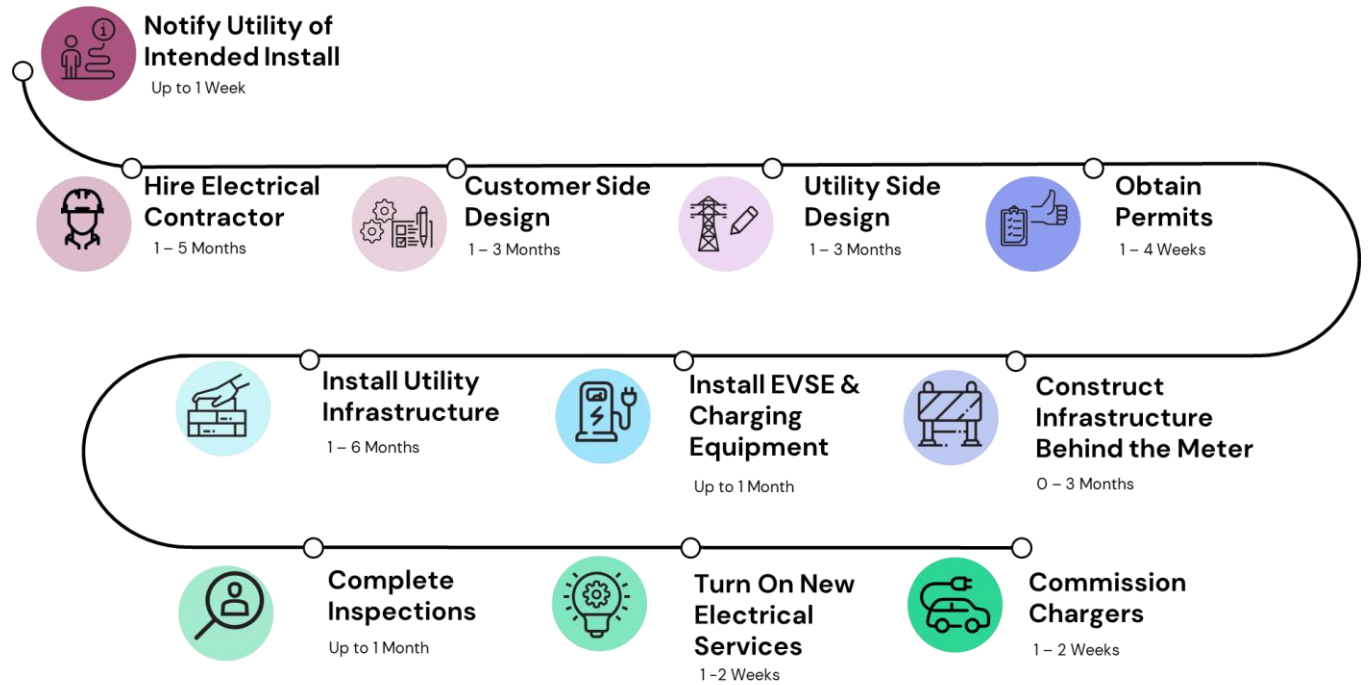


Figure 5. Annual Infrastructure Costs for All Sites Based on Vehicle Retirement Schedule



In addition to conducting cost estimates to help the City and County of Honolulu to plan the electrification of its city fleet, ICF developed a planning timeline for EV charging deployment, which, if followed, can help to reduce the costs associated with infrastructure development. The phased planning timeline is depicted in Figure 6 and estimates that EVSE installation from start to finish could take anywhere from at least 7 months to at most 24 months.

Figure 6. Phased Planning Timeline



Appendix A. Departmental Fleet Strategies

I. Department of Facility Maintenance (DFM) Fleet Electrification Strategy

The City and County of Honolulu (CCH) has an ambitious goal to achieve 100 percent renewable fuel use in ground transportation among all City fleets by 2035. This report aims to provide strategic support to the Department of Facility Maintenance (DFM) in planning for transitioning its fleet to electric vehicles (EVs) and the deployment of charging infrastructure, building off the Capital Fleet Transition Plan (CFTP). Based on the original CFTP analysis and the department level electrification planning workshop, the project team has identified the following strategies for DFM to consider when planning and designing its EV transition plan.

Establish Annual Department EV Suitability Review Process

The limited availability of EVs, especially for vehicle types most frequently used by DFM (e.g., medium-duty pickups and heavy-duty utility trucks), is among one of the major barriers to department fleet electrification. Besides, due to the relatively small production scale and still relatively high cost of the battery, the upfront costs of the available EV models are also noticeably higher than their conventional internal combustion engine (ICE) counterparts. However, as major original equipment manufacturers (OEMs) are committed to [expanding EV lineup](#) and both the [federal](#) and [state](#) government are establishing policies and programs to encourage EV adoption, a surge in new EV model variations and a drop in EV prices¹ are expected in the next few years. Although large-scale department EV replacement may not be feasible immediately, DFM should establish procedures to review EV suitability regularly and identify early electrification opportunities.

The department EV suitability review should focus on whether the existing or upcoming EV models can support the current fleet operational/logistical needs. As part of this review, the department shall carefully consider duty cycles, and vehicle characteristics such as body type, function, fast charging capability, EV range,

payload, and horsepower. It should be noted that EV replacement can still be feasible even though an exact match of the existing vehicle may not exist, as long as the fleet functional requirements can be fulfilled. As the market is rapidly evolving, it is recommended that such a review should be conducted at least once every year.

In addition to EV functionality, the department fleet replacement budget should also be examined and adjusted based on new demands. While commercial EV costs need to come down before City proceeds with wholesale fleet replacement, it is nonetheless necessary and appropriate to secure budget to support near-term department EV deployment. For instance, DFM may consider launching pilot programs to evaluate EV performance when a suitable model becomes commercially available, or replacing certain vehicles that are presented with cost-effective EV options or comparable total cost of ownership as ICEs.

Evaluate Vehicle and Infrastructure-as-a-service (VaaS and IaaS) Options

The Hawai'i Department of Transportation (HDOT) has partnered with its Vehicle and Infrastructure-as-a-service (VaaS and IaaS) vendor, Sustainability Partners (SP), to deploy Tesla Model Y EVs and charging stations through a Service Contract which is open to other Hawai'i public agencies to join. The Department of Environmental Services (ENV) has also established a preliminary service agreement with SP through the HDOT contract to deploy three electric refuse collection trucks and electric vehicle supply equipment (EVSE). These VaaS and IaaS programs can present a valuable opportunity for DFM to evaluate EVs' performance against existing ICE vehicles and to assess vehicle suitability with no significant upfront investment. If DFM decides to proceed with its own VaaS and IaaS pilot projects, service rates and options should be carefully examined and tailored to department operational needs. DFM operations might differ from other existing programs; while a VaaS and IaaS program setup may be effective for ENV, it might not necessarily work for DFM. Key factors to evaluate prior to launching pilot projects include vehicle type, models, daily usage, charging demands, vehicle and equipment useful

life, maintenance and operation costs, vehicle and equipment downtime, and required staffing levels.

Identify Priority Sites for EVSE Installation and Assess Facility Energy Demand

Although the overall fleet electrification requires incremental steps, work on infrastructure and site development shall begin immediately and before the vehicles are being delivered. We recommended DFM to immediately start identifying facilities and vehicle dwelling sites that are suitable for early EV deployment and strategically plan the EV make ready² processes. Given that there are more EV availability and cost-effective options for light-duty vehicles, DFM has identified priority sites with higher percentage of light-duty vehicles for early electrification consideration, including Kapolei Hale, Kapalama Hale, Kokea Street, Civic Center Parking Structure, and Halawa. Several of the previously mentioned sites are scheduled for renovation in the near future. Coordinating these renovations with EV infrastructure development could be a cost-effective and efficient approach for DFM.

While planning for EV site development, it is critical to examine charging demand on a site-by-site basis given the distinct fleet operation and power usage, which alters with many factors, such as the type and usage of vehicles operated at each site, maximum EV charging events that the site needs to accommodate, available hours for each vehicle to charge at the facility, and the current facility peak load which is needed to calculate the available load capacity. As stated in a proposed City administrative policy, each City department and agency shall, when undertaking capital improvements at facilities under their management, plan for the installation of EVSE to accommodate 100 percent of the vehicles sited at such facilities. Furthermore, developing a comprehensive EVSE plan that addresses all charging demands at a facility can assist in identifying potential grid upgrade requirements early on. Additionally, strategically building out EV-ready infrastructure with sufficient capacity to accommodate all EVSE deployment in a single effort presents a significant cost-saving opportunity for DFM.

Explore Opportunities to Integrate Off-Grid Renewable Energy Sources with Charging Infrastructure

As widespread EV adoption is taking place, DFM shall also explore opportunities to integrate off-grid renewable energy sources such as solar and wind power for more sustainable, affordable, and cleaner fleet operation. Renewable energy sources can be employed independently, which allows DFM and its individual charging sites to generate their own power while decreasing their dependence on centralized power grids and to save on utility bills and electrical infrastructure upgrade costs. Because renewable energy generation can be distributed and the generated electricity can be stored and discharged without the need for fuel deliveries, it also serves as a unique and reliable asset for grid resilience, which can help the facilities keep the power on during disruptions.

Given that Hawai'i has one of the highest sunlight exposure rates in the country and significant onshore and offshore wind resources, DFM may consider installing solar panels or small-scale wind turbines along with battery energy storage systems (BESS) at individual sites to power EV charging if space allows. Although the installation of off-grid renewable power sources can have higher upfront cost³ than conventional grid upgrades, it helps to reduce fleet operational costs significantly from energy bills.

Use Telematics to Better Understand Current Fleet Usage

In order to plan for EV transition and assess infrastructure charging demand and power need, all City departments need to fully understand the current fleet operation and characteristics, which includes, but not limited to, fleet composition, average and maximum daily usage, and fuel consumption. Telematics data can present a wealth of asset information that may facilitate fleet electrification process, beyond what traditional fleet data (e.g., odometer) can provide. For example, telematics data can help to determine both the average and maximum daily range that EVs will need to provide; time of the day that vehicles can spend at dwelling or home sites for charging; the number and frequency of charging events; vehicle downtime and spare ratio; and the optimal number of vehicles needed at a given site. An accurate and comprehensive understanding of current fleet operation is critical to identify charging demand and power need of the entire fleet. In addition, telematics can also allow fleets to improve safety, reduce downtime



through intelligent predictive maintenance, and help with fleet optimization down the road. All of these could result in significant cost-saving opportunities for the department as well.

Not only it is crucial for DFM to consider using telematics to better understand and optimize department fleet operations, but the department is also playing an indispensable role to support the City to install telematics for City fleet. DFM should continue working with other City departments, especially the Office of Climate Change, Sustainability and Resiliency (CCSR), to procure and deploy telematics across City fleet at prioritized sites.

Establish Communication Platform with Other City Departments and City Leadership to Share Lessons Learnt

While the City leadership has committed to supporting City departments in fleet electrification, communication will be needed to help the leadership understand both the strategies being recommended to move towards these goals and the limitations of those strategies based on operational and logistical constraints. As DFM is transitioning its fleet to EV, it is important to closely collaborate with other City departments and City leadership to establish an open platform to communicate barriers and difficulties encountered, share department fleet electrification experience and lessons learned, and help the City to adjust and establish new transportation electrification and climate goals moving forward.

Next Steps for Fleet Electrification within DFM

Near-term priorities for DFM to enable successful fleet electrification include:

1. Support Mayor's Clean Fleet Policy: Plan for EV charging as part of major capital improvements in the pipeline at DFM facilities.
2. Implement Expanded Fleet Telematics: Work with CCSR to procure and deploy telematics across City fleet vehicles at prioritized sites as a means of collecting higher resolution data for EVs and infrastructure deployment.

3. EVSE Master Agreement: Budget for and, in collaboration with CCSR, put in-place a master agreement for the provision of services to operate and maintain City fleet and City owned public EV chargers. Plan for additional staff capacity as needed based on increasing number of chargers coming online over time.
4. Light Duty EV Purchasing: Plan and budget for replacement of DFM light duty ICE vehicles with EV models in next round of vehicle purchases where chargers are/will be available in the near term.
5. EVSE Installations: Confirm priority sites for next DFM EVSE installation:

Kapolei Hale: complete summer/fall 2024 (per the Department of Design and Construction)

Kapalama Hale: in planning

Kokea Street: under consideration for near term implementation

Civic Center Parking Structure: being planned near term concurrent with other renovations and repairs.

6. EV specifications: Develop standard vehicle specifications for fleet EVs to be added to existing standard vehicle specifications shared by the Department of Budget and Fiscal Services.

Summary and Conclusion

Based on the previous CFTP report and feedback collected from the workshop, DFM has developed a number of strategies to move forward with department fleet transition. These strategies highlight the importance of evaluating EV operational demand and needs based on current fleet usage and characteristics and present several opportunities for department EV adoption. The project team also acknowledges that the commercial availability for current DFM frequently used vehicles is limited. While fleet electrification may not be ready for large-scale

deployment yet, there are immediate and incremental steps that DFM can take in the near future to prepare the fleet for later EV transition.

II. Department of Parks and Recreation (DPR) Fleet Electrification Strategy

The City and County of Honolulu (CCH) has an ambitious goal to achieve 100 percent renewable fuel use in ground transportation among all City fleets by 2035. This report aims to provide strategic support to the Department of Parks and Recreation (DPR) in planning for transitioning its fleet to electric vehicles (EVs) and the deployment of charging infrastructure, building off the Capital Fleet Transition Plan (CFTP). Based on the original CFTP analysis and the department level electrification planning workshop, the project team has identified the following strategies for DPR to consider when planning and designing its EV transition plan.

Establish Annual Department EV Suitability Review Process

The limited availability of EVs, especially for medium-duty pickups, the vehicle type most frequently used by DPR, is among one of the major barriers to department fleet electrification. Besides, due to the relatively small production scale and still relatively high cost of the battery, the upfront costs of the available EV models are also noticeably higher than their conventional internal combustion engine (ICE) counterparts. However, as major original equipment manufacturers (OEMs) are committed to expanding EV lineup and both the federal and state government are establishing policies and programs to encourage EV adoption, a surge in new EV model variations and a drop in EV prices¹ are expected in the next few years. Although large-scale department EV replacement may not be feasible immediately, DPR should establish procedures to review EV suitability regularly and identify early electrification opportunities.

The department EV suitability review should focus on whether the existing or upcoming EV models can support the current fleet operational/logistical needs. As part of this review, the department shall carefully consider duty cycles, and vehicle characteristics such as body type, function, fast charging capability, EV range,

payload, and horsepower. It should be noted that EV replacement can still be feasible even though an exact match of the existing vehicle may not exist, as long as the fleet functional requirements can be fulfilled. As the market is rapidly evolving, it is recommended that an industry review should be conducted at least once every year.

In addition to EV functionality, the department fleet replacement budget should also be examined and adjusted based on new demands. While commercial EV costs need to come down before City proceeds with wholesale fleet replacement, it is nonetheless necessary and appropriate to secure budget to support near-term department EV deployment. DPR may consider launching pilot programs to evaluate EV performance when a suitable model becomes commercially available, or replacing certain vehicles that are presented with cost-effective EV options or comparable total cost of ownership as ICEs. For instance, DPR may evaluate options to electrify light-duty pickups with high fuel consumptions, which represents a vehicle type with adequate EV model availability and comparable TCO to their current ICE models.

Evaluate Vehicle and Infrastructure-as-a-service (VaaS and IaaS) Options

The Hawai'i Department of Transportation (HDOT) has partnered with its Vehicle and Infrastructure-as-a-service (VaaS and IaaS) vendor, Sustainability Partners (SP), to deploy Tesla Model Y EVs and charging stations through a Service Contract which is open to other Hawai'i public agencies to join. The Department of Environmental Services (ENV) has also established a preliminary service agreement with SP through the HDOT contract to deploy three electric refuse collection trucks and electric vehicle supply equipment (EVSE). Similar opportunities may also become available through the existing Energy Savings Performance Contract (ESPC) with NORESKO to electrify multiple DPR dwelling sites across the City.

These VaaS and IaaS programs can present a valuable opportunity for DPR to evaluate EVs' performance against existing ICE vehicles and to assess vehicle suitability with no significant upfront investment. If DPR decides to proceed with its



own VaaS and laaS pilot projects, service rates and options should be carefully examined and tailored to department operational needs. DPR operations might differ from other existing programs; while a VaaS and laaS program setup may be effective for ENV, it might not necessarily work for DPR. Key factors to evaluate prior to launching pilot projects include vehicle type, models, daily usage, charging demands, vehicle and equipment useful life, maintenance and operation costs, vehicle and equipment downtime, and required staffing levels.

Identify Priority Sites for EVSE Installation and Assess Facility Energy Demand

Although the overall fleet electrification requires incremental steps, work on infrastructure and site development should begin immediately and before the vehicles are delivered. We recommended DPR to immediately start identifying facilities and vehicle dwelling sites that are suitable for early EV deployment and strategically plan the EV make ready² processes. Given that there are more EV availability and cost-effective options for light-duty vehicles, DPR has identified priority sites with higher percentage of light-duty pickups for early electrification consideration, including Kualoa Maintenance Yard, Ewa Mahiko District Park, Keehi Lagoon Park, Waianae Maintenance Yard, and Beretania Neighborhood Community Center.

While planning for EV site development, it is critical to examine charging demand on a site-by-site basis given the distinct fleet operation and power usage, which alters with many factors, such as the type and usage of vehicles operated at each site, maximum EV charging events that the site needs to accommodate, available hours for each vehicle to charge at the facility, and the current facility peak load which is needed to calculate the available load capacity. As stated in a proposed City administrative policy, each City department and agency shall, when undertaking capital improvements at facilities under their management, plan for the installation of EVSE to accommodate 100 percent of the vehicles sited at such facilities. Furthermore, developing a comprehensive EVSE plan that addresses all charging demands at a facility can assist in identifying potential grid upgrade requirements

early on. Additionally, strategically building out EV-ready infrastructure with sufficient capacity to accommodate all EVSE deployment in a single effort presents a significant cost-saving opportunity for DPR.

Explore Opportunities to Integrate Off-Grid Renewable Energy Sources with Charging Infrastructure

As widespread EV adoption is taking place, DPR should explore opportunities to integrate off-grid renewable energy sources such as solar and wind power for more sustainable, affordable, and cleaner fleet operations. Renewable energy sources can be employed independently, which allows DPR and its individual charging sites to generate their own power while decreasing their dependence on centralized power grids and to save on utility bills and electrical infrastructure upgrade costs. Because renewable energy generation can be distributed and the generated electricity can be stored and discharged without the need for fuel deliveries, it also serves as a unique and reliable asset for grid resilience, which can help the facilities keep the power on during disruptions.

Given that Hawai'i has one of the highest sunlight exposure rates in the country and significant onshore and offshore wind resources, DPR may consider installing solar panels or small-scale wind turbines along with battery energy storage systems (BESS) at individual sites to power EV charging if space allows. Although the installation of off-grid renewable power sources can have higher upfront cost³ than conventional grid upgrades, it helps to reduce fleet operational costs significantly from energy bills.

Use Telematics to Better Understand Current Fleet Usage

In order to plan for EV transition and assess infrastructure charging demand and power need, all City departments need to fully understand the current fleet operation and characteristics, which includes, but not limited to, fleet composition, average and maximum daily usage, and fuel consumption. Telematics data can present a wealth of asset information that may facilitate fleet electrification process, beyond what traditional fleet data (e.g., odometer) can provide. For example, telematics data can help to determine both the average and maximum daily range that EVs will need to provide; time of the day that vehicles can spend at



dwelling or home sites for charging; the number and frequency of charging events; vehicle downtime and spare ratio; and the optimal number of vehicles needed at a given site. An accurate and comprehensive understanding of current fleet operation is critical to identify charging demand and power need of the entire fleet. In addition, telematics can also allow fleets to improve safety, reduce downtime through intelligent predictive maintenance, and help with fleet optimization down the road. All of these could result in significant cost-saving opportunities for the department as well.

The City currently has a budget allocated for telematics installations, with support from the Department of Facility Maintenance (DFM). DPR should work with DFM and other City departments, especially the Office of Climate Change, Sustainability and Resiliency (CCSR), to identify several priority vehicles to collect telematics data for the initial round of installation.

Establish Communication Platform with Other City Departments and City Leadership to Share Lessons Learnt

While the City leadership has committed to supporting City departments in fleet electrification, communication is necessary to help the leadership understand both the strategies being recommended to move towards these goals and the limitations of those strategies based on operational and logistical constraints. As DPR transitions its fleet to EV, it is important to closely collaborate with other City departments and City leadership to establish an open platform to communicate barriers and difficulties encountered, share department fleet electrification experience and lessons learned, and help the City to adjust and establish new transportation electrification and climate goals moving forward.

Next Steps for Fleet Electrification within DPR

Near-term priorities for DPR to enable successful fleet electrification include:

1. Support Mayor's Clean Fleet Policy: Plan for EV charging as part of major capital improvements in the pipeline at DPR facilities.
2. Implement Expanded Fleet Telematics: Work with CCSR and DFM to install telematics on selected vehicles.

3. Site Electrification through NORESCO ESPC: Plan and budget for pilot project through NORESCO ESPC to electrify priority sites across the City (one site in each district).
4. EV specifications: Develop standard vehicle specifications for fleet EVs to be added to existing standard vehicle specifications shared by the Department of Budget and Fiscal Services.

Summary and Conclusion

Based on the previous CFTP report and feedback collected from the workshop, DPR has developed a number of strategies to move forward with department fleet transition. These strategies highlight the importance of evaluating EV operational demand and needs based on current fleet usage and characteristics and present several opportunities for department EV adoption. The project team also acknowledges that the commercial availability for current DPR frequently used vehicles is limited. While fleet electrification may not be ready for large-scale deployment yet, there are immediate and incremental steps that DPR can take in the near future to prepare the fleet for later EV transition.

III. Department of Environmental Services (ENV) Fleet Electrification Strategy

The ambitious goal for the City and County of Honolulu (CCH) to achieve 100 percent renewable fuel use in ground transportation among all City fleets by 2035, coupled with the State of Hawai‘i becoming one of fifteen states and the District of Columbia to ensure 30 percent of all new medium- and heavy-duty vehicles sales be zero emission vehicles (ZEVs) by 2030 and 100 percent by 2050, can present a series of pressing challenges among all departments. This report aims to provide strategic support to the Department of Environmental Services (ENV) in planning for transitioning its fleet to electric vehicles (EVs) and the deployment of charging infrastructure, building off the Capital Fleet Transition Plan (CFTP). Based on the original CFTP analysis and the department level electrification planning workshop,

the project team has identified the following strategies for ENV to consider when planning and designing for department EV deployment.

Prioritize EV Replacement for Vehicles with Cost-Effective Options

Although EVs can present great opportunities to reduce the total cost of ownership (TCO) for fleet operation due to their lower maintenance and fuel costs, the upfront costs for both equipment purchase and infrastructure installation are still noticeably higher than their conventional internal combustion engine (ICE) counterparts. Therefore, fleet electrification needs to be conducted using a gradual and phased approach and ENV should consider prioritizing replacement of vehicles that are presented with cost-effective EV replacement options. For example, ENV may prioritize replacing vehicles with higher fuel consumptions (e.g., refuse trucks and haulers), with adequate EV model availability and comparable TCO to their current ICE models.

Evaluate Vehicle and Infrastructure-as-a-service (VaaS and IaaS) Options

The Hawai'i Department of Transportation (HDOT) has partnered with its Vehicle and Infrastructure-as-a-service (VaaS and IaaS) vendor, Sustainability Partners (SP), to deploy Tesla Model Y EVs and charging stations through a Service Contract which is open to other Hawai'i departments to join. ENV has also created several preliminary service addenda with SP through the HDOT contract to deploy both light-duty pickups and heavy-duty refuse EV models and charging infrastructure for small-scale use-case applications. While these VaaS and IaaS pilot projects with SP provide a valuable opportunity for ENV to evaluate EVs' performance against existing ICE vehicles and to assess user acceptance with no upfront costs, ENV should also consider further evaluating service rates and options with SP and tailoring the service contract to meet real-world fleet operational needs. For instance, the current refuse truck and charging infrastructure service addendum assumed each refuse truck drives 2,400 miles every month, which needs to be confirmed based on actual fleet daily mileage. In addition, the charger usage rate in

the current contract is provided as a package of 90 charging events per charging port per month. The project team has estimated that given the refuse EV model range and battery capacity, each truck will need at most one charging event per day to fully charge the battery from its depleted levels due to normal daily operation, which is a lot less than what is included in the current charging package. ENV should consider further evaluating the details of the current charging package and financial implications associated with having fewer than 90 charging events per charging port per month. The current addendum also assumes a 10-year useful life for each truck, which may require further examination based on fleet operation and behaviors.

Identify Facility Charging Demand and Load Capacity in Advance

The facility charging demand and load capacity needs can alter with many factors, such as the type and usage of vehicles operated at each site, maximum EV charging events that the site needs to accommodate, available hours for each vehicle to charge at the facility, and the current facility peak load which is needed to calculate the available load capacity. It is critical to examine charging demand on a site-by-site basis given the distinct fleet operation and power usage.

Although the overall fleet electrification requires incremental steps, working on identifying the total charging demand and improving the grid shall begin immediately. As stated in a proposed City administrative policy, each City department and agency shall, when undertaking capital improvements at facilities under their management, plan for the installation of Electric Vehicle Supply Equipment (EVSE) to accommodate 100 percent of the vehicles sited at such facilities. Furthermore, developing a comprehensive EVSE plan that addresses all charging demands at a facility can assist in identifying potential grid upgrade requirements early on. Additionally, strategically building out make-ready infrastructure with sufficient capacity to accommodate all EVSE deployment in a single effort presents a significant cost-saving opportunity for ENV.

Explore Opportunities to Integrate Off-Grid Renewable Energy Sources with Charging Infrastructure

As widespread EV adoption is taking place, ENV shall also explore opportunities to integrate off-grid renewable energy sources such as solar and wind power for more sustainable, affordable, and cleaner fleet operation. Renewable energy sources can be harnessed independently, which allows ENV and its individual charging sites to generate their own power while decreasing their dependence on centralized power grids and to save on utility bills. Given that Hawai‘i has one of the highest sunlight exposure rates in the country and significant onshore and offshore wind resources, ENV may consider installing solar panels or small-scale wind turbines along with battery energy storage systems (BESS) at individual sites to power EV charging if space allows. Although the installation of off-grid renewable power sources can have higher upfront cost¹ than conventional grid upgrades, it helps to reduce fleet operational costs significantly from energy bills. Based on the preliminary analysis that the project team has conducted, for a facility with six megawatts of daily charging demand, the return on investment (ROI) can be expected within seven years with the installation of solar panels and BESS.

Use Telematics to Better Understand Current Fleet Usage

In order to plan for EV transition and assess infrastructure charging demand and power need, ENV first needs to fully understand the current fleet operation and characteristics, which includes, but not limited to, fleet composition, average and maximum daily usage, and fuel consumption. Telematics data can present a wealth of asset information that may facilitate fleet electrification process, beyond what traditional fleet data (e.g., odometer) can provide. For example, telematics data can help to determine both the average and maximum daily range that EVs will need to provide; time of the day that vehicles can spend at dwelling or home sites for charging; the number and frequency of charging events; vehicle downtime and spare ratio; and the optimal number of vehicles needed at a given site. An accurate and comprehensive understanding of current fleet operation is critical to identify charging demand and power need of the entire fleet. The City currently has a

budget allocated for telematics installations, with support from the Department of Facility Maintenance (DFM). ENV may consider working with DFM and identifying a number of priority vehicles to collect telematics data for the initial round of installation.

Next Steps for Fleet Electrification within ENV

Near-term priorities for ENV to enable successful fleet electrification include:

1. Proceed with Refuse Collection Truck Pilot with Sustainability Partners in 2023
2. Identify prioritization of ENV sites for EVSE installations by fiscal year for FY 25 and projections through 2035.
3. Budget for 'Fleet Infrastructure Planning' in FY '25 to support department wide deployment of zero-emissions vehicles.

2 phases: Electrification at ENV will be broken up into two phases. The first phase will include an early implementation for passenger vehicles & light duty trucks and a planning phase for the infrastructure required for the heavy-duty fleet. The second phase, electrification of heavy-duty trucks, will occur after the market for these vehicles matures further.

Current progress: ENV has been able to procure 2 EV vehicles in 2023 due to Kapolei Hale having EV charging infrastructure on site and have plans to expand EV vehicles and infrastructure to EQ, WTD, and CSM divisions for FY2025, which begins in July 2024.

Heavy vehicle infrastructure planning: Charging infrastructure is complex for heavy duty vehicles due to the high amount of energy that the vehicles require along with the time requirement to charge these vehicles. The bulk of ENV's heavy duty fleet is in the Refuse Department as refuse collection vehicles, where operational demands are high. To systemically plan for the electrification of the fleet, Refuse will focus on infrastructure planning and implementation and pilot projects to better understand EV refuse vehicle operations. CSM and WTD heavy duty vehicles are specialty heavy duty vehicles currently without viable EV

alternatives and will focus on alternative fuels or alternative fuel vehicles. Alternative fuels to consider could include compressed biogas, hydrogen, biodiesel, and renewable diesel.

Phase 1 Replacements: Phase 1 replacement schedules within Department of Environmental Services (ENV) is divided into fleet vehicles at the (1) new ENV Support Facilities at Honouliuli WWTP, (2) vehicles at other WWTPs within Wastewater Treatment and Disposal Division, and (3) Collection System Maintenance Division. Vehicles and schedules included in these projections are based only on passenger EV vehicles and light duty vehicles, as heavy-duty vehicles will require additional infrastructure planning. The light duty trucks do include trucks configured for industrial use such as extended bed length and high output diesel engines, even though they are not yet widely available in EV format. Heavy-duty vehicles are not currently in the projection due to limited production of these vehicles especially given that ENV uses several specialty vehicles.

Schedules for EV charging infrastructure are currently limited to Level 2 chargers as there are much fewer electrical requirements and chargers can typically be installed without intensive upgrades to the infrastructure. Heavy-duty vehicle charging infrastructure typically requires 75 kVa up to 300 kVa per charging stations, which can easily exceed electrical service at our facilities that do not include WWTP and PS. The infrastructure upgrades will be substantial and will require detailed engineering and will likely be paired with Solar PV and battery systems along with a microgrid to enhance reliability of vehicle energy sources.

EV Vehicle and Charging Infrastructure Projection at ENV Support Facilities

The EV vehicle replacement schedule below (*Table A-1*) includes all EV vehicles that will be relocated to the new ENV Support Facilities at Honouliuli WWTP that will complete in the second half 2025. Currently the vehicles in 2023 have been received and are in use and the vehicles projected in 2025 have been included in the budget proposal for FY 2025. Sufficient EV charging infrastructure will serve the

vehicles projected through 2029 and more chargers will need to be installed in 2030.

Table A-1. EV Replacement Schedule for Honouliuli

Agency	# of Vehicles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
EQ Lab	11			2	2			2		2		3		
EQ M&C	4					2			2					
EQ RC	11			2		2		2		2		3		
EQ Admin	1							1						
OAS	9	2		2		2		2		1				
Refuse	15			2		3		3		3		4		
WTD	15			2	2		3		3		3	2		
SWQ	17			2		3		4		4		4		
SWQ Ph. 1	11						3	3	3	2				
SWQ Ph. 2	12									4	4	4		
Total	106	2		12	4	12	6	17	8	18	7	20		

The charging infrastructure installation schedule below (Table A-2) are at the new ENV Support Facilities at Honouliuli WWTP. These chargers are currently designed to be level 2 chargers for light-duty and passenger vehicles with 17 spaces to be available in 2025 and the rest of the spaces with underground conduit and electrical to support the future charging stations. The scope of this project does not currently include Level 3 chargers.

Table A-2. Charger Installation Schedule for Honouliuli

Facility or Location	# of Charger Spaces	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
North Admin	11			2		2		14						
South Admin	4			10		10						10		
West Admin	11			1		1						4		
East Admin	1			0		0								
North Lab Building	9			1		1		12						
East Lab Building	15			1		1		10				4		
North Central Shop	15			0		0						10		
South Central Shop	17			2		2		14						
Total	106			17		17		50				28		

EV Charging Infrastructure at Wastewater Treatment Plants (WWTPs)

The projected EV vehicle replacement schedule below (Table A-3) includes all EV vehicles that are based at ENV's nine wastewater treatment plants. Vehicles shown for FY 2025 have been included in the budget proposal -submitted in the fall of 2023. No heavy-duty vehicles are scheduled given the specialty nature of the vehicles in use at WTD and pending an infrastructure study. Vehicles included are a mix of passenger vehicles and light duty trucks including trucks used in industry such as Ford Super Duty trucks.

Table A-3. EV Replacement Schedule for WWTPs

Facility (WWTP)	# of Vehicles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Sand Island	54			5	4	5	5	5	5	5	5	5	5	5
Honouliuli	25			1	3	4	3	3	3	3	3	2		
Waimanalo	2			1	1									
Laie	3			3										
Kahuku	2			0	1	1								
Paalaa Kai	2			1	1									
Kailua	27			3	3	3	3	3	3	3	3	3		
Waianae	2			0	1	1								
Wahiawa	1			0	1	0								
Total	118	0	0	14	15	14	11	11	11	11	11	10	5	5

The charging infrastructure installation schedule is shown below (Table A-4) for each of the 9 wastewater treatment plants. The chargers for 2025 and 2026 have

been included in the draft FY2025 budget. The level 2 chargers are planned for 2025 while the level 3 chargers will likely be completed in 2026 in the second half of FY2025. WWTPs typically include large electrical service so a complicated infrastructure upgrade may not be needed. Level 3 chargers are currently planned for light duty trucks and passenger vehicles. Pump stations currently are excluded from charging infrastructure as there are no vehicles based at the pump stations.

Table A-4. Charging Infrastructure Schedule for WWTPs

Facility (WWTP)	# of Vehicles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Sand Island	54			10	6	20			18					
Honouliuli	25			6	2	10			8					
Waimanalo	2			2	2									
Laie	3			4	2									
Kahuku	2			2	2									
Paalaa Kai	2			2	2									
Kailua	27			6	4	8			10					
Waianae	2			2	0									
Wahiawa	1			2	0									
Total	118	0	0	36	15	38			36					

EV and Charging Infrastructure for Collections System Maintenance (CSM)

The replacement schedule below (Table A-5) includes all vehicles across Collections System Maintenance Division. The vehicles shown for 2025 have been included in the draft budget proposal for FY 2025. No heavy-duty vehicles are scheduled given the specialty nature of the vehicles in use at CSM and pending the results of an infrastructure study. Vehicles included are a mix of passenger vehicles and light duty trucks including trucks used in industry such as Ford Super Duty trucks.

Table A-5. Replacement Schedule for CSM

CSM Division	# of Vehicles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Admin	4			2	2									
Support	5			1	2		2							
CCTV	10			1	2		2	2	2	1				
Leeward	15				2		3	3	3	3	1			
Metro	18				2	2	3	3	3	3	2			
Windward	20				2	2	3	3	3	3	3	1		
Field Services	0													
Pump Stations	0													
Total	72			4	12	4	13	11	11	10	6	1		

The charging infrastructure installation schedule below (Table A-6) are located at CSM facilities based on each division. Currently the chargers for 2025 have been included in the FY2025 budget. The level 2 chargers are planned for 2025 while the level 3 chargers will be included in a larger infrastructure study.

Table A-6. Charging Infrastructure Installation for CSM

CSM Division	# of Vehicles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Admin	4			2	2									
Support	5			2	2		2							
CCTV	10				4		6							
Leeward	15				2		14							
Metro	18				4		14							
Windward	20				4		16							
Field Services	0													
Pump Stations	0													
Total	72			4	18		52							

EV Charging Infrastructure Study at All ENV Facilities

EV charging infrastructure for heavy duty vehicles will need to be further studied at all of ENVs facilities that will support heavy-duty vehicles given their large battery capacities and operational requirement to charge in a reasonable amount of time. These DC fast chargers typically range from 75 kVa to 300 kVa and many of the corp yards at ENV where these vehicles are at do not have the capacity for even one DC fast charger.

Refuse comprises the bulk of heavy-duty vehicle fleet specifically as refuse collection vehicles that operate on a demanding schedule that may require large amounts of electricity overnight and throughout the day. CSM and WTD also operate many heavy-duty vehicles but are more specialized and of a wide variety.

Refuse, CSM, and WTD are currently all included in an existing electrical planning project of ENV facilities for Energy Improvements that include developing electrical infrastructure and standards. The focus of the projects will be to expand Solar PV, batteries, microgrids, and EV charging to project sites. This work is currently being executed in 2024 and 2025.

Summary and Conclusion

Based on the previous CFTP report and feedback collected from the workshop, the project team has provided a list of strategies and recommendations for ENV to consider while moving forward with department fleet transition. These strategies highlight the importance of evaluating EV operational demand and needs based on current fleet usage and characteristics and present several cost-saving opportunities for department EV adoption. The project team also acknowledges that there are other available options for transitioning fleet to renewable fuel use in addition to electrification, such as renewable natural gas and hydrogen fuel-cell technology, pending further technology feasibility, cost, and environmental impact assessments by the department.

IV. Honolulu Police Department (HPD) Fleet Electrification Strategy

The City and County of Honolulu (CCH) has an ambitious goal to achieve 100 percent renewable fuel use in ground transportation among all City fleets by 2035. This report aims to provide strategic support to the Honolulu Police Department (HPD) in planning for transitioning its fleet to electric vehicles (EVs) and the deployment of charging infrastructure, building off the Capital Fleet Transition Plan (CFTP). Based on the original CFTP analysis and the department level electrification planning workshop, the project team has identified the following strategies for HPD to consider when planning and designing its EV transition plan.

Establish Annual Department EV Suitability Review Process

The limited availability of electric police vehicles, especially pursuit-rated vehicles, is among one of the major barriers to department fleet electrification. Because not all original equipment manufacturers (OEMs) sell a factory police package with their EV models, it can take months to retrofit and install the [necessary equipment](#), such as a front push bar, prisoner seat and partition. Besides, due to the relatively small production scale and still relatively high cost of the battery, the upfront costs of the available EV models are also noticeably higher than their conventional internal combustion engine (ICE) counterparts. However, as major OEMs are committed to [expanding EV lineup](#) and both the [federal](#) and [state](#) government are establishing policies and programs to encourage EV adoption, a surge in new EV model variations that can fulfil police department duties and a drop in EV prices¹ have been observed in recent years and are expected to continue in the next decade. For example, in 2021, the Ford Mustang Mach-E became the first EV model to pass the rigorous [Michigan State Police \(MSP\)](#) testing standards, and the first pursuit-rated police EV, the [Chevy Blazer EV PPV](#), is also expected to be available in early 2024. Although large-scale department EV replacement may not be feasible immediately, HPD should establish procedures to review EV suitability regularly and identify early electrification opportunities.

The department EV suitability review should focus on whether the existing or upcoming EV models can support the current department operational needs. As part of this review, the department shall carefully consider duty cycles, and vehicle characteristics such as body type, function, fast charging capability, EV range, payload, and horsepower. It should be noted that EV replacement can still be feasible even though an exact match of the existing vehicle may not exist, as long as the fleet functional requirements can be fulfilled. As the market is rapidly evolving, it is recommended that such a review should be conducted at least once every year.

In addition to EV functionality, the department fleet replacement budget should also be examined and adjusted based on new demands. While commercial EV costs need to come down before City proceeds with wholesale fleet replacement, it is nonetheless necessary and appropriate to secure budget to support near-term department EV deployment. For instance, HPD may consider launching pilot programs to evaluate EV performance when a suitable model becomes commercially available, or replacing certain vehicles that are presented with cost-effective EV options or comparable total cost of ownership as ICEs.

Evaluate Vehicle and Infrastructure-as-a-service (VaaS and IaaS) Options

The Hawai'i Department of Transportation (HDOT) has partnered with its Vehicle and Infrastructure-as-a-service (VaaS and IaaS) vendor, Sustainability Partners (SP), to deploy Tesla Model Y EVs and charging stations through a Service Contract which is open to other Hawai'i public agencies to join. The Department of Environmental Services (ENV) has also established a preliminary service agreement with SP through the HDOT contract to deploy three electric refuse collection trucks and electric vehicle supply equipment (EVSE). These VaaS and IaaS programs can present a valuable opportunity for HPD to evaluate EVs' performance against existing ICE vehicles and to assess vehicle suitability with no significant upfront investment.

If HPD decides to proceed with its own VaaS and IaaS pilot projects, service rates and options should be carefully examined and tailored to department operational needs. HPD operations might differ from other existing programs; while a VaaS and IaaS program setup may be effective for ENV, it might not necessarily work for HPD. Key factors to evaluate prior to launching pilot projects include vehicle type, models, daily usage, charging demands, vehicle and equipment useful life, maintenance and operation costs, vehicle, and equipment downtime, and required staffing levels. HPD may also consider reviewing outcomes of other [police department EV pilots](#) across the country, such as the [Fremont Police Department](#) and the [New York Police Department](#) programs, before establishing its own pilot project.

Identify Priority Sites for EVSE Installation and Assess Facility Energy Demand

Although the overall fleet electrification requires incremental steps, work on infrastructure and site development shall begin immediately and before the vehicles are being delivered. We recommended HPD to immediately start identifying facilities and vehicle dwelling sites that are suitable for early EV deployment and strategically plan the EV make ready² processes.

While planning for EV site development, it is critical to examine charging demand on a site-by-site basis given the distinct fleet operation and power usage, which alters

with many factors, such as the type and usage of vehicles operated at each site, maximum EV charging events that the site needs to accommodate, available hours for each vehicle to charge at the facility, and the current facility peak load which is needed to calculate the available load capacity. As stated in a proposed City administrative policy, each City department and agency shall, when undertaking capital improvements at facilities under their management, plan for the installation of EVSE to accommodate 100 percent of the vehicles sited at such facilities. Furthermore, developing a comprehensive EVSE plan that addresses all charging demands at a facility can assist in identifying potential grid upgrade requirements early on. Additionally, strategically building out EV-ready infrastructure with sufficient capacity to accommodate all EVSE deployment in a single effort presents a significant cost-saving opportunity for HPD.

In addition to overnight depot charging, because one charging may not last for a complete [13-hour shift](#) and sometimes fast turnaround will be required between shifts, HPD should also explore ultrafast charging options and en-route opportunity charging³ in the patrol area.

Evaluate EV Take-Home Policy Options for Officers

It is a common practice for law enforcement officers to take their vehicles home after duty so that they can respond quickly to emergencies and become familiar with their vehicles. Currently, HPD tracks the on-duty miles of take-home vehicles by manually filling out mileage sheet on a daily basis and provides fuel compensation for on-duty miles as well as allowance for maintenance to officers. As the department plans for fleet electrification, it is critical to consider possibilities of amending and updating the current department vehicle take-home policy. For instance, what EV models shall be eligible for inclusion in the current take-home vehicle list, how will electricity usage be reimbursed for EVs, and what additional incentives can be offered to offset EV costs and home charging infrastructure and electrical upgrade.

Use Telematics to Better Understand Current Fleet Usage

In order to plan for EV transition and assess infrastructure charging demand and power need, all City departments need to fully understand the current fleet operation and characteristics, which includes, but is not limited to, fleet

composition, average and maximum daily usage, and fuel consumption. Telematics data can present a wealth of asset information that may facilitate the fleet electrification process, beyond what traditional fleet data (e.g., odometer) can provide. For example, telematics data can help to determine both the average and maximum daily range that EVs will need to provide; time of the day that vehicles can spend at dwelling or home sites for charging; the number and frequency of charging events; vehicle downtime and spare ratio; and the optimal number of vehicles needed at a given site. An accurate and comprehensive understanding of current fleet operation is critical to identify charging demand and power need of the entire fleet. In addition, telematics allows fleets to improve safety, reduce downtime through intelligent predictive maintenance, and help with fleet optimization down the road. All of these could result in significant cost-saving opportunities for the department as well. Telematics data can also help to monitor and track fuel or electricity usage for on-duty vehicle operation, which serves as a feasible solution to determine take-home vehicle compensation, in replacement of the current manual system.

The City currently has a budget allocated for telematics installations, with support from the Department of Facility Maintenance (DFM). HPD may consider working with DFM to identify several priority vehicles to collect telematics data for the initial round of installation. It is also noteworthy that while most telematics devices come with a GPS tracker, HPD can also work with DFM to disable GPS service on telematics to ensure police operation safety and privacy.

Next Steps for Fleet Electrification within HPD

Near-term priorities for HPD to enable successful fleet electrification include:

1. **Police EV Pilot:** Design a department specific pilot program to test EV suitability for HPD operations. HPD may also consider connecting with other law enforcement agencies who have previously launched EV pilot programs, learning from their experience, and test-driving EV models.
2. **EVSE Installations:** Identify priority sites for HPD EVSE installation.

3. EV specifications: Develop standard vehicle specifications for fleet EVs to be added to existing standard vehicle specifications shared by the Department of Budget and Fiscal Services.
4. City-Wide Communications: Collaborate with other City departments such as the Office of Climate Change, Sustainability and Resiliency (CCSR) and City leadership to establish an open platform to communicate barriers and difficulties encountered.

Summary and Conclusion

Based on the previous CFTP report and feedback collected from the workshop, HPD has developed a number of strategies to move forward with department fleet transition. These strategies highlight the importance of evaluating EV operational demand and needs based on current fleet usage and characteristics and present several opportunities for department EV adoption. The project team also acknowledges that the commercial availability for police EVs is limited. While fleet electrification may not be ready for large-scale deployment yet, there are immediate and incremental steps that can be taken in the near term to prepare the department for later EV transition.

Appendix B. Site-Level Assessment Methodology

Part I: Charger Specification Determination Methodology

Note: This methodology assumes that vehicles will charge overnight, which may not be applicable to certain departments, such as HPD. For example, finding time to charge may be challenging for HPD's patrol cars if they are used on multiple shifts by multiple drivers such that when an officer ends the first shift, the next officer must start a second shift with the same vehicle shortly thereafter. In instances like this, a DCFC that can charge at vehicle maximum battery acceptance rate may be more appropriate to provide the vehicle with more energy in a shorter timeframe.

In addition, the methodology for ICF's analysis is based on vehicle miles traveled (VMT), and while driving typically makes up the majority of EV energy usage, there are other vehicle uses that consume energy. For example, when responding to calls, HPD's vehicles may need to sit idle while in use with the battery and/or engine on to power red and blue lights, computers, and other equipment. This activity also consumes energy even when the vehicle is stationary, and it could deplete EV batteries faster than ICF's analysis currently assumes, potentially requiring altered charging schedules or higher charger power levels to provide EVs with more energy in the same overnight charging timeframe.

Step 1: To determine what type of charger would be suitable to meet the needs of the vehicles in each fleet, find the average daily operating behaviors of vehicles in the fleet. Collect the following data from the fleet data and reference³ fuel economy data:

- **Fleet data:** Average and maximum daily mileage per vehicle type (van, light-duty pickup truck, refuse truck, etc.). For each individual vehicle, collect their fuel consumption information. Then, use the fuel economy by vehicle type to

³ Fuel economy and energy efficiency data are provided in the attached spreadsheet. However, these values are manufacturer "sticker" data and may not represent the accurate fleet operational characteristics.

calculate vehicle VMT. Calculate the average and maximum daily VMT by vehicle type.

- **EV Model Specifications:** Average EV range across EVs in each vehicle type category, average battery capacity of EVs per vehicle type, the typical maximum vehicle power acceptance rating of EVs per vehicle, and average energy efficiency of EVs per vehicle type.⁴

Step 2: Estimate the average and maximum daily battery depletion for recommended EVs of each vehicle type, and in turn, the amount of energy needed to return the batteries to a full charge from their depleted levels.

To calculate the average daily battery depletion and the energy required to recharge vehicles, divide the average daily vehicle miles traveled (VMT) by the average energy efficiency of the EV. Repeat the same process of the maximum VMT.

Step 3: Estimate the amount of power (in kW) needed to charge the vehicles to full capacity under selected charging scenarios (See Table 1).⁵

The managed charging scenario assumes that the overnight charging period is held constant every night, that every vehicle drives the average or maximum daily VMT for its vehicle type, and that the EVSE power levels are throttled through smart charging software.⁶

The unmanaged charging scenarios assumes that the EV chargers at each site provide energy to EVs at their full rated capacity for the overnight charging period.

⁴ Scenarios 1-6 assume an arbitrary vehicle-to-charger ratio; Scenario 7 relies on existing vehicle operations data to estimate energy demand and solve for the high possible vehicle-to-charger ratio per site and vehicle type; All scenarios assume overnight charging.

⁵ Managed chargers require a charging port that is capable of outputting power at a lower value than the maximum capacity. By using technology solutions such as direct load control and smart charging software, the City and County can adapt EV charging patterns to reduce energy costs and charging loads. However, there are upfront costs associated with managed chargers.

⁶ The 1:1 ratio scenario imply the number of chargers is equal to the number of EVs deployed. The 2:1 ratio scenario connote that the number of chargers equals half the number of vehicles at each site, rounded up to the nearest whole number. The optimized scenario is the highest possible vehicle-to-charger ratio on a per-site per-vehicle.

Table 1 Charging Infrastructure Analysis Scenarios

Scenario Number	Daily Mileage	Managed Vs Unmanaged Charging	Vehicle-to-Charger Ratio ⁵
1	Average Daily VMT	Managed Charging	1:1
2	Average Daily VMT	Unmanaged Charging	1:1
3	Average Daily VMT	Unmanaged Charging	2:1
4	Maximum Daily VMT	Managed Charging	1:1
5	Maximum Daily VMT	Unmanaged Charging	1:1
6	Maximum Daily VMT	Unmanaged Charging	2:1
7	Average Daily VMT	Unmanaged Charging	Optimized Ratio

Step 4: Assign each vehicle type an appropriate EVSE power type (level 2 or Direct Current Fast Charger (DCFC)) for all scenarios.

1. Vehicles with estimated power needs ≤ 6.6 kW recommend a Level 2 charger.
2. Vehicles with estimated power needs > 6.6 kW but ≤ 19.2 kW recommend a 19.2 kW charger.
3. Vehicles with estimated power needs > 19.2 kW recommend a 50 kW DCFC or higher.

Note: Using the average daily and maximum daily miles traveled is important to understand the worst-case-scenario and ensure that the charging capacity of the

dwelling sites meets the requirements of the vehicles. For example, in *Figure B-1* below, the analysis shows the maximum VMT creates a larger power demand, resulting in the need for a 50 kW DCFC charger, rather than a 12–15 or 15–19 kW L2 charger.

Figure B-1. Example of charging needs assessment that relies on average vs, maximum daily VMT

Vehicle Type	# of Vehicles	Average Daily VMT (Miles)	Maximum Daily VMT (Miles)	Vehicle Efficiency (kWh/100 mi)	Charging Energy Requirement/Average Daily Depletion from Battery (kWh/charge)	Power Demand to Charge from Battery Level to Full in 9 Hours (AVERAGE VMT)	Charger Type for Overnight Managed Charging Average VMT	Charging Energy Requirement/Maximum Daily Depletion from Battery (kWh/charge)	Power Demand to Charge from Battery Level to Full in 9 Hours (ESTIMATE D MAX VMT)	Charger Type for Overnight Managed Charging Max VMT
Light-Duty Pickup	1	23.87	23.87	48	11.46	1.27	L2 (3-6 kW)	11.46	1.27	L2 (3-6 kW)
Medium-Duty Pickup	1	26.03	26.03	49	12.76	1.42	L2 (3-6 kW)	12.76	1.42	L2 (3-6 kW)
Refuse Truck	3	50.58	51.68	333	168.42	18.71	L2 (15-19 kw)	172.08	19.12	DCFC (50 kW)
Street Sweeper	14	19.12	33.47	667	127.51	14.17	L2 (12-15 kW)	223.22	24.80	DCFC (50 kW)
Dump Truck	1	15.87	15.87	333	52.86	5.87	L2 (3-6 kW)	52.86	5.87	L2 (3-6 kW)
Fleet Total	20	485.15	689.33		2367.52	263.06		3718.38	413.15	

Note: This figure is available in the site analysis spreadsheet.

Part II: Site-Level Charging Infrastructure Requirements and Cost Estimates

Step 5: Using the results from the previous section (EVSE quantities and power levels per vehicle type), estimate the power required at the potential EV dwelling site by determining how many chargers are needed at the vehicle dwelling site, and the estimated power demand from charger deployed at each site.

Assess site-level infrastructure requirements using the same six scenarios above, plus the seventh, optimized vehicle-to-charger ratio scenario. Assess the number of chargers needed to minimize costs and maximize fleet efficiency.

1:1 ratio: the number of chargers equals the number of EVs at that site

2:1 ratio: the number of chargers equals half the number of vehicles at the site, rounded up to the nearest whole number.

Optimized: highest possible vehicle-to-charger ratio on a per-site per vehicle type basis based on the operating profile of vehicles in AES, HFD, and HPD fleets. The optimized ratio scenario needs a case-by-case evaluation for individual facilities. For example, if both Vehicle A and Vehicle B are low usage (one charging event can last for at least two days), they can share one charging port and charge on alternate days. On the other hand, if Vehicle C has the tendency to drain battery completely after a full day of operation, it may need a charging port just to serve its own charging demand.

To find the optimized ratio, divide the EV's battery capacity value by the average daily energy demand of a vehicle to get the number of days the EV can operate before reaching 20% battery state-of-charge (SOC).

$$\text{NUMBER OF DAYS BEFORE 20\% CHARGE} = \frac{\text{battery capacity value (kWh)} \times 0.8}{\text{Avg. daily energy demand}}$$

The optimized ratio is the quotient of the number of vehicles in the same category⁶ per dwelling location and the reciprocal of the number of days.

$$\text{OPTIMIZED RATIO} = \text{ROUNDUP} \left[\frac{(\text{\# of vehicles of the same vehicle class and dwell site})}{\frac{\text{\# of vehicles of the same class and dwell site}}{\text{\# of days before 20\% SOC}}} \right]$$

Note: Since the optimized ratio uses maximum VMT, the equation uses the "ROUNDUP" function in Excel. To get a more conservative optimized ratio, use the "CEILING" function.

Note: The optimized ratio equation on Excel will split up the number of vehicles per charger in the most efficient way possible. For example, in *Figure B-2* below, the optimized ratio could be 9:1 (given the minimum number of days that it takes for the vehicle to reach 20% battery capacity) but is noted as 6:1 because it assigns an equal number of vehicles to each charger.

Figure B-2. Optimized Ratio Example

Charger Type	Sum of # of Vehicles	Min of # of days before 20% charge (Avg VMT)
DCFC (50 kW)	3	2
L2 (12-15 kW)	9	9
L2 (6-8 kW)	2	13
Grand Total	14	2

Vehicle Class	Number of Vehicles	Optimized Ratio - # of Vehicles:Charger (by vehicle class)	Number of Chargers Required
HDV (DCFC 50 kW)	3	2 :1	2
LDV (12-15 kW)	11	6 :1	2

To determine the estimated power demand, multiply the average or maximum power demand by the optimized ratio, and repeat for each vehicle and scenario, then add the products.

Step 6: Estimate the site-level infrastructure investments required based on the number and types of chargers and vehicles likely to be deployed at each site.

Site-level costs include EVSE hardware, EVSE installation, and ongoing EVSE maintenance costs. This data can be found in Tables 32 through 41 in the Fleet Transition Plan, but the actual costs may differ in Hawai‘i.

Use the vehicle replacement schedule data to determine the number of EVs adopted in a single year across all dwell sites, and accordingly the number of EVSEs to deploy each year.

Part III: Evaluation of Grid Impacts and Upgrade Requirements for EV Charging

Step 7: Identify EV dwell sites where the estimated incremental load from EV charging would exceed the power transfer capability of installed equipment (service transformers).

Estimate the number of chargers to be installed at each EV dwell site, and the power level from the chargers based on average daily VMT.

Use the power demand from the chargers and the baseline nighttime peak loads (EV dwell site meter and energy monitor information) in conjunction with service transformer ratings from each EV dwell site to identify locations with potential grid constraints. This should be done in partnership with HECO.

Evaluate grid impacts and upgrade requirements for EV charging by estimating the maximum incremental EV charging load at each EV dwell site using billing data and service transformer capacities. Under the overnight charging assumption, estimate the new nighttime peak load at the site by dividing the maximum incremental EV charging load by 9 (assuming 9 hours overnight charging).

Note: Adjacent sites may need to share charging or may require utility-side upgrades.

Step 8: Compare the new nighttime peak load to the power transfer capability of the service transformers to identify if there will be an overload due to anticipated EV charging demands.

If the site is below the current site service capacity, upgrades are not needed.

If the site is overloaded, estimate the cost of new electrical distribution system equipment required to accommodate incremental EV load while maintaining safety and reliability.

Part IV: Grid Distribution System Upgrade Cost Estimates

Step 9: Based on the projected overload at each site, estimate the incremental transformer capacity and new conductor type that would be required at each site. For managed and unmanaged charging scenarios, ICF assumed that the costs associated with distribution system upgrades for sites with overloads 10 kW and lower would be captured in the “site-level installation costs” category. Furthermore, HECO could potentially mitigate any site overloads below 10 kW by feeder reconfiguration, load balancing, and demand-side management measures.

Step 10: Evaluate if the site can fit photovoltaic systems and batteries for charging through a Total Cost of Ownership analysis, which involves comparing the total



costs associated with the cost of grid power versus the cost of PV or battery storage over a specified period.



2024

ENERGY CONSERVATION AND EMISSIONS REDUCTION PLAN

Electric Vehicle Infrastructure Action Plan

Prepared by the City and County of Honolulu Office of Climate Change, Sustainability and Resiliency in Cooperation with the O‘ahu Metropolitan Planning Organization and the United States Department of Transportation.

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Introduction

Vehicle electrification and electric vehicle (EV) charging infrastructure, known as electric vehicle supply equipment (EVSE), are vital to lowering emissions associated with transportation and meeting O‘ahu’s decarbonization goals. Historically, EV adoption has faced many barriers including affordability, accessibility to charging infrastructure, and driving range.¹ However, federal government pollution standards for passenger cars, light-duty trucks, and medium-duty vehicles are becoming stronger,² and there are ongoing market shifts which is increasing consumer interest in EVs as well as historic investment in EVs. These shifts and mechanisms incentivize the adoption of EVs, thereby increasing the demand for EV chargers.

As O‘ahu looks to encourage the adoption of clean vehicle technology, it is important to ensure that all residents benefit from the transition, and that underserved communities have access to charging infrastructure. In the City and County of Honolulu’s (the City) Priority Climate Action Plan (PCAP), expanding public EV charging on O‘ahu was identified as a key priority. The PCAP identified that access to EV charging for residents of multi-unit housing is a particularly challenging barrier to EV adoption.

¹

<https://www.osti.gov/servlets/purl/1854730#:~:text=An%20online%20survey%20was%20commissioned,station%20availability%2C%20and%20driving%20range.>

² <https://www.epa.gov/newsreleases/biden-harris-administration-finalizes-strongest-ever-pollution-standards-cars-position>

As of 2024, O‘ahu has 690 public charging stations planned or in operation, many of which are in Honolulu’s Urban Core.³ Using the National Renewable Energy Laboratory’s (NREL) Electric Vehicle Infrastructure Projection Tool (EVI-Pro Lite)⁴ and Hawaiian Electric Company’s (HECO) EV adoption projections, the number of private and public charging stations were modeled for O‘ahu from 2024 until 2045. This analysis found that by 2045, O‘ahu will need over 17,000 public ports to meet the projected demand. With more EVs on the road, EV charging infrastructure will have to be planned and deployed carefully and equitably to meet the growing demand.

This Electric Vehicle Infrastructure Action Plan serves as an in-depth analysis of anticipated charging demand and identifies locations that would benefit a wide range of existing and anticipated users.

Electric Vehicle Charging Infrastructure Needs

EV Adoption Projections

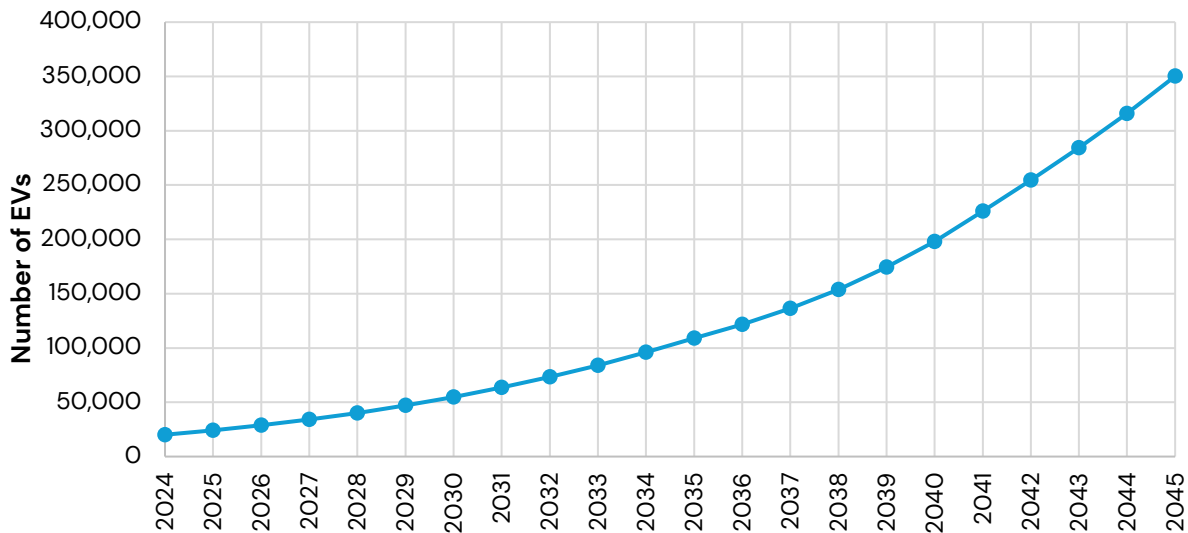
HECO previously estimated O‘ahu’s EV annual population from 2024 to 2045 (see Figure 1 below).⁵ The EV population on O‘ahu will increase from 20,106 to 350,243 EVs from 2024 to 2045, a growth rate of 1,641 percent.

³ <https://www.plugshare.com/directory/us/hawaii/urban-honolulu>

⁴ <https://github.com/NREL/EVI-Pro-Lite/tree/master>

⁵ https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/for_ecast_assumptions/PUC-HECO-IR-1_att_8_electric_vehicles.xlsx

Figure 1. Projected EV Population



Charging Infrastructure Requirements

Using the NREL's EVI-Pro Lite Tool and HECO's EV adoption projections, the total number of private and public charging stations were modeled for O'ahu from 2024 until 2045. Based on these projections, in 2024 there will need to be 15,812 private EV charging stations and 592 public charging stations. By 2045, there will need to be 154,253 private and 17,531 public charging stations across the island to meet the estimated demand. Private chargers are considered to be "behind the fence" and are only accessible to a certain group of EV drivers, such as residential home charging, workplace charging on private lots, multi-unit dwelling (MUD) tenants charging in underground parking lots, and fleet charging. Public chargers are accessible to all EV drivers. Examples of public chargers include curbside charging, charging at retail parking lots, tourist destinations, and rail stations or mobility hubs.⁶

Based on these projections, the vehicle-to-port ratio for private and public chargers in 2045 will be 3.39 and 20.91 respectively. *Figure 2* and *Figure 3* show the

⁶

https://www.hawaiielectric.com/documents/clean_energy_hawaii/electrification_of_transportation/2018-0135_20190730_cos_ev_backbone_study.pdf

projections of annual public and private charging ports requirements from 2024 through 2045 on O‘ahu. Each year is inclusive of the chargers required to meet the demand of the EV population for that specific year and years prior. For example, in *Figure 3*, there will need to be around 11,000 chargers in 2040, and in 2045 there will need to be about 17,000 chargers. Therefore, in the five intervening years, about 6,000 EV charging ports should be added.

Figure 2. O‘ahu Private EV Charging Ports Projection

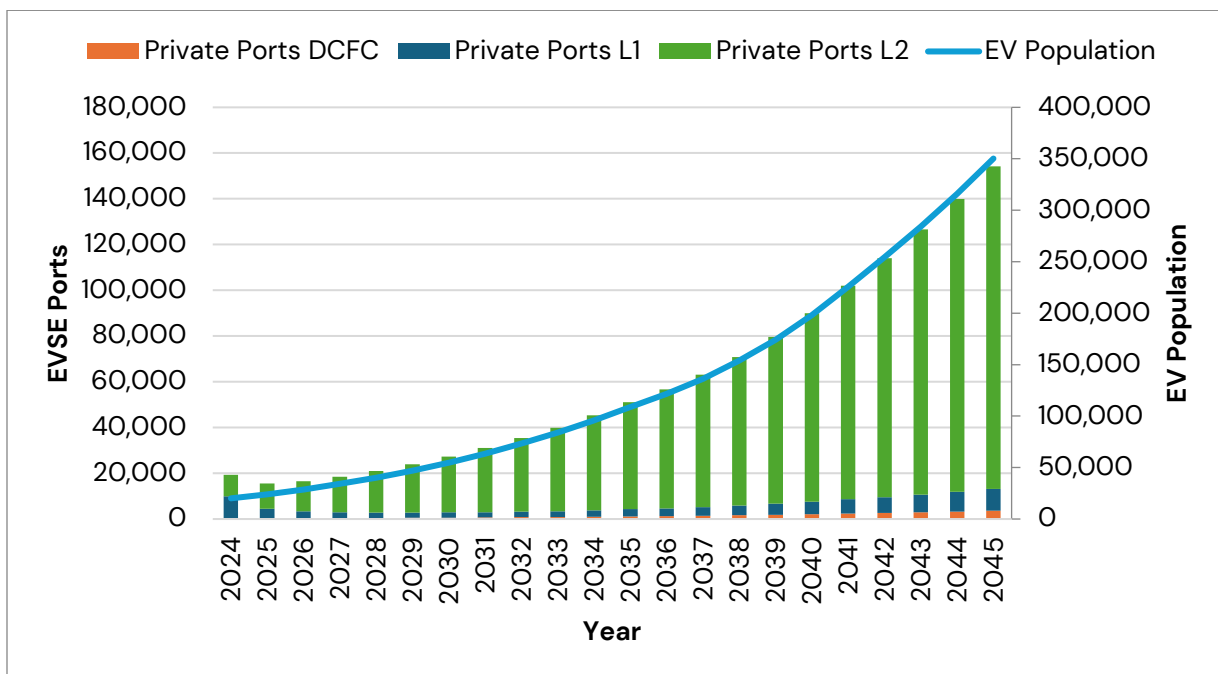
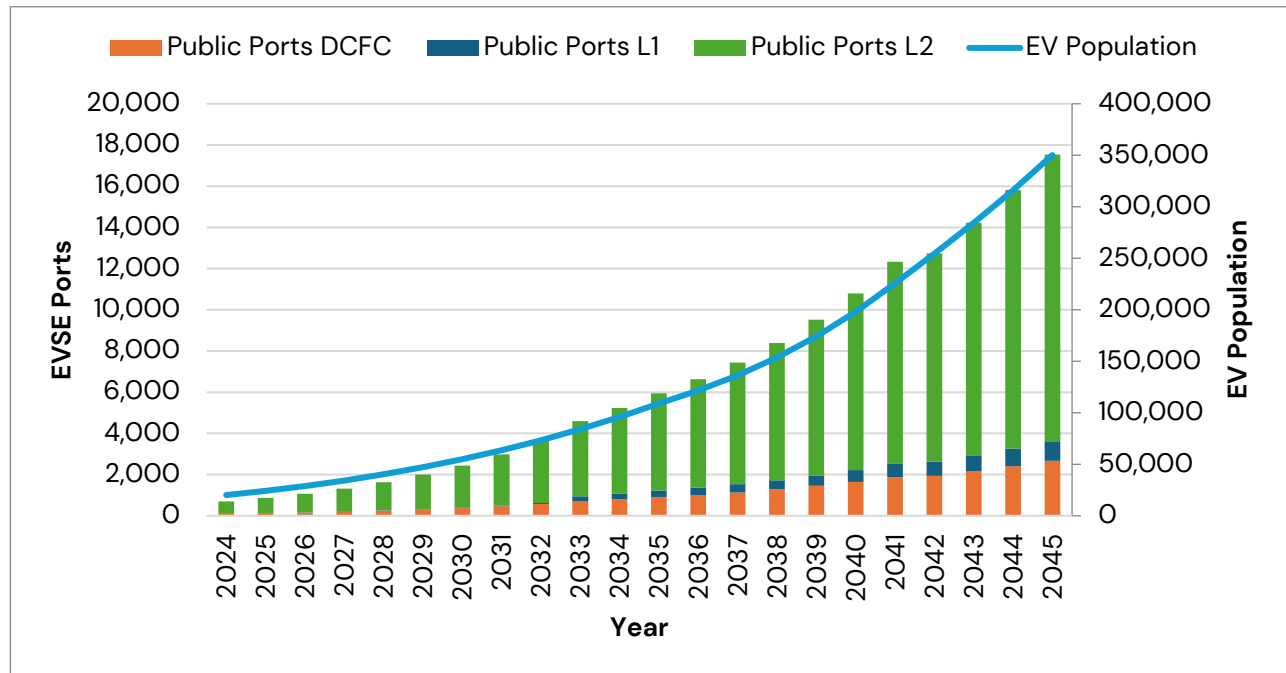


Figure 3. O‘ahu Public EV Charging Ports Projections



Inventory, Distribution, and Characteristics of City Public Parking Facilities

The City and County of Honolulu created a Parking Pricing Framework, which reviewed the City’s parking inventories and rates. The City currently manages approximately 3,113 on-street metered parking spaces, which includes 1,838 on-street IPS Smart Meters and 1,275 coin meters. The City is exploring the potential for on-street EV charging. Charging would require both stakeholder outreach and coordination between the utility who owns the pole and the City Department responsible for the Right-of-Way.

Additionally, the City manages several paid off-street lots and garages. Some facilities are metered and allow hourly parking only; these facilities generally have maximum time limits. Other facilities have attendants and offer hourly, daily, or

monthly parking. There are a total of 30 city-owned parking facilities, which include public parking facilities and Park & Ride locations, and have a total of 5,835 parking spaces and 212 accessible parking spaces.⁷ There are seven parking facilities that have public EV chargers and one facility with restricted EV chargers.⁸ Table 2 below lists the parking facilities located across O‘ahu.

Table 1. City Owned Parking Facilities on O‘ahu

Facility Name	Location	Address	Parking Spaces	Accessible Parking Spaces
Smith – Beretania*	Chinatown	Smith and Beretania	121	5
Hale Pauahi*	Chinatown	111 N. Beretania Street	197	13
Harbor Village Parking	Chinatown	901 River Street	70	4
Marin Tower Parking	Chinatown	918 Smith St	258	14
Harbor Court	Chinatown	66 Queen St	458	18
Chinatown Gateway*	Chinatown	1041 Nu‘uanu Ave	112	7
Civic Center Lot*	Downtown	1130 Alapai	72	4
HPD Garage	Downtown	801 S. Beretania St	10	6
Neal Blaisdell Center*	Kakaako	777 Ward Ave	1467	26
Capitol Place*	Downtown	1200 Queen Emma	150	4
Kukui Plaza	Chinatown	1255 Nu‘uanu	434	14
Kekaulike Court	Chinatown	1016 Maunakea St	52	11
Palace Square	Downtown	364 S. King St	38	2
Kūhiō–Kailou Lot	Waikiki	Kūhiō Ave and Kaiolu St	58	3
Zoo Lot*	Diamond Head Kapihulu	151 Kapihulu Ave	221	9
Kaimuki Lot 1	Kaimuki	1150 12th Ave	262	12
Kaimuki Lot 2	Kaimuki	Koko Head Ave and 12th Ave	106	0
Kailua Lot	Kailua	26 Aulike St	139	6

⁷ <https://honolulu-cchnl.opendata.arcgis.com/datasets/5137c2133e4c497e8eb86d63785a253d/explore>

⁸

<https://cchnl.maps.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=ed681816dc3e47adb3d433959e77d3c1&layerId=0>

Facility Name	Location	Address	Parking Spaces	Accessible Parking Spaces
Kailua Elderly Lot	Kailua	25 Aulike St	140	5
Kalākaua Lot	Diamond Head Kapaehulu	2748 Kalākaua Ave	271	0
Salt Lake Lot	Salt Lake	5375 Likini St	152	0
Hawai'i Kai Park & Ride	Hawai'i Kai	220 Keahole St	134	5
Mililani Mauka Park & Ride	Mililani	95-1101 Ukuwai St	148	3
Royal Kunia Park & Ride	Waipahu	94-640 Kupuohi St	110	5
Wahiawā Armory Park & Ride	Wheeler AFB	Leilehua Golf Course Rd and Kamehameha Hwy	216	10
Hale'iwa Park & Ride	Hale'iwa	66-434 Kamehameha Highway	17	4
Ali'i Place	Downtown	1099 Alakea St	227	8
Wahiawā Transit Center Park & Ride	Wahiawā	956 California Ave	37	3
Kapolei Hale**	Kapolei	1000 Uluohia St	71	7
Middle Street Intermodal Center w/ Park & Ride	Kalihi-Pālama	611 Middle Street	87	4
Total Number of Parking Spaces			5,835	212

* Public EV chargers available

** Restricted EV chargers – available for employees and disabled only

Siting Prioritization

Ensuring that the benefits of EVs and zero-emission mobility are equitably distributed throughout O‘ahu is a key priority. Planning EV infrastructure deployment with equity as a pillar will support low-income and disadvantaged communities in gaining access to EVs and EV charging infrastructure. In addition, public EVSE deployment can have a number of economic and health benefits for low-income and disadvantaged communities, such as lower transportation costs and reduced air pollution.⁹ To support the City’s equitable deployment of EVSE, the City conducted an ArcGIS-based analysis to determine EV charging priority areas across

⁹ <https://www.transportation.gov/rural/ev/toolkit/ev-benefits-and-challenges/community-benefits>

O‘ahu. Further direct engagement with communities on a project-by-project basis may be required to help the City understand specific community needs ahead of final project deployment.

Assumptions and Methodology

The siting analysis began with determining three scenarios that had differing prioritization criteria. The scenarios and metrics help to determine the priority locations to deploy EV charging infrastructure across O‘ahu. The main metrics for scoring were proximity of facilities to low-income and disadvantaged communities (LIDACs); proximity of facilities to MUDs; trip origin and destination; trip length; and dwelling time. Next, three scenarios were determined based on the City’s priorities, including 1) prioritizing access for residents with limited access to home charging, 2) prioritizing equitable access in non-residential zones, and 3) prioritizing convenience and accessibility to public fast charging. The metrics for each scenario were selected for their applicability and were given a score weighting.

Scenario 1 metrics are intended to yield results that prioritize equitable charging access for residents that have limited access to home charging, such as residents living in apartment and high-rise buildings, LIDAC census block areas, and where vehicles are parked for longer than two hours. Scenario 2 metrics prioritize equitable access to charging infrastructure in non-residential zones, with the most consideration given to trips originating from LIDACs, and equal consideration given to trip destinations other than home and trips beginning in a census block with multi-unit dwelling development areas. Finally, Scenario 3 prioritizes convenience and accessibility to public fast charging, and considers metrics such as long-distance trips, the destination of trips not being home, and time spent at a location being under 1 hour. The three scenarios and related criteria weights are listed in Table 3 below.

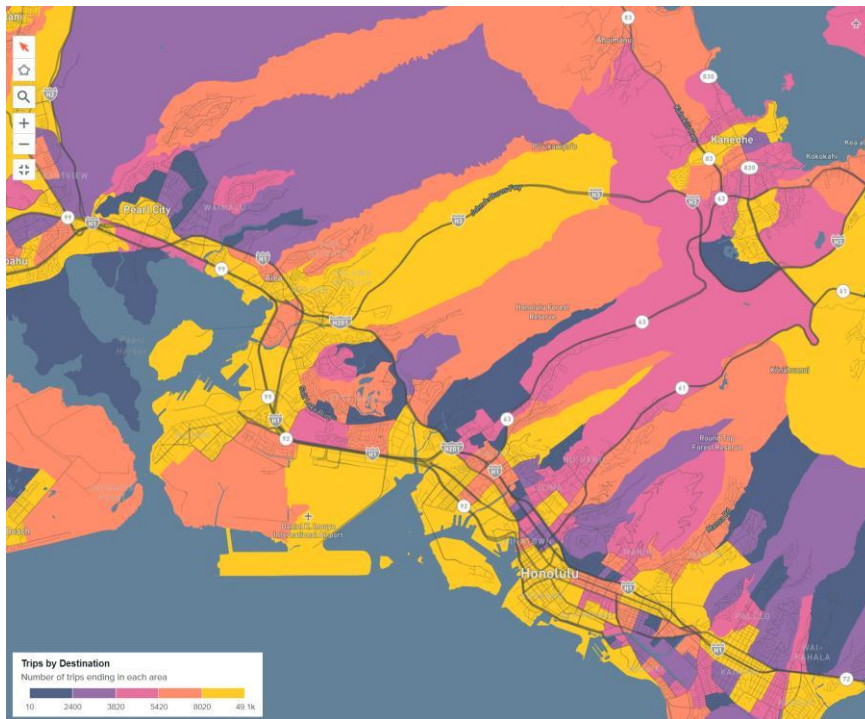
Table 2. Siting Analysis Scenarios and Criteria

Scenario 1 – Prioritize access for residents with limited access to home charging	
Metric	Weight
Trip destination being home	30
Trip destination in low-income and disadvantaged households and communities	20
Trip destination in census with MUDs development	40
Dwell time greater than 2 hrs	10
Total	100
Scenario 2 – Prioritize equitable access in non-residential zones	
Metric	Weight
Trip originated from low-income and disadvantaged households and communities	40
Trip destination not being home	30
Trip originated from census with MUDs development	30
Total	100
Scenario 3 – Prioritize convenience and accessibility to public fast charging	
Metric	Weight
Trip destination not being home	20
Long distance trip (≥20 miles)	50
Dwell time less than 1 hr	30
Total	100

Once the scenarios and criteria weighting were established, we gathered data from various sources to input into our web mapping software and applied the criteria weighting. Data for dwell time and trip origin, destination, and length was sourced from Replica¹⁰, a big data analytics platform that simulates travel patterns using anonymized cell phone data. An example of the Replica trip data is shown in *Figure 4*. The City has data on zoning codes throughout O‘ahu, which was used to determine the MUDs.

¹⁰ <https://www.replicahq.com/> For this analysis, the project team used Spring 2023 Thursday private auto trip data in Honolulu from Replica.

Figure 4. Replica Private Auto Trips by Destination in Honolulu, HI.



For LIDAC communities, data was collected from the Climate and Economic Justice Screening Tool (CEJST)¹¹ and the U.S. Department of Transportation (DOT) Equitable Transportation Community (ETC) Explorer.¹² Both data sources were used to determine where the disadvantaged communities are located, in terms of the Census Block Groups (CBG). Although the CBGs indicated by the CEJST and ETC often overlap, there are also some differences. For example, one CBG may be indicated by both the CEJST and ETC, but another may be only indicated by the CEJST or the ETC. In the event that a CBG was only indicated by one of the CEJST or the ETC, the CBG that is designated by the CEJST was prioritized. For example, CEJST communities were given full weighting, whereas ETC designated communities were given a half weighting. This is because ETC CBGs are focused solely on

¹¹ <https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5>

¹² <https://www.transportation.gov/priorities/equity/justice40/etc-explorer>



transportation insecure communities, whereas CEJST CBGs experience a range of burdens and are underserved.

Finally, the weighting of the MUDs was determined by overlaying the MUD with the CBGs. The proportion of the CBG area covered by MUD areas (zoning polygons) were calculated. Using the proportions, a weighted average calculation of the various MUD scores based on density (3, 6, and 10) were designated within each CBG. MUD scores were assigned by low, medium, and high density, respectively. Then, the number of destination and origin trips to the various CBGs were calculated and normalized on a scale from 0-10. The weighted averages of the MUDs and normalized trips were multiplied to determine the final score, which was further normalized to fall within a scale from 0 to 10 and weighted based on the scenario.

Results and Analysis

Each scenario analyzed based on a determined set of criteria, which highlights the different priority areas across O'ahu. The priority areas are determined by a score from 0 to 10, with 0 the lowest and 10 the highest priority. The priority areas and scores are differentiated by color. The results of scenarios 1, 2, and 3 are depicted in Figures 4, 5, and 6, respectively.

Figure 6. Scenario 2 (Prioritize equitable access in non-residential zones) Results

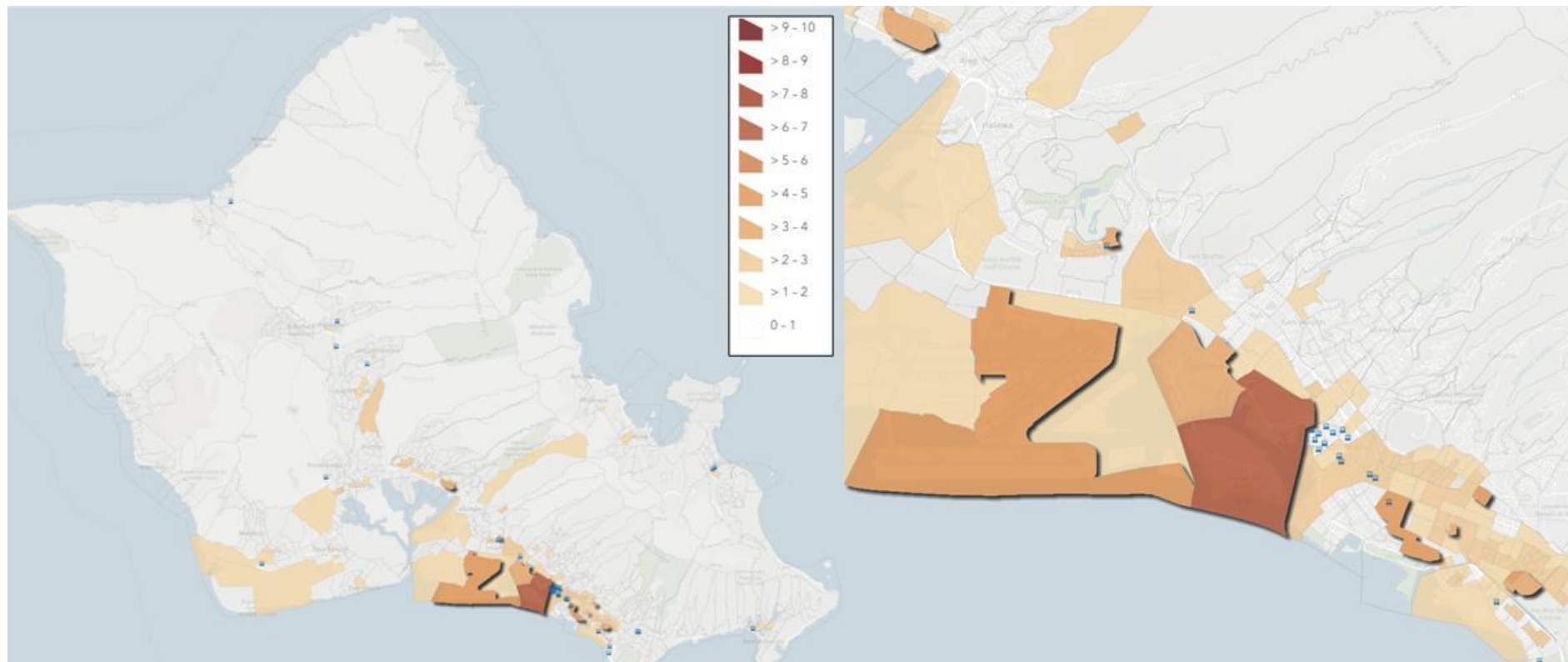
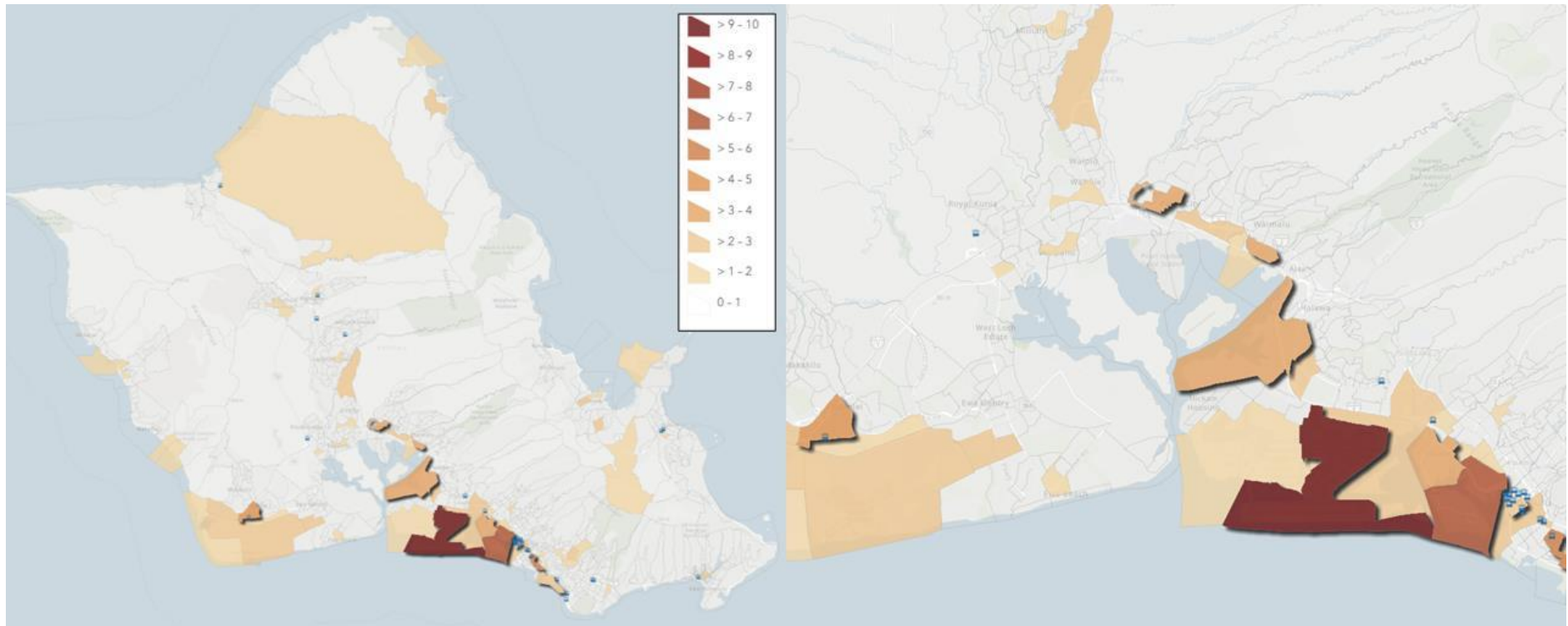


Figure 7. Scenario 3 (Prioritize convenience and accessibility to public fast charging) Results

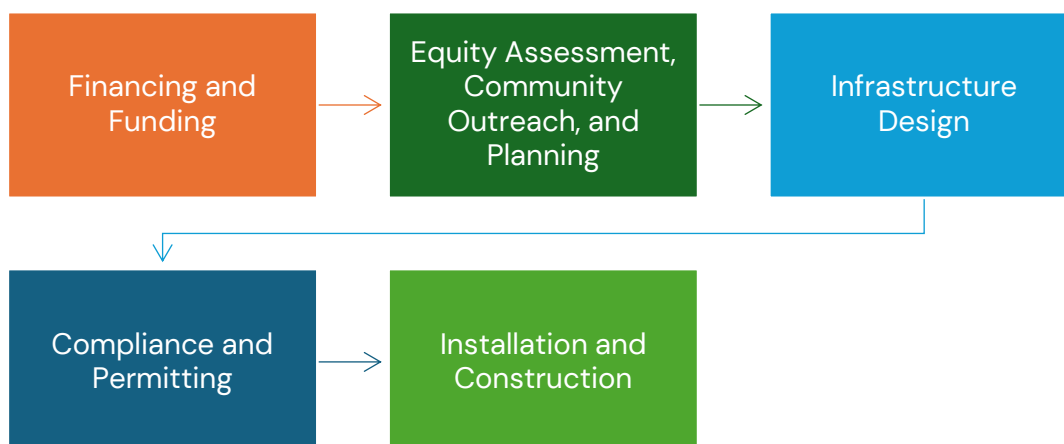


In Scenario 1, “prioritize access to residents with limited home charging”, the Salt Lake Lot and the surrounding area were identified as high-priority areas. For Scenario 2, “prioritize equitable access in non-residential zones,” the CBG that is inclusive of Sand Island and Iwilei is identified as a high-priority area given that many trips originating in disadvantaged communities end in that CBG for purposes other than going home. Scenario 3, “prioritize convenience and accessibility to public fast charging,” highlights the CBG containing Ala Moana Shopping Center and the Neal S. Blaisdell Center due to its high scoring with metrics such as “destination not home” and “dwell time under one hour”.

Deployment Strategy

Ensuring equitable access to EV charging infrastructure will help the City to achieve its ambitious decarbonization goals and provide communities with the social, environmental, and economic benefits associated with low or zero-emission transportation options. As the City plans to deploy additional public EV charging infrastructure, it should follow a strategy that consists of five key steps as follows: financing and funding; equity assessment, outreach, and planning; infrastructure design; compliance and permitting; and installation and construction. This deployment strategy is depicted in Figure 9 below.

Figure 8. Deployment Strategy



Funding Opportunities and Financing Strategies

Federal Funding

Securing funding and having diverse financing strategies is vital to ensure that the City can scale public EV charging to meet the growing demand around the island. The City and its partners are evaluating the U.S. Department of Transportation Charging and Fueling Infrastructure Grant Program funding to pilot pole-mounted charging around the state. There are additional federal funding opportunities for EV chargers that the City may take advantage of, including the National Electric Vehicle Infrastructure (NEVI) Formula Program.

In addition, the 2022 Inflation Reduction Act (IRA) established the Alternative Fuel Infrastructure Tax Credit, which provides a tax credit of 6 percent of the cost of property subject to depreciation, with a maximum credit of \$100,000 for each single item of qualified refueling property, which includes property that stores or dispenses clean-burning fuel or to recharge EVs. Projects that meet the [prevailing wage and apprenticeship requirements](#) may be eligible to receive a tax credit equal to 30 percent of the cost of the property subject to depreciation.¹³ For state, local, and Tribal governments or other tax-exempt entities, the Alternative Fuel Infrastructure Tax Credit is direct pay eligible, which means entities can elect to receive these tax credits in the form of direct payment. To be eligible for direct pay, projects must be installed in an eligible census tract, which can be determined by using the [30C Tax Credit Eligibility Locator tool](#). It is important to note that only qualified refueling properties are included in the tax credit, and permitting and inspection fees are not included as part of covered expenses.¹⁴

Financing Strategies

Beyond funding opportunities, there are financing mechanisms that the City can explore to deploy EV charging infrastructure. Options that the City can pursue are public-private partnerships (P3), Infrastructure-as-a-Service (IaaS), and Green Bank

¹³ <https://afdc.energy.gov/laws/ev-tax-credits>

¹⁴ <https://www.irs.gov/credits-deductions/alternative-fuel-vehicle-refueling-property-credit>

Financing such as recently announced Greenhouse Gas Reduction Funds. Additionally, national cooperative purchasing contracts such as Sourcewell may offer more competitive purchasing for the City by aggregating buying power with other municipalities nationally.

Public-Private Partnerships

P3s can be an effective way to scale charging infrastructure, and involves a private partner, such as a utility company, that finances initial capital costs with private debt and equity in exchange for returns on investment over time. The partnership between the government and a private entity would require the latter to take the lead in designing, financing, constructing, and operating the charging infrastructure while the government entity provides funding, land, and other resources. PPPs allow for the sharing of risks and benefits and can lead to a quicker deployment of charging infrastructure and encourage innovation. There are several P3 models that can be used for charging infrastructure deployment, and the ultimate choice of model depends on the specific needs of the government and private partners. Some of the common P3 models include:

- **Build-Operate-Transfer (BOT) Model:** A private partner would be responsible for the design, construction, and operation of charging infrastructure, and transfers the ownership to the government after a specified period of time.
- **Design-Build-Finance-Operate-Maintain (DBFOM) Model:** Similar to the BOT model, a private partner would take responsibility for design, construction, financing, operation, and maintenance of the EV charging infrastructure, but operates it for a specific time before transferring ownership back to the government.
- **Concession Model:** Under this model, the government would grant a private partner the right to build and operate charging infrastructure in a specified area for an agreed upon period of time in exchange for payment or revenue share.
- **Joint-Venture Model:** A joint venture would be established between the public and private sectors under this model, and both partners would collaborate to develop and operate charging infrastructure.

The Georgia Department of Transportation (GDOT) has a P3 program that leverages limited transportation funds by partnering with the private sector using innovative delivery methods. GDOT recently used NEVI funding to create a P3 EV charging network under a Design-Build-Finance-Operate-Maintain agreement for a minimum of five years. The partners were selected from a competitive solicitation process and set a payment cap that helped to govern the allocation of funding to complete the installation of NEVI-compliant charging stations.¹⁵

Another example of a P3 program that is currently underway can be found in San Diego, California, where the City seeks to install EV chargers on city-owned land for public and workplace charging. As a first step, the City of San Diego published a Request for Information (RFI) from EVSE providers to build EVSE infrastructure on public land.¹⁶ Based on the responses received to the RFI, the City of San Diego published a Request for Proposals (RFP) to select an exclusive EVSE provider to install, operate, and maintain networked EV chargers on city-owned property for public and workplace charging.¹⁷

Purchasing Contracts from Sourcewell

Sourcewell is a government agency that provides cooperative purchasing contracts to public entities and governments in the United States and Canada. Sourcewell financing helps entities to finance the purchase of goods or services, spreading the cost of the purchase over time. Sourcewell is able to negotiate lower prices and better terms on the products and services it procures because it pools the purchasing power of its members. For EV charging infrastructure, Sourcewell may negotiate contracts with EV charging equipment suppliers and manufacturers and offer these contracts to its members. Sourcewell has many competitively solicited cooperative contract options available for EV chargers that are available for use by any public sector agency. Signing up for Sourcewell is free.

¹⁵ <https://nevi-gdot.hub.arcgis.com/>

¹⁶ <https://vendors.planetbids.com/portal/17950/bo/bo-detail/94825>

¹⁷ <https://vendors.planetbids.com/portal/17950/bo/bo-detail/103675#>

Infrastructure-as-a-service

Infrastructure-as-a-service (IaaS) for EV chargers refers to a model that allows businesses or government to purchase and install infrastructure, such as EVSE, with low upfront costs. IaaS for EV chargers offers a range of charging solutions and services that are highly adaptable to the needs of governments and property managers. IaaS allows organizations to provide EV charging to the public without needing to invest in the equipment themselves, while also allowing organizations to manage the installations, maintenance, and billing of the service. These help to make the adoption of EVs more accessible and convenient for end-users. Established companies providing IaaS for EV chargers include Sustainability Partners, ChargePoint, Blink Charging, and EVgo.

Equity Assessment, Community Outreach, and Planning

Determining Priority Areas: Using the results of the siting analysis can determine the priority areas for public EV charging deployment. For example, based on Scenario 3 results, Kapolei Hale could be a priority facility given its existing charging infrastructure. However, Kapolei Hale is currently restricted to government employees, so the City could open the parking facility for public use. In addition to considering equitable access to chargers, the City should consider the estimated available capacity on HECO's primary distribution system. HECO's EV Charger Siting Tool indicates the areas on O'ahu where capacity may be constrained and shows where the system could require upgrades to support additional load.¹⁸

Assessing Infrastructure Coverage and Gaps: In tandem with determining priority areas and load capacity, the City should consider the current gaps in EV charging and community mobility needs. The City conducted outreach to key partners to collect input for the need for public EV charging, including with HECO's Charge Up Hawai'i program. Building on this effort, the City should regularly engage with communities to gain a holistic understanding of transportation needs. Building deep relationships through regular engagement can result in more holistic and responsive mobility investments, and lead to an increasingly equitable transportation system.

¹⁸ [https://www.hawaiianelectric.com/products-and-services/electric-vehicles/electric-vehicle-\(ev\)-charger-siting-tool/oahu-electric-vehicle-\(ev\)-charger-siting-tool](https://www.hawaiianelectric.com/products-and-services/electric-vehicles/electric-vehicle-(ev)-charger-siting-tool/oahu-electric-vehicle-(ev)-charger-siting-tool)

Further, when engaging with communities, it is important to understand that deploying EV infrastructure is not the primary or exclusive solution to addressing community mobility needs. The City should also focus on sharing information about opportunities for the community to receive broader access to EVs. The Resilience Office's Equitable Community Engagement Guide provides valuable information on community-centered engagement practices and decision-making processes.¹⁹

Infrastructure Design

Once the site for installing new EV infrastructure is selected, the City should determine the charging station types based on the user needs. EV charging equipment is categorized based on the rate at which the batteries are charged. There are four charger types that the City may consider:

- **Level 1 (L1) Chargers:** L1 chargers offer charging through a 120-volt (V) AC plug. L1 charging is typically used for home charging and provides approximately 5 miles of range per one hour of charging. L1 chargers consist of a nozzle cord and a standard electrical outlet, which make them ideal for home charging, but not for public use. According to the Alternative Fuels Data Center, as of 2022, less than one percent of public EV chargers are L1 chargers.²⁰
- **Level 2 (L2) Chargers:** L2 chargers provide charging through a 240 V or 208 V AC plug, dependent on application (residential or commercial). A L2 charger can range from 2.9 to 19.2 kW power output and provides approximately 25 miles of range per hour of charging.²¹ L2 chargers are the most common chargers for public charging, and depending on the power output can be used for users that will stay on site for an extended period of time.
- **Level 3 (L3) Chargers, Direct Current Fast Charging (DCFC):** L3 chargers, commonly referred to as DCFC equipment, can charge an EV from depleted

¹⁹

<https://static1.squarespace.com/static/5e3885654a153a6ef84e6c9c/t/61006a81bdf6542c63e27a71/1627417226346/Equitable+Community+Engagement+Guide.pdf>

²⁰ <https://afdc.energy.gov/fuels/electricity-stations>

²¹ <https://afdc.energy.gov/fuels/electricity-stations>

to 80 percent in 20 minutes to an hour. DCFC equipment is commonly found along heavy-traffic corridors and is ideal for users that do not stay at their location for a long time.²² The main challenge with DCFC equipment is that it is expensive to install, especially if the grid capacity is unable to meet the power demand of the added DCFC equipment.

- **Pole Mounted Charger:** Pole mounted EVSE are typically installed onto existing power supplies, such as utility poles and streetlights, and are located in residential areas, where overnight parking is prevalent. Pole-mounted chargers are most commonly L2 chargers. Utility poles are EV-charging retrofit ready, and chargers can use existing power supply. Adding chargers to streetlights is a relatively low-cost option that is easy to permit. However, streetlights may not have sufficient power for L2 charging.²³ Furthermore, the addition of pole mounted chargers will result in a loss of valuable street parking for non-electric vehicle drivers.

The City should consider futureproofing sites, and although the upfront costs may be higher, it may benefit the City in the long run to future-proof sites.

Futureproofing involves ensuring future easy and low-cost expansion of chargers, equipment upgrades, and customer experience at a site. Futureproofing actions include:

- **Parking Layout:** EVSE will require considerations beyond typical parking lot designs. Adding EVSE to parking lots and garages may cost planners valuable floor area as installation and access can require several extra square feet of space.²⁴
- **Cables and Conduits:** Laying down additional cable and/or conduit during new construction or renovations beyond what is required for the current project.
- **Electrical Capacity:** The City should work with HECO to understand grid capacity and the potential of installing excess electrical capacity in anticipation of future charging installations. Collaborating closely with HECO

²² <https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds>

²³ <https://driveelectric.gov/files/webinar-2023-04-25-community-charging-market-scan.pdf>

²⁴ https://www.transportationandclimate.org/sites/default/files/EV_Siting_and_Design_Guidelines.pdf

to design and install EV charging stations at the onset will help to minimize the amount of time needed to deploy EV charging stations.

- **On-site Power Generation and Energy Storage:** Installing on-site renewable power generation and energy storage can work together to minimize the cost of electricity by reducing peak demand on the grid.²⁵

Installing the site-level make-ready infrastructure needed to enable future EVSE deployments without pre-emptively installing the EVSEs themselves (e.g., trenching, running conduit and cable, building circuitry, etc.) could be a more cost-effective approach. This development could be completed in phases, with the first phase involving development of make-ready infrastructure scaled for near- and long-term needs, then a second phase involving the deployment of EVSE required for near-term EV deployments, followed by a final and ongoing phase of EVSE deployment for additional EV deployments over time.

Finally, other factors such as parking spaces, user convenience, and Americans with Disabilities Act (ADA) compliance should be top of mind while working with engineers to create site-specific infrastructure plans.

Compliance and Permitting

The City can work with an electrical contractor and HECO to obtain the necessary permits to make site upgrades. In preparation for the permits, the City should compile relevant information including site plans, electrical diagrams, load estimates, and safety measures. Permitting is often an area where EVSE deployment is slowed down. To address this, the City should determine if the existing permitting processes create barriers for EVSE deployment. For example, California required cities and counties to adopt ordinances to streamline the permitting process for EV charging installation and provided a resource on permitting best practices to facilitate this.²⁶ The City should also be aware of and comply with building codes, zoning regulations, and environmental regulations.

For example, flood zones present specific permitting challenges for installing EVSE. On O‘ahu, everyone lives in a flood zone, but the severity of flood zones varies. Any

²⁵ <https://business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf>

²⁶ <https://afdc.energy.gov/fuels/electricity-permitting-processes>

place with a one percent or higher chance of experiencing a flood annually is considered to have a high flood risk.²⁷ When L2 or DCFC chargers are needed in a flood zone, special attention must be paid to location and installation details to comply with code requirements. Per the Revised Ordinances of Honolulu §17-1.1, stationary and portable electrical equipment must be located above the base flood elevation or enclosed in a waterproof barrier, with the ground fault protector on the main disconnecting means.²⁸ For EVSE components, elevation and component protection are the two best practices for minimizing flood damage. Elevation refers to the location of EVSE above the anticipated flood levels, and all EVSE should be installed above the flood level. Component protection refers to design techniques that protect EVSE from flood damage if they are located below the flood level.

Installation and Construction

EVSE installation costs vary based on several factors. These include the type of charging infrastructure, geographic location, site conditions (such as trenching requirements), electrical upgrades for future EVSE installation, and labor costs. Understanding cost burdens is important throughout the EVSE deployment process because the infrastructure associated with EV charging is a sizable investment. Traditionally, HECO is responsible for providing electric service up to the utility side of the meter, and customers are responsible for designing, procuring, installing, and maintaining the EVSE.²⁹ HECO currently has a Charge Up Commercial Pilot that helps non-residential customers reduce the upfront costs of installing EV charging equipment. Under this pilot program, HECO will pay for, install, and maintain the electrical infrastructure required for EV charging, which reduces the cost and complexity of EV charging installation for its customers.

In addition to high physical infrastructure costs, the Rocky Mountain Institute (RMI), notes that EVSE installation costs are three to five times the cost of the charger because of 'soft costs'. Soft costs include process costs, marketing and opportunity costs, and the cost of delays in permitting. Reducing soft costs has the highest

²⁷ <https://www.fema.gov/flood-maps>

²⁸ <https://codelibrary.amlegal.com/codes/honolulu/latest/honolulu/O-O-O-16816>

²⁹

https://www.hawaiianelectric.com/documents/products_and_services/electric_vehicles/charge_up_commercial_handbook.pdf

potential for savings throughout the EVSE deployment process. RMI notes that poor communication between utilities and EVSE providers was the most common source of delays and the need to rework EVSE deployment plans.³⁰ HECO's EV Charger Siting Tool is a first step to breaking down communication barriers. For smoother communication and installation process, having designated points of contact for each charging site project on the city and utility sides is essential. If the installation and construction process is slowed down, the service providers typically take on the majority of the cost burden.

Conclusion

Electric vehicle charging infrastructure is a key pillar in a low-emission transportation future. Current projections show that O'ahu will need to adopt EV charging stations at a rapid rate to meet the growing demand from increased EV adoption. However, EVSE deployment needs to ensure equitable access so that all communities can enjoy the social, economic, and environmental benefits of the zero-emission vehicles. As the City meets this growing demand, it should consider areas that have limited access to EV charging, which includes LIDACs and residents living in multi-unit dwellings, such as apartments and condominiums.

³⁰ <https://rmi.org/wp-content/uploads/2020/01/RMI-EV-Charging-Infrastructure-Costs.pdf>