

Incorporating Equity and Sustainability in Bay Area Transportation

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SDG Undergraduate
Research Group

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EXECUTIVE SUMMARY

To provide context and explore the broader implications of transportation justice and sustainability in the Bay Area, we aimed to discuss the role of the United Nations Sustainable Development Goals in transportation justice and sustainability challenges in the Bay Area, with an emphasis on SDG 8 (Reduced Inequalities) and SDG 10 (Responsible Consumption and Production). By providing perspectives on how current and future modes of progress can integrate with the ideals of both SDGs, we can more effectively solve and discuss issues of transportation equity and sustainability. We also aimed to represent the current state of transportation justice in the Bay Area and some of the most effective tools for incorporating the ideas of transportation justice into decision making processes. Analyzing transportation equity across Bay Area communities, we took a detailed look into how public policy, minority communities, the transportation industry, and environmental impacts as core components of transportation justice allow us to recognize inequality to build a future based on accessibility for all. These were meant to contextualize and center our research for our areas of focus.

Due to its reliance on fossil fuels, the transport sector is one of the largest sources of greenhouse gas and air pollutant emissions. Decoupling the growth of population and transport demand from negative environmental impacts like greenhouse gas emissions and air pollution requires strategic transportation planning and a persistent political will.

Renewables such as wind and solar are zero-carbon energy sources that are beneficial for the environment. Having public transportation systems in the Bay Area transition into using clean energy sources would allow them to reduce their carbon footprint and operating costs (in terms of electricity).

Walking is an underutilized mode of transportation in cities that promotes both sustainability and equity. In order to increase the convenience and practicality of walking over driving, cities need to be designed strategically to make walking a primary transit option.

Microtransit is a newer form of public transit that provides convenient, customizable routes for riders at the same price rates as conventional bus services. This transit option has the potential to increase accessibility and equity for Bay Area commuters, and it could be more sustainable than current options such as buses and trains.

Covid-19 has highlighted inequalities amongst commuters and put a financial strain on transit agencies. Federal aid has delayed drastic cuts, but long term concerns still exist.

INTRODUCTION

The SDG Undergraduate Research Group (SURG) is an undergraduate-led research group affiliated with the UC Berkeley Office of Sustainability and guided by the UN Sustainable Development Goals. Through student-led research, SURG aims to take action on the major challenges of our time, expand undergraduate leadership in topics of interest, and increase transdisciplinary learning of these issues.

The Transportation Justice and Sustainability committee focused on analyzing the impacts of climate change on transportation systems and the intersection of climate solutions and transportation justice in the Bay Area. This research was conducted by Brianna Ong, Annie Miller, Alvin Li, Ankita Morari, Kayla Hidayat, Lydia Zou, Meg Kalaw, and Patrick Choi. This committee's research was guided by our mentor, Dr. Daniel Chatman.

This research committee made use of a variety of quantitative and qualitative data sources. Through the analysis of reports from local transit organizations, pilot programs, case studies from other metropolitan areas, emissions data, and transit data we were able to research quantifiable answers to our foundational questions. We also analyzed a variety of qualitative sources including scholarly articles, as well as interviews and documentation from local transit organizers and organizations. Through the evaluation of these sources we were able to gain a broader understanding of the current state of sustainability and justice in the Bay Area transportation sector.

This report aims to discuss the pressing issue of sustainability in the transportation sector and the incorporation of transportation justice when evaluating these solutions. This research was guided by both general thematic and topic specific questions. To provide context and explore the broader implications of sustainability and justice in transit, we analyzed different modes of transportation and their effects on accessibility and sustainability, the role of the United Nations Sustainable Development Goals, and the impact of COVID-19 on transportation.

EXPLORATORY/ FOUNDATIONAL SECTIONS

- **01** Foundational Questions
- **02** UN Sustainable Development Goals and Bay Area Transportation
- **03** Transportation Justice in the Bay Area and Incorporating Transportation Justice into Decision Making
- **04** Transportation Equity in the Bay Area

FOUNDATIONAL QUESTIONS

To begin our research, we created foundational questions to guide us in our exploration of the intersection of transportation justice and sustainability in the Bay Area, as follows:

What is the current state of transportation justice in the Bay Area and how has it been affected by the pandemic?

What would micro transit look like in the Bay Area and what are some of the transportation justice issues associated with it? Would micro transportation actually be a more sustainable option in the Bay Area?

What will happen to the current systems in place that aren't as safe for travelling or riding as personal services?

How can we make transportation more affordable and accessible while still being sustainable?

These questions allowed us to focus on core components of our research that is led by the United Nations Sustainable Development Goals (UN SDGs) and our analyses of how Bay Area transportation services reflect growth in terms of the completion of the goals that we have outlined.

CONNECTION TO THE UN SDGS

How do the UN Sustainable Development Goals (SDGs) sync up with Bay Area's regional/local transportation justice challenges?

8 DECENT WORK AND ECONOMIC GROWTH



10 REDUCED INEQUALITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



Figure 1. The United Nations Sustainable Development Goals. From the United Nations, 2015. (<https://sdgs.un.org/goals>)

Transportation justice is, without a doubt, an underlying long-haul challenge in urgent need to be recognised by public and private sectors across the globe. With the adoption of the United Nations Sustainable Development Goals (UN SDGs, also known as Agenda 2030) in 2015, nations worldwide are tailoring their policies towards better social, environmental, and economic consciousness and actions. It is imperative to realise how the UN SDGs provide a universal framework for the world to adapt to, with the emphasis on public transport sectors. Due to the versatility of the UN SDGs, the complexity of transportation justice in the Bay Area ought to interconnect with three main SDGs: **Goal 8 - Decent Work and Economic Growth**, **Goal 10 - Reduced Inequalities**, and **Goal 12 - Responsible Consumption and Production**. The main objective of this foundational segment is to examine and reimagine how the overarching UN SDGs (can) sync well beyond the current modes of progress, in the context of COVID-19.

With a vision of sustainable and equitable public transport for all, numerous co-benefits outlined by voluntary national reviews (VNRs) across the world indicating how the UN SDGs' 'Leaving No One Behind' ideal can mobilise a diverse range of global communities towards more just and sustainable public transport (Figure 2). Conducted by the Partnership on Sustainable, Low Carbon Transport (SLOCAT), "30 out of 47 VNRs reported on transport co-benefits", with substantial outcomes on regional connectivity, social equity, and urban access.

In 2019, 30 out of 47 VNRs reported on transport co-benefits

Analysis is based on the 40 submitted VNRs as of 3 July 2019



Figure 2. Co-Benefits of Sustainable Public Transport. From "Sustainable Transport: A Critical Driver to Achieve the Sustainable Development Goals", 2019. (<https://slocat.net/publications/vnr-sustainable-transport-sdgs/>)

As the global community unexpectedly enters the COVID-19 pandemic in early 2020, attention quickly shifted to speculating a significant reduction in vehicle air pollution and congestion – shown in satellite images across major cities in the world (France24). Meanwhile, it is imperative to realise how the pandemic undermines existing efforts of social equity, food security, and poverty alleviation, where two of these factors are co-benefits in need of further development.

SDG 8 Decent Work and Economic Growth

SDG 10 Reduced Inequalities

Speculating Bay Area’s overarching landscape on sustainable transportation justice, UN SDGs 8 (Decent Work and Economic Growth) and 10 (Reduced Inequalities) complement one another to address the loss of equitable employment, pay, and access to essential public transport sectors amid the COVID-19 pandemic. Target 8.5 (Full Employment and Decent Work with Equal Pay) of SDG 8, and Target 10.1 (Reduce Income Inequalities) from SDG 10, in particular, have become ideals that would take years to fully realise.

As the primary focus of the report is on transportation justice, attention has been paid on how COVID-19, along with the accessibility and credibility of public transport in the Bay Area, impacted civilians’ access to basic necessities, healthcare employment, and other essential (public) services. While riderships have fallen dramatically across , due to high unemployment, disadvantaged communities of Latinx and African-American populations rely the most on public transport - particularly the Bay Area Rapid Transit (Bay Area Council Economic Institute).

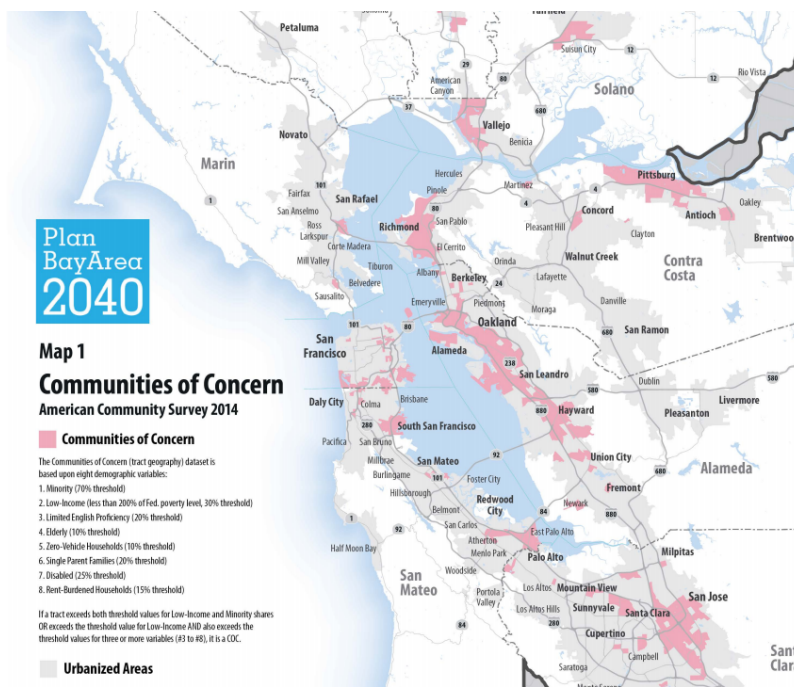


Figure 3. Communities of Concern in the Bay Area. From the Metropolitan Transportation Commission (MTC), 2017. (<http://bay.stanford.edu/blog/2018/3/9/advancing-transportation-equity-in-the-bay-area>).

Vulnerability Index

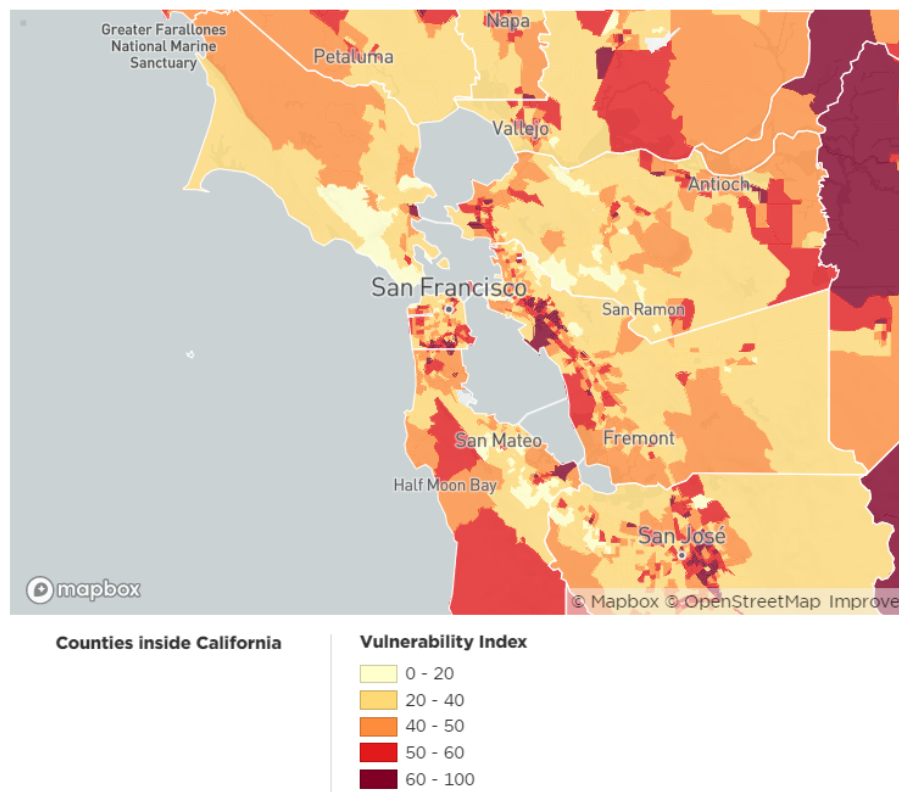


Figure 4: Bay Area Vulnerability Index. From the Bay Area Council Economic Institute, 2020. (<https://reports.mysidewalk.com/0e5dde2302>).

Worrysome signs of increasing marginalised communities have revealed across various corners of the Bay Area, even at an early stage far before the COVID-19 pandemic. The Metropolitan Transportation Commission (MTC), acting as a central coordinator for Bay Area's transportation, mapped out a dissemination of 'communities of concern' in 2014 (figure __, marked in pink). These communities are, unfortunately, translated as highly vulnerable in the Vulnerability Index of 50 and above (figure _ marked in dark-colour red), according to the Bay Area Council Economic Institute. Various factors leading to vulnerable communities in the Bay Area range from income levels to number of immigrants (foreign born population), burdened renter households (of 30% and 50%), access to personal vehicles and public transport, English language competency, and blue collar job statuses (whether workers obtain a secondary school diploma).

To fulfil SDG 8 and 10 simultaneously, equal pay amongst minority and white communities must become a priority (for both public and private sectors and businesses), while ensuring decent working conditions for all civilians should be accessible to everyone. SDG 8's Target 8.5 (Full Employment and Decent Work with Equal Pay) directly urges the mobilisation of upskilling programmes, public work investments, and reduced interest rates for everyone as a long term vision. Action must be taken now before it is too late.

SDG 12 Responsible Consumption and Production

Established public and private sectors and businesses -- being small or large -- should remain responsible in forerunning sustainable development efforts, particularly addressing SDG 12's Responsible Consumption and Production perspective. Recent trends on corporate social responsibility (CSR) reports across the world made sustainability a crucial component of any operating corporation or sector.

As SDG 12's Target 12.6 (Encourage companies to adopt sustainable practices & reporting) aims to hold companies and public sectors accountable for producing sustainability reports accessible to the general public, it also encourages them to take concrete action on sustainable consumption practices internally and externally. An example of how the San Francisco Municipal Transportation Agency (SFMTA) is propelling their sustainable visions (set in 2017) can be shown below:

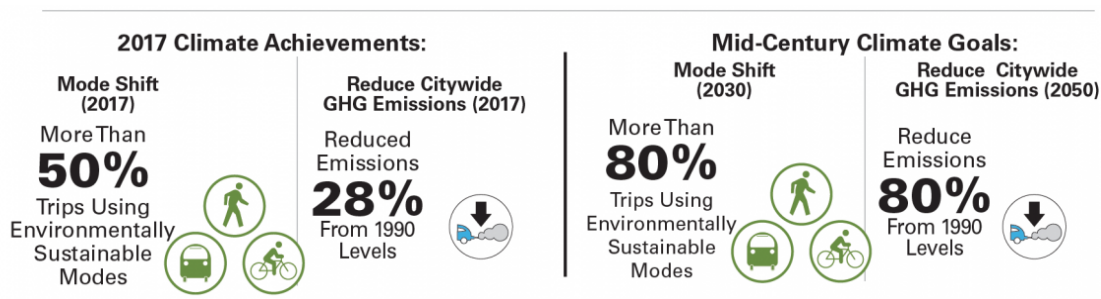


Figure 5: SFMTA Climate Goal Progresses. From the San Francisco Municipal Transportation Agency (SFMTA), 2017. (<https://www.sfmta.com/about-us/sustainability-and-climate-action/climate-goals-targets-and-trends>).

On the other hand, acknowledging stimulus funds from state and federal agencies are insufficient in providing long-term support for small businesses currently struggling with their livelihoods, SDG 12 Target 12.B -- Develop and Implement Tools to Monitor Sustainable Tourism -- becomes a key priority on the way out of the pandemic. One approach to support the hardest-hit Bay Area small businesses (estimated 2,000 of them, fears to have more) is to create an interactive map and dataset -- outlining the degree of small-business livelihood struggles and recovery progress made for each Bay Area city and county. Such a tool must be accessible to everyone and open to constant improvements and modifications. Meanwhile, sustainable tourism strategies in the Bay Area should also promote local representative cultures of each designated community in a city or town to attract more consumerism.

Final Note

In this section, though in recognition of potentially wider perspectives of the subject matter, due to the major influence of the COVID-19 pandemic, the above future modes of progress, reflected on selected SDGs and their respective targets, may not appear as entirely comprehensive.

TRANSPORTATION JUSTICE IN THE BAY AREA AND INCORPORATING IT INTO DECISION MAKING

For most of the 20th century, transportation planning goals were almost mobility or accessibility based. The focus was congestion reduction, improved travel times, reduced travel costs, and enhanced safety. (Beyazit, 2011; Manaugh, et al., 2014). Investment decisions for transit agencies depended primarily on the modeling of supply, demand and activities within predefined zones of transportation. This line of decision making was informed by the principles of free markets, consumer preferences being sovereign, and the power of the market's self regulation. Based on these criteria, roads were expanded at the expense of public transportation (Martens, 2006). The lack of "sufficient" demand for bus lines led to their elimination and reduced the levels of transit service. At this time, rail lines were also being laid in suburbs and peripheral areas under the assumption that they would be creating "new demand". Since travel and transportation demand are informed by their ability to pay, transit agencies focused on the needs of more affluent communities, directly defining who would benefit from government spending on transportation. The focus on this set of demand criteria excluded the needs of poorer communities and communities of color, and lessened the dollar for dollar investment into these communities. (Hananel and Berechman, 2016)

AC Transit, California's largest bus-only operator, runs busses from North Richmond through Oakland and into southern Alameda County, providing bus services to many communities with high poverty rates. Almost 80% of AC Transit riders identify as people of color, and more than 70% have an income below \$30,000. Almost 60% of riders are entirely transit dependent, meaning they have no means of transportation outside of public transit options. Many who do own cars have older vehicles and they cannot afford to operate and maintain them on a regular basis. Despite the growing and urgent need for better, more reliable public transportation in the East Bay, the Metropolitan Transportation Commission continuously underfunds AC Transit. The underfunding of AC Transit leads to a decline in their bus services and fare hikes that greatly affect the communities that AC Transit serves. The Metropolitan Transportation Commission is the government agency responsible for regional transportation planning and financing in the Bay Area. The Metropolitan Transportation Commission controls almost \$1 billion annually from both the federal and state levels, and continually overlooks the needs of the most vulnerable transit users. Instead opting to fund costly rail expansions under BART (Bay Area Rapid Transit) and Caltrain, serving communities that are disproportionately white and affluent. (Mayer and Marcantonio)

There are many different definitions of transportation justice but all definitions focus on equitable distribution of outcomes, fair processes for decision making, the inclusion of all relevant parties in decision making, and the recognition of diverse types of knowledge. Correcting the injustices in our transportation systems will require the recognition of historical and current systems and processes that are inherently racist and classist. Transportation Justice requires the redistribution of resources throughout society, as well as the redistribution of financial resources and political power. Instead of addressing the root causes and inequities in our system decision makers and transportation planners focus on technical fixes within the system and quantitative equity. (Karner et al., 2020)

Currently there are four major barriers to transportation justice. They are excessive focus on congestion relief, emphasis on capital spending rather than tangible improvements, focus on flashy new projects, and the lack of community feedback mechanisms. (Hobson, 2005)

Four Main Obstacles to Achieving Transportation Justice

- 01 Focus on Congestion Relief
- 02 Emphasis on Capital Spending
- 03 Focus on new projects
- 04 Lack of Community Feedback Processes

For the focus on congestion relief, oftentimes the focus of the transportation crisis is a focus on increased congestion on freeways. The high profile solutions that agencies propose - widening freeways, extending suburban commuter trains, even express buses - aim at relieving the burden of congestion for people commuting long distances from suburban homes to work. These commuters are more likely than not white, with above average incomes. However, only one in four trips in the Bay Area involves commuting to work. (Karner et al., 2020) Most trips are for shopping, childcare, school, and other daily needs. These trips tend to be shorter and it is more likely that they will occur outside peak commuting hours. Although transportation planning usually focuses on congestion and long-distance commutes, many people, including more than a third of Bay Area residents do not own or operate a vehicle. The obstacles facing low-income families making these trips are a transportation crisis, and one of the focus points of transportation justice. (Hobson, 2005)

Figure 5 shows the discriminatory funding decisions made by The Metropolitan Transportation Commission. People of color make up two thirds of all transit users in the Bay Area. But white populations make up a disproportionate share of BART and Caltrain passengers, 43% for BART and 60% for Caltrain passengers. White rail riders also have significantly higher incomes than AC Transit bus passengers, 75% of BART riders have incomes above \$30,000 and 53% of Caltrain riders have incomes above \$75,000. Additionally, 83% of Caltrain riders and 80% of BART riders own a private automobile. The Metropolitan Transportation Commission is aware of these income and racial disparities yet continues to give significantly greater public subsidies for trips on BART or Caltrain than AC Transit. AC Transit riders receive a subsidy of \$2.78 from public funds per trip, BART riders receive \$6.14 per trip and Caltrain riders receive \$13.79. Because of this disparity in public subsidies commuter rail systems have growing ridership while services for AC Transit continue to decline and fares continue to rise. (Mayer and Marcantonio)

Public Subsidies and Race of Riders

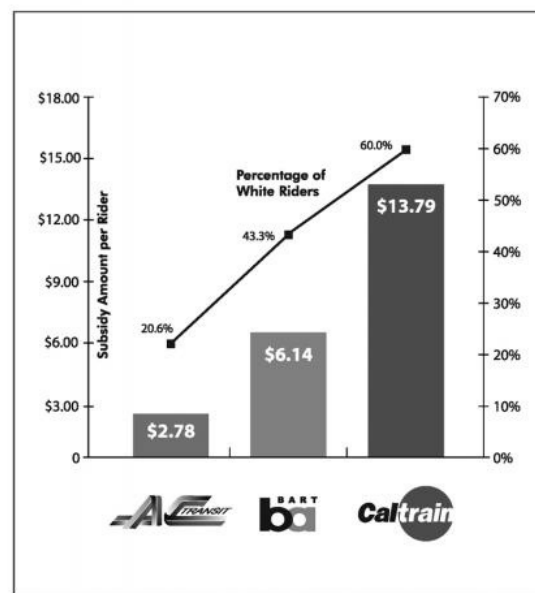


Figure 6: Public Subsidies and Race of Riders by Transit Company (Mayer and Marcantonio)

In terms of focus on capital spending, often federal and state transportation funding can only be used for capital expenses, such as new highway or rail projects. Often, urban low-income and communities of color the most funding is needed for repairs which fall under operations and maintenance expenses. Due to the restrictions on federal and state funding, community groups are forced to use every opportunity to define how new sources of money will be spent. It is also critical to hold agencies accountable, which requires demanding that they not spend money on new projects until there is long term funding available for their operation and maintenance. (Hobson, 2005)



Figure 7: Map of Bay Area Transit Companies (Seamless Bay Area)

The third barrier that exists is the tendency of transit companies to give excessive attention to flashy projects. When politicians set priorities for transportation money, they often choose news-making, flashy projects. They choose these projects over the cost-effective ones that pay for themselves much more quickly and are a better dollar for dollar investment. Agencies also tend to underestimate costs and overestimate benefits for proposed high profile, big projects. Often, they also lack the money to maintain these projects long term. (Hobson, 2005) In the Bay Area, two prime examples of this are the BART extension to San Francisco International Airport and its proposed extension to San Jose. The focus on high profile, expensive projects hurts low-income and communities of color in two main ways. First, these huge projects utilize money that could provide better mass transit for a greater number of people. Second, oftentimes when agencies run out of money for operation and maintenance costs for the new project, they have to tap into existing budgets, this leads to service cuts and fare hikes to transit systems that serve the communities that rely on their services the most. (Hananel and Berechman, 2016)

Another obstacle in achieving transportation justice is that complexity in systems reduces participation. Transportation agencies make investment and policy decisions without adequate feedback and involvement from people of color and low income people. The decision-making processes for transit agencies are complex, especially since multiple agencies can be involved at different points. The lack of accessibility surrounding the knowledge of these processes for decision making is a major barrier for encouraging community participation, and incorporating that feedback. Government agencies and transit companies need to restructure their decision making processes to involve the whole community, and center the voices of those who are most impacted by the decisions. (Hobson, 2005)

In the Bay Area, similarly to many other metropolitan areas, transportation consistently rates as a top concern. These polls guarantee that elected officials will continue to propose billions of dollars in new transportation initiatives. Many of these initiatives require voter approval, so transportation agencies pay the most attention to community groups that can turn out the vote and grab media headlines. Also, new funding programs typically have fewer restrictions than existing ones, so communities have a better chance to influence the outcomes- such as more reliable transit services or safer streets for pedestrians and bicyclists. Along with that transit agencies need more community transportation needs assessments and clearer, more well known avenues for the participation of local organizations and individuals in decision making. A needs based assessment should always be the first step in transportation planning, this will be even more important when discussing climate solutions and environmental justice. (Massey et al., 2019)

Needs assessments should collect data to help determine the current residents' transportation needs and habits, the challenges faced in accessing and utilizing various transit options for their families and themselves, demographics, and other project specific information. It is also valuable to distribute the survey through many avenues including, door-to-door, community networks, and community event distribution. It is also necessary to offer the assessment in multiple languages and provide additional language support if needed. These surveys would refocus transportation planners on the services that residents need and want so that decisions made will best serve the community. It is also crucial that decision makers interact and communicate with local organizers and organizations based in the communities that they serve. This also means promoting effective leadership from communities of color and low income communities during decision making processes. Luckily, in the Bay Area there are transportation justice organizations that are fighting for equity for marginalized communities. (Massey et al., 2019)

Inadequate access to transportation is one of the top three barriers to the transition out of poverty for many families. (Hobson, 2005) Transportation inequities and the processes that perpetuate these inequities another form of structural racism meant to uphold the status-quo.

Public policy heavily depends on varying policies and limitations set by different counties, and within the Bay Area, there is an indicator of the metropolitan areas of San Francisco, Oakland, and San Jose having different patterns of race, economic activity, and development that consequently affect transportation patterns and policies. Density levels and fiscal output also impacts the policies made, which can be further analyzed through newer outlooks on public policy within the Bay Area.

SPUR, formally referred to as the San Francisco Bay Area Planning and Urban Research Association, addresses 3 main components of public policy that is currently being worked towards to sustain public transit. It outlines funding of transportation networks as a key priority. As outlined previously, funding is dependent upon various factors of the cities and counties within the Bay Area. SPUR works to consider solutions to issues that cities face and develop policies to reshape communities to become more equitable and efficient.

Working towards increasing walkability and usage of public transit as contrasted to private driving rates, SPUR signifies the importance of making transportation both accessible and sustainable for the current and future generations located around the Bay Area. In the figure below, a planned reallocation of street space allows policymakers to visualize how mobility initiatives can significantly decrease congestion through careful design of streets and ensuring safe and fast transportation.

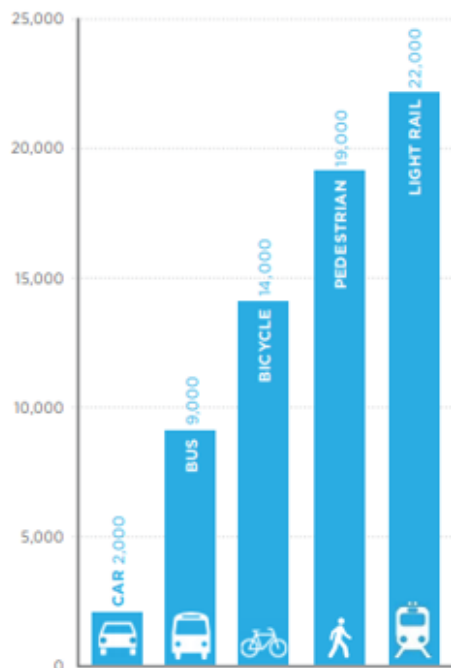


FIGURE 7
Reallocating Street Space Can Move More People
Number of people an 11.5-foot-wide lane can convey per hour

Some transportation modes can move far more people than others using the same size lane. Allocating more space for biking or transit can move more people than designating lanes exclusively for cars.

Figure 9: Reallocating Street Space Can Move More People

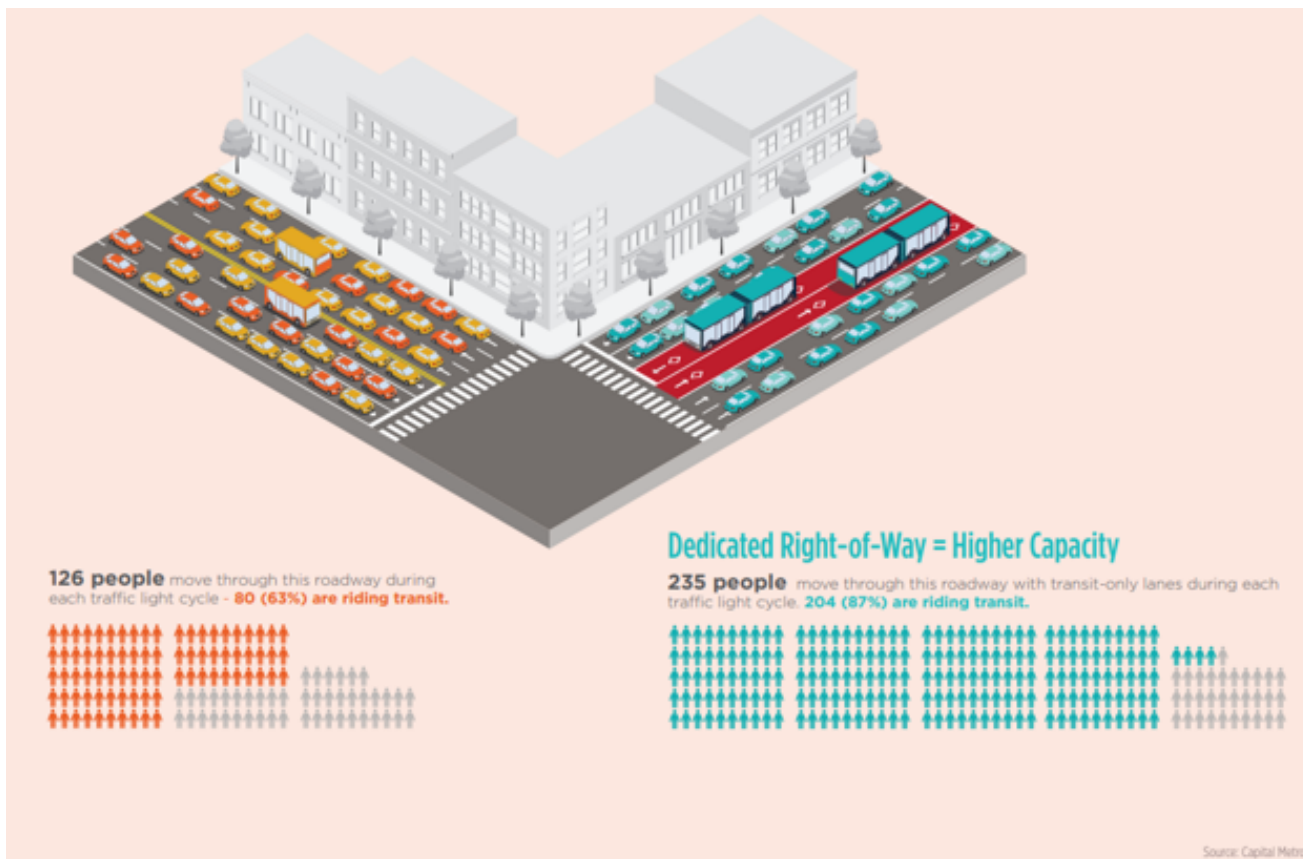
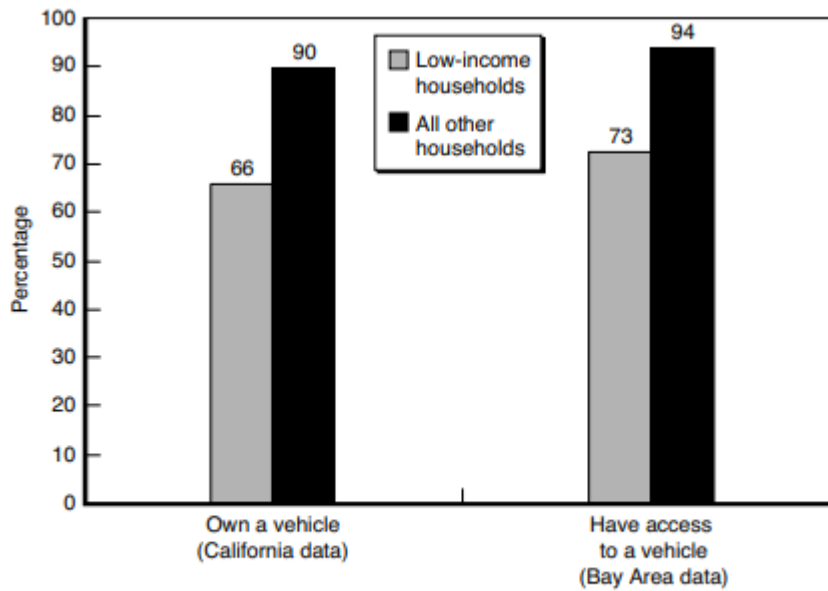


Figure 10: Reallocating Street Space Can Move More People

To ensure that transportation can adequately and effectively improve the quality of life, SPUR also recognizes the need for transportation to be more accessible to various communities around the Bay Area. By considering housing and land use, the organization has determined that housing and land use are crucial parts of incorporating a worldview centered around marginalized communities and understanding that policies for transportation need to consider the industrialization of living spaces and plan for accommodating more people in denser areas where transportation is centralized.

Minority Communities

Along with rising costs of housing within the Bay Area and declining disposable income due to the coronavirus pandemic, low-income families are displaced through lack of adequate and affordable transportation. The Public Policy Institute of California has found that low-income households have transportation as third in spending in their budget, outlining its importance in getting to and from work to make enough money to pay for rent, food, and other necessities. However, as demonstrated in the figure below, ownership and access to vehicles display a disproportionate change for low-income households as contrasted to middle- and high-earning families. Without steady access to a personal vehicle, workers are heavily dependent on transportation services to travel to work and earn at least a living wage.



SOURCES: Consumer Expenditure Survey, 1999–2001; Census 2000 Public Use Microdata Sample.

Figure 11: Vehicle Ownership and Access Rates, by Income Group

New challenges emerge, though, as portrayed in this map of low income people in the Bay Area, according to the 2000 Census. These areas show a sizeable difference between the populations of various counties, and with higher densities in lower-income areas as shown, it is difficult for working wage earners to find a reliable source of transit to use on a regular basis due to both the lack of feasibility in travelling with a specific service route as well as lack of transit stations in dense areas.

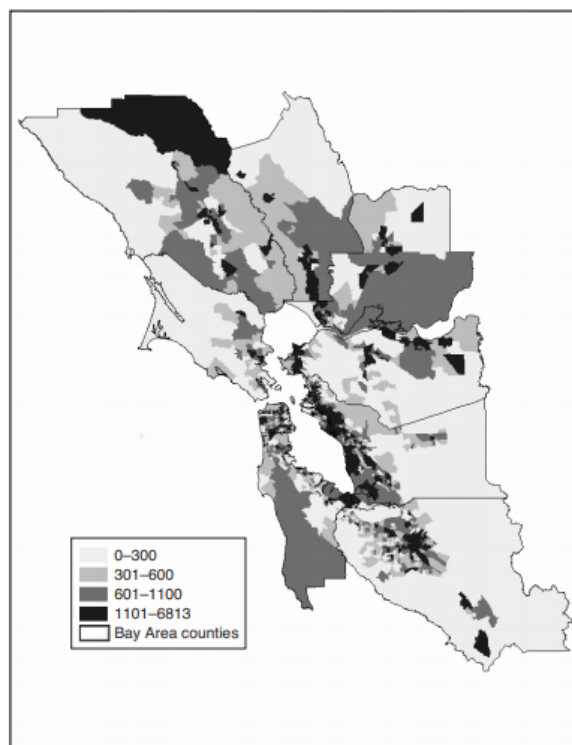


Figure 12: Number of Low-Income Persons in the Bay Area, Census 2000 Tract Level

Transportation Industry

Transportation equity through the lens of internal operations within transit agencies allows a shift in focus on external community reach and a detailed look into the labor standards of the Bay Area transportation industry. On Thursday, September 24, 2020, the Metropolitan Transportation Commission passed a mandate to hold employers accountable for ensuring that 60% of their workers would work from home by the next 30 years. As a plan stemming from the urgency to lower greenhouse gas emissions, the mandate was however criticized as transportation services would greatly suffer, as seen with the onset of the COVID-19 pandemic and its impacts on travel services. Allowing the fulfillment of the mandate also raises questions for equality within the workplace, namely the benefits and drawbacks of working from home and those of working at a physical location.



Figure 13: Using Bay Area transit services as part of the Commuter Benefits Ordinance (part 1)

As outlined in San Francisco's Commuter Benefits Ordinance, on the other hand, instead of reducing emissions through cutting transportation entirely from the workplace, commuter benefits programs offer both the reduction of harmful greenhouse gases as well as the continuation of physical workspaces through cutting single-ridership and improving transit and walkability measures. Single-occupancy vehicles not only emit emissions, but also increase traffic that contributes to harmful effects on the environment. This is also a reflection of greater workplace satisfaction and care for employees as the program offers a reduction in private vehicle costs and offers employment benefits and opportunities to work in a cleaner environment.



Figure 14: Using Bay Area transit services as part of the Commuter Benefits Ordinance (part 2)

Environmental Impact

The intersection between transportation justice and environmentalism has largely been rooted in issues surrounding environmental injustice. Redlining and gentrification have historically set barriers for people living in low-income communities, in addition to communities of color. To consider environmental racism as a part of sustainability measures and to preserve transit systems for the future, understanding the impacts of gentrification and linking them to potential green infrastructure initiatives is significant.

Redlining has led to a rapid increase in the segregation between low and high income households, with 87% of low income neighborhoods in San Francisco continuing to suffer from gentrification as a result of redlining. Labelling areas with minority communities as toxic and hazardous has been reflected in the lack of transportation services and a sufficient amount of stops and stations to support the marginalized communities.

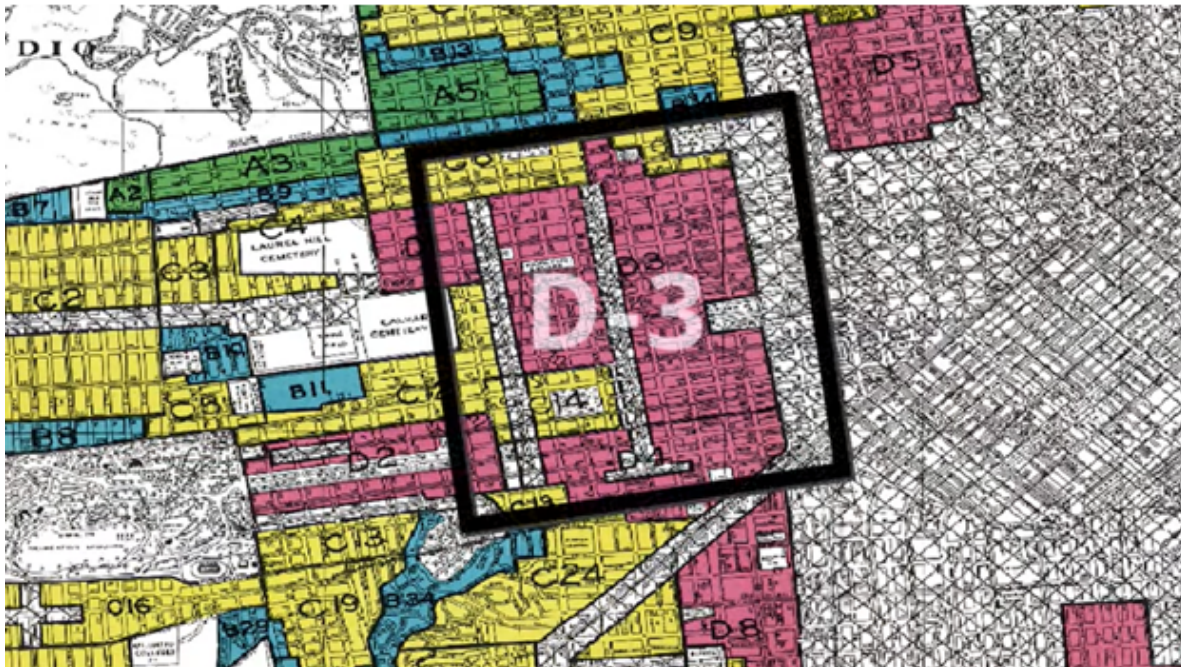


Figure 15: Redlining in San Francisco

However, with rising concerns about the climate crisis, green infrastructure is being considered as a leading contender of how to improve transit. BART, for example, is working towards a model considering the implementation of recycled aluminum for train cars and an updated cooling system that places less emphasis on electricity-generated power and more on white roofs to reflect heat off of the train. Accommodating more space for riders to place their bikes also allows a better understanding of not only reducing waste by single-occupancy vehicles but also shapes a perspective that also considers the needs of various people within a community that have limited access to transportation services.

PRIMARY AREAS OF FOCUS



01 Emissions



02 Energy, Sustainability,
and Accessibility



03 Walkability of Cities



04 Microtransit



05 COVID-19 Impacts

TRANSPORTATION GREENHOUSE GAS EMISSIONS

How to Decouple the Growth of Transport Demand from GHG Emissions and Air Pollution?

Assessments of transport GHG emissions require a comprehensive understanding of the transportation system and travel patterns of people and goods. GHG emissions by the transport sector accounts for a large amount of total atmospheric GHG emissions. In 2010, the global transport sector produced about 7.0 Gt CO₂eq of direct GHG emissions, which include non-CO₂ gases, and this made up approximately 23% of total energy-related CO₂ emissions (Sims 648). Transport's share of total GHG emissions has been and will keep rising, and without aggressive and sustained mitigation measures being put in place, GHG emissions by the transport sector could reach around 12 Gt CO₂eq per year by 2050 (Sims 604).

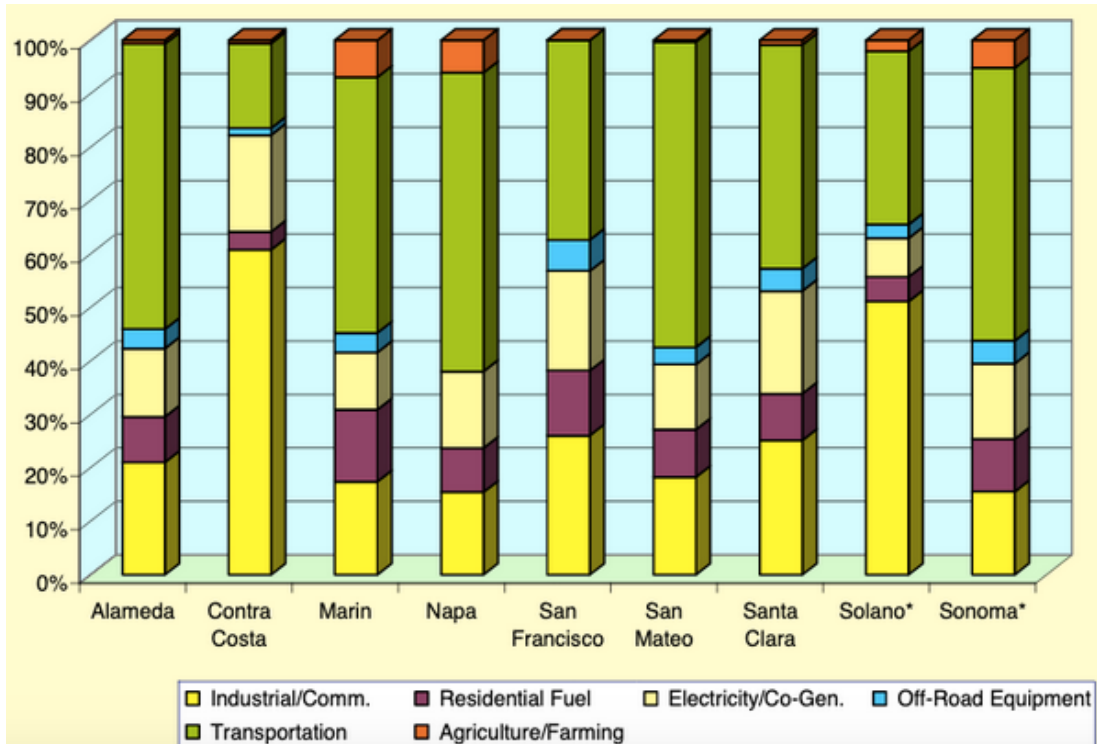
In recent decades, the transport sector has accounted for approximately 40-65% of GHG emissions in Silicon Valley. In 2007, transport's share of GHG emissions in the Bay Area was the largest among 6 end-use sectors listed in the table below (BAAQMD 10).

Table 1: 2007 Bay Area GHG Emissions by Sector

End-Use Sector	% of Total Emissions	CO2- Equivalent (Million Metric Tons / Year)
Industrial / Commercial	36.40%	34.86
Residential Fuel Usage	7.12%	6.82
Electricity / Co-Generation *	15.87%	15.20
Off-Road Equipment	3.05%	2.92
Transportation	36.41%	34.87
Agriculture / Farming	1.16%	1.11
Total	100%	95.8

* Includes Imported Electricity emissions of 7.1 MMTCO₂ E

Figure 16: 2007 County Emissions Breakdown by Sector



All counties except for Contra Costa and Solano Counties show the largest contribution to GHG emissions from the transportation sector, as shown in Figure 16 (BAAQMD 15). Transportation-related air pollutant emissions, which are linked to cardiovascular and respiratory diseases, have led to a number of negative health outcomes (Joint Venture 7). During the outbreak of Covid-19 in 2020, pandemic-related measured freeway VMT (vehicle miles traveled) reductions led to a total of 4.5 million fewer miles driven in 2020

than in 2019 on Silicon Valley's freeways alone. This is a preliminary estimate based on 50-85% reductions in travel and the assumption that the shares of PM2.5 and nitrogen oxide emissions coming from on-road travel are 30% and 50%, respectively. On-road transportation has had a huge impact on air pollution in the Bay Area. Assuming that the average light-duty gasoline- and diesel-powered vehicles have a range of 22-25 miles per gallon and that the share of these vehicles on the road is proportional to miles driven, then a total of 1.4-1.6 million metric tons of CO2e could be reduced in the region in 2020 due to the pandemic compared to 2019. Similarly, there were declines in air pollutant emissions. As a result of regional pandemic-related traffic reductions alone, emissions of PM2.5, a type of fine particulate matter, and nitrogen oxides have decreased by 15-25% and 20-45%, respectively (Joint Venture 15).

The San Francisco Climate Action Strategy has committed San Francisco to significant emissions reductions by shifting 80% of trips to sustainable by 2030, transitioning to 100% clean energy by 2030, etc. As one of the leaders in curbing GHG emissions, the City strives to achieve carbon neutrality by 2050. To reach these ambitious goals, emissions by the transport sector needs to be significantly reduced. In 2017, the City surpassed its interim mode shift goal of 50%, having non-automobile trips make up 52% of total trips, and it aims to meet its mode shift goal of 80% by mid-century (see Figure 17). In doing so, the City will have reduced its GHG emissions by 80% from 1990 levels by 2040, as shown in Figure 18 (Stefiuk 2).

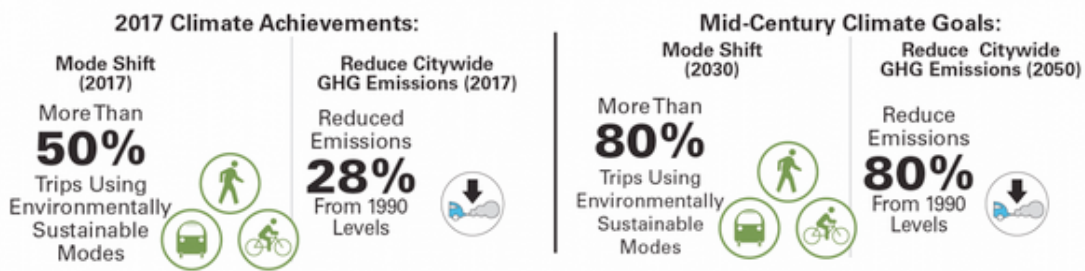


Figure 17: 2017 Climate Achievements and Mid-Century Climate Goals

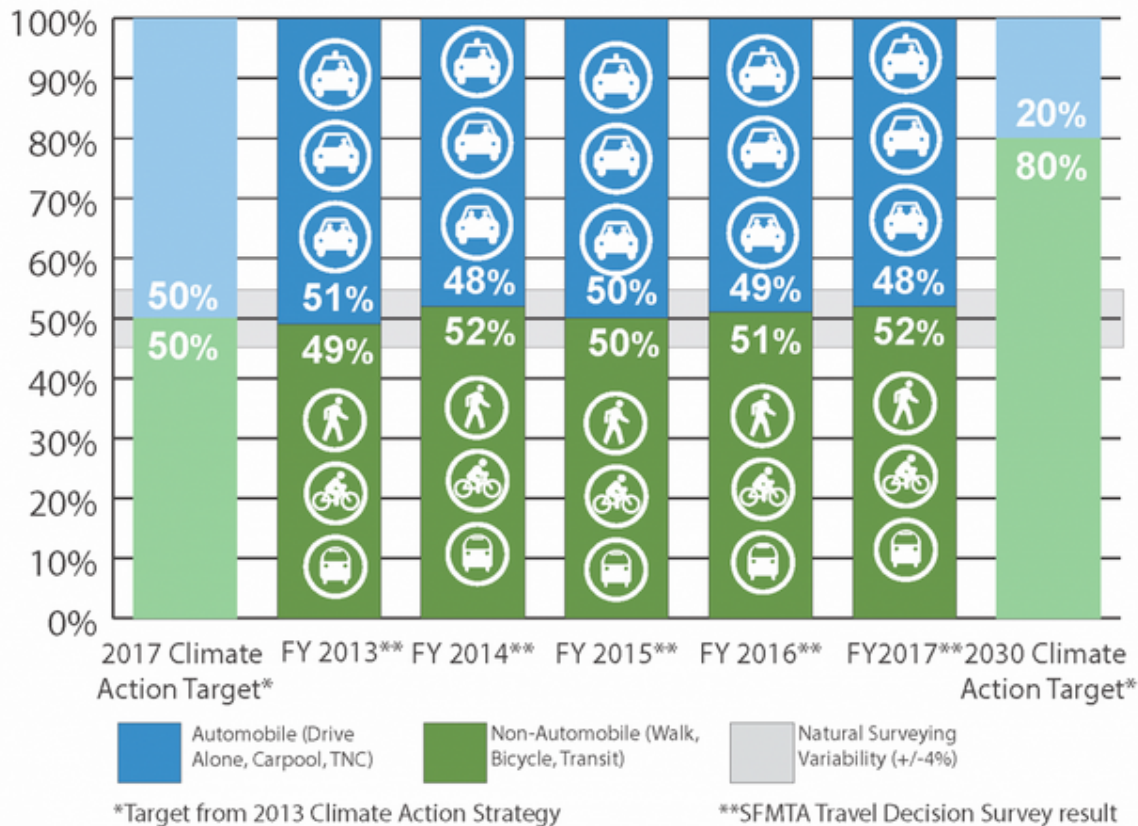
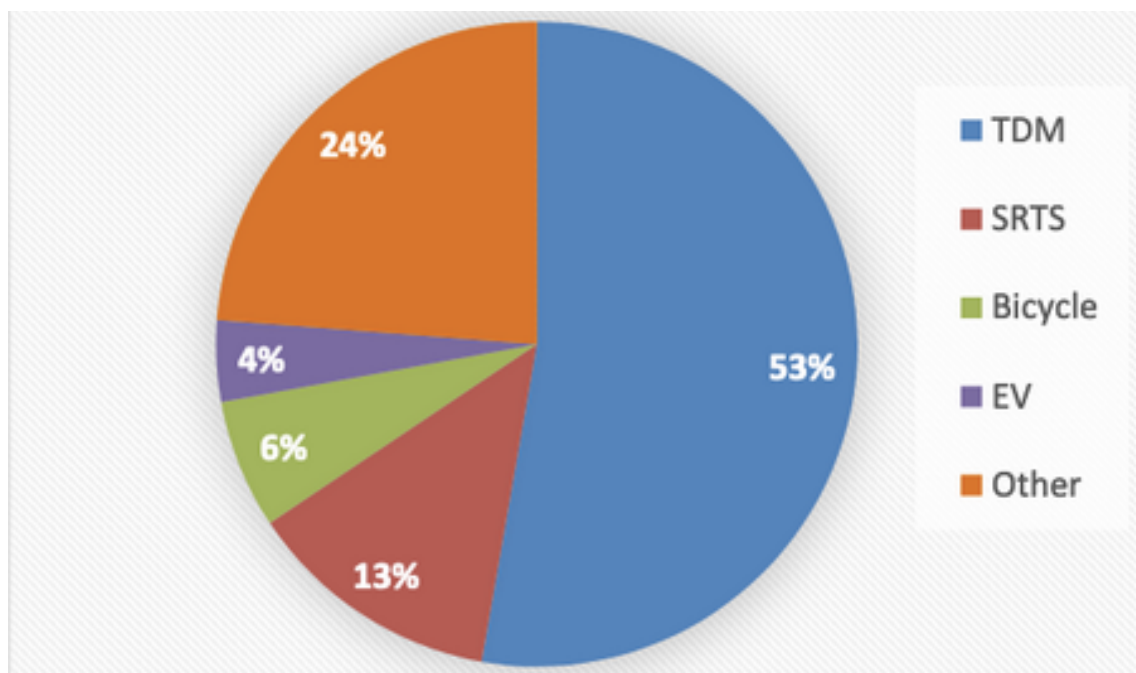


Figure 18: Shares of Automobile Trips versus Non-automobile Trips

Plan Bay Area 2040, which is a long-range transportation and land use plan mandated by the state, coordinates with the California Transportation Plan 2040 to develop transportation investment strategies that move the Bay Area toward sustainable development. Both plans focus on fixing the existing transportation system instead of significantly increasing the geographical extent of the transportation infrastructure (ICF 10). Since the population of the Bay Area is projected to continue growing, it is critical that transportation planning ensures that existing transit service levels can be sustained in the future years, while reducing per-capita GHG emissions. Therefore, the Metropolitan Transportation Commission (MTC), which is the federally designated Metropolitan Planning Organization that is responsible for the transportation planning, coordinating, and financing for the Bay Area, implemented the Climate Initiatives Program (CIP).

With primary objectives of reducing transportation-related emissions and shifting to cleaner fuels, the CIP launched 5 major types of projects, including transportation demand management (TDM), safe route to school (SRTS), bicycle projects, electric vehicles (EV), and others (ICF 7). These projects led to measurable increases in walking, biking, carsharing, and other modes of transportation that are alternatives to single-occupancy vehicles, and they have not only reduced vehicle miles traveled but also GHG, such as riding transit, carsharing, vanpooling, walking, biking and so on, for a larger share of trips can have huge environmental benefits. In the figure that shows GHG reductions by project type, it appears that the TDM projects account for more than half of all the GHG reductions attributable to the CIP (ICF 20). While the share of GHG reductions accounted for by EVs is the smallest among all 5 project types, the EV projects will have increasingly larger impacts once more EVs are deployed. Through siting more charging stations and providing incentives for vehicle users, the EV projects have been increasing EV penetration in the Bay Area market, incorporating technological advances to efficiently reduce GHG and air pollutant emissions (ICF 60).

Figure 19: GHG Reductions by Project Type



As transport demand continues to increase, more stringent policy instruments are needed to mitigate greenhouse gas emissions by the transport sector, which is necessary to meet future climate action targets. Since the vast majority of the emissions from transportation come from the combustion of fossil fuels, it is critical and urgent to transition to cleaner fuels, decarbonizing this carbon-intensive sector.



CLEAN ENERGY AND SUSTAINABILITY

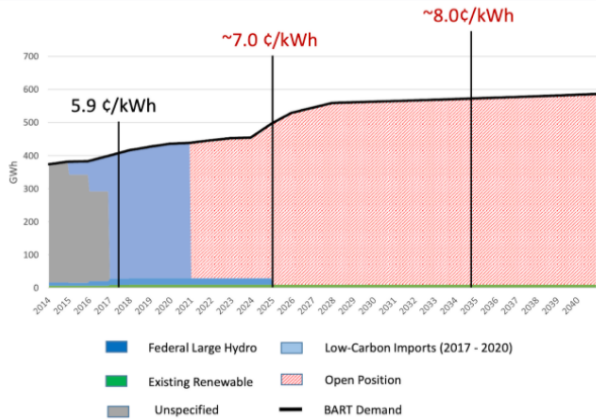
How Green Public Transportation Impacts the Environment and Accessibility: BART Case Study

Achieving sustainable and environmentally-friendly methods of public transportation is possible in the Bay Area through efficient energy choices. By transitioning from non-renewable to renewable energy, public transportation can become less carbon-intensive. High-speed trains in the Bay Area have gradually been transitioning into renewable energy, which is a big step towards sustainability. For instance, BART's efforts to become more sustainable by switching to cleaner energy have helped 1) reduce its carbon footprint and 2) improve its accessibility to riders by charging cheaper rates.

As of 2020, BART is using 90% renewable energy to operate their train services and stations by obtaining zero-carbon sources from the Pacific Northwest (BART 2019). This transition has led to a decrease in GHG emissions and their overall electricity costs beginning in 2017. Regarding carbon emissions, BART's 2019 sustainability report indicates that BART reduced their carbon footprint by 27 pounds of CO₂ emissions per average BART trip within just a year.

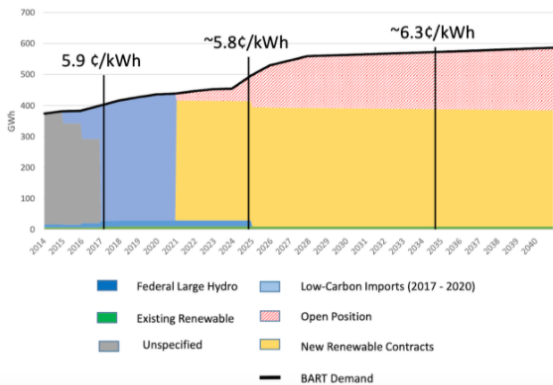
Additionally, BART projected that transitioning into cleaner energy and adopting a renewable contract would lower electricity costs from 7 cents per kwh to 5.8 cents per kwh in 2025 (BART 2017). A reduction in electricity costs is possible because of cheaper electricity supply rates from renewable supplies (BART 2017). As BART transitioned into renewables and are using energy-efficient light bulbs for their stations, BART saved approximately 379,000 kwh of energy in 2019 (BART 2019). Lower operation costs from a reduction in energy costs has allowed BART to charge cheaper transportation rates to riders. Transitioning into cleaner energy not only reduced their carbon footprint but has also increased accessibility of its services to more people in the Bay Area in terms of cost.

BART Energy Supply without Renewable Contracts



7

BART Energy Supply with Renewable Contracts



8

Figure 20: BART Electricity Cost Before and After Renewable Contract

Figure 21: BART Station



BART's decrease in transportation costs would not have been possible without Alameda County and their efforts to promote sustainable transportation. Alameda County subsidized BART's renewable energy program, which helped them transition from using non-renewables to zero-carbon sources within the past three years (BART 2018). Although BART still has to purchase electricity to run their services, they are spending less money on their electricity than their initial reliance on non-renewable resources.

Policy intervention and political support are necessary for sustainable public transportation to be a reality in the Bay Area. In addition to reducing carbon emissions, having local political bodies invest in renewable energy can create savings in the long run in terms of electricity, which has an indirect impact on transportation rates. Similar to BART, transportation companies in the Bay Area would need assistance from local county officials to help subsidize their transition into cleaner energy.

WALKABLE AND BIKE-ABLE CITIES :

How thoughtful urban design and land use can impact emission from transportation in cities

A. Walking and Biking As Primary Modes of Transport:

It is known that the transportation sector contributes the largest amount of greenhouse gases, and when broken down, light duty vehicles are the largest contributor of 56% (EPA). During this semester, I was inclined to research how urban design can completely replace the need and eventually the want for passenger vehicles in the city, where the proximity of essential needs can be taken advantage of. Designing cities to be more walkable and bikeable has the ability to massively reduce a city's carbon footprint.

Another reason to consider walking and biking is because electric vehicles still have uncontrollable embodied emissions whereas walking and biking can both be made cleaner with low-carbon diets. (Mizdrak et. al) When testing the "embodied" emissions associated with walking or biking, researchers found that an increase in energy expenditure through walking, can lead to increased food intake which contribute to the embodied emissions of walking and biking.

However, when compared to electric and gas vehicles, the emissions from walking and biking can be controlled. Moreover, biking is the most energy efficient and practical solution because it doesn't require the amount of energy walking takes (Mizdrak et. al). Both walking and biking, otherwise referred to as "active transport" have an ample amount of public health benefits as well. They promote healthy lifestyles by incorporating consistent physical activity, reduce the amount of air pollution in a city due to vehicles, and build a more equitable society by creating "social capital" through increasing people interaction. Additionally, a decrease in pollution and traffic creates a more equitable city to avoid the unfair health impacts implemented on lower income communities who are usually placed by heavily polluted areas such as the freeway.

Figure 1

From: [Fuelling walking and cycling: human powered locomotion is associated with non-negligible greenhouse gas emissions](#)

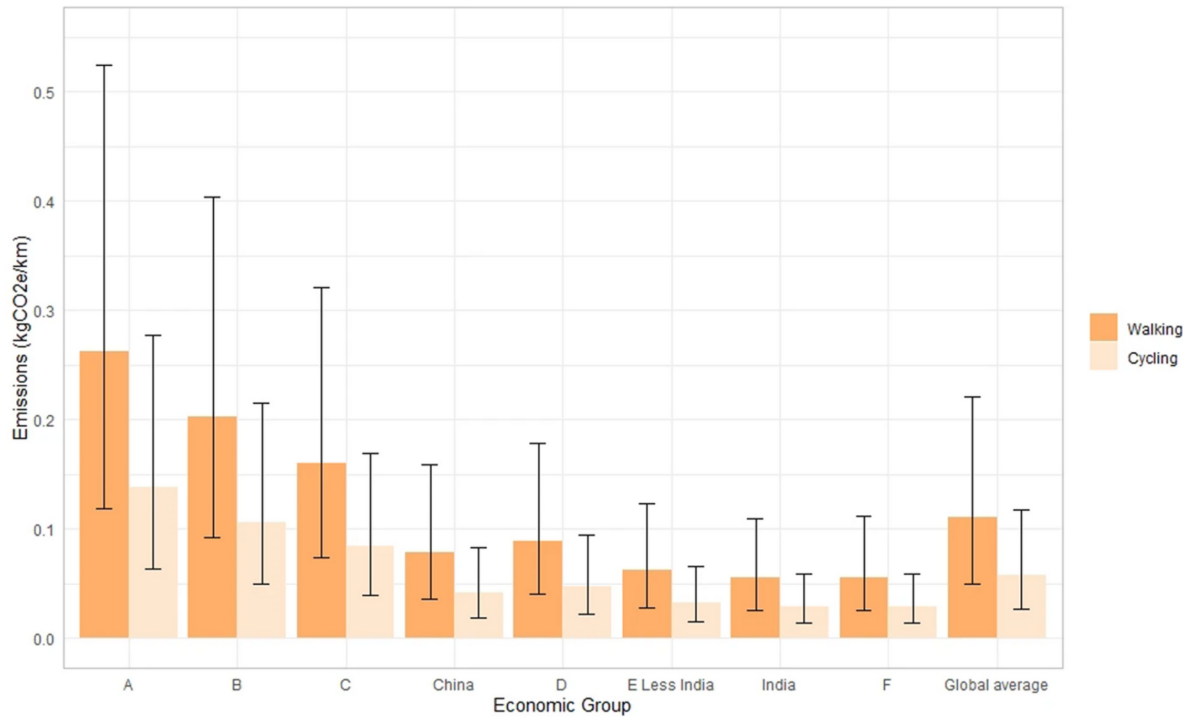


Figure 22: Walking vs. Biking, emissions from traveling 1Km, compensated for most economically developed (A) to least developed (F). (Mizdrak et. al)

B. Urban Design as the Desired and Ideal Approach

The urban design of a city is crucial in order to actually implement the needed infrastructure for walkable and bikeable cities. Some methods apply for cities that are yet to be built, while others prove great remedies for existing cities. In this paper, high density cities are the main subject, as low density cities are by nature, required to rely on vehicles. The former type of city has a lower environmental footprint due to the feasibility of walking and biking and falls under the category of Adaptive Cities and utilizes the method of Transit Oriented Development (Cervero).

Adaptive Cities alter their urban form for sustainable growth. This means environmentally and socially thoughtful growth which leads to the adoption of high density public transports such as metros and walking and biking as great alternative modes (Robert Cervero).

Transit Oriented Development (TOD): TOD strategizes “green mobility” by making developments compact, mixed use, and by having routes planned for convenience. (Cervero)

	Walking	Cycling
Reallocating space and time	<p>“Woonerfs” or home zones: Space shared by pedestrians, bicyclists, and low-speed motor vehicles, without curbs or pavements. Vehicles are slowed <16 km/h by road narrowing and obstacles, such as trees</p> <p>Less car parking</p> <p>Lower speed limits</p> <p>Longer pedestrian crossing times</p> <p>Improved connectivity and permeability for pedestrians and cyclists including:</p> <p>Wider pavements</p> <p>Pedestrianised areas</p> <p>Road crossings at most convenient places for pedestrians</p> <p>Grid layouts not cul-de-sacs</p>	<p>Less car parking</p> <p>Lower speed limits</p> <p>Priority at junctions</p> <p>Opening up road closures to cycle traffic</p> <p>Closing roads to through motor vehicles</p> <p>Removing one-way systems or allowing contraflow cycling</p> <p>Grid layouts not cul-de-sacs</p>
Making use easier and more pleasant	<p>Human scale, mixed-use urban villages, with unique identities. Improved local services, neighbourhood events and activities</p> <p>Accessible public transport for pedestrians and cyclists</p> <p>High-quality pavements, pedestrian orientated lighting, benches, and public art</p>	<p>Secure, convenient parking facilities.</p> <p>Changing rooms and showers at work.</p> <p>Ramps</p>
Legal priority	Requiring motorists to anticipate the variability of walking and cycling practices	
Financial	Carbon permits, fuel and road taxation, parking charges. Payments/discounts for cycling to destinations	

*Active transport principally refers to walking and cycling, but also includes non-motorised wheel chairs, scooters, skateboards, and roller skates or blades.

Table: Policies prioritising active transport*

Figure 23: (Woodcock et. al) Policies and strategies for increasing the feasibility of transit via bikes and foot.

Like Cervero’s assertion, Woodcock et al. also conclude that design for active transport is an underutilized option for converting to low emission transportation within small distances. The issue with active transport is that it often lacks investment and infrastructure. Moreover, low income communities have to rely on the low quality existing active transport. As such, improving walking and biking routes and infrastructure will allow cities to progress in a sustainable direction for everyone. In Figure __, Woodcock et. al, created a list of urban policy and land use strategies could lead to active transport as primary modes of transportation in cities. Out of this table, the reallocation of space and time has the largest amount of policy changes. Suggestions such as grid layouts instead of cul-de-sacs, wider and better quality pavements, and mixed use urban villages all require active implementation and are best carried out in the design of cities.

C: Case Study: Oakland

It is known that the transportation sector contributes the largest amount of greenhouse gases, and when broken down, light duty vehicles are the largest contributor of 56% (EPA). During this semester, I was inclined to research how urban design can completely replace the need and eventually the want for passenger vehicles in the city, where the proximity of essential needs can be taken advantage of. Designing cities to be more walkable and bikeable has the ability to massively reduce a city's carbon footprint.

Another reason to consider walking and biking is because electric vehicles still have uncontrollable embodied emissions whereas walking and biking can both be made cleaner with low-carbon diets. (Mizdrak et. al) When testing the "embodied" emissions associated with walking or biking, researchers found that an increase in energy expenditure through walking, can lead to increased food intake which contribute to the embodied emissions of walking and biking.

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What we learned about walking in Oakland

We looked at seven years of police collision data, the most recent census data, City records, public health studies and the results of our survey. These findings are the highlights of this analysis.

Existing Conditions	Safety Analysis	Community Outreach
27% 27% of all trips in Oakland are made by walking.	267 Each year in Oakland, an average of 267 pedestrians are injured in motor vehicle collisions.	588 Almost 600 Oaklanders responded to our online survey about pedestrian conditions and potential improvements.
78% 78% of trips to public transit are made on foot.	7 On average, 7 pedestrians are killed each year in motor vehicle collisions.	7 We attended meetings across Oakland and asked community and neighborhood groups for input.
1,120 Oakland has 1,120 miles of sidewalk.	36% 36% of pedestrian injuries and deaths happen on...	4 We met four times with the Plan's Pedestrian Advisory Group and Technical Advisory Group, to receive and apply their input.
31 and 31 miles of sidewalk gaps.	2% ...just 2% of Oakland's streets.	
3x Asian Americans in Oakland are more than 3x as likely to	62% Motorists are at fault for 62% of	

figure 24: oakland study

MICROTRANSIT IN THE BAY AREA

Microtransit, as defined by Caltrans and the Transportation Sustainability Research Center at UC Berkeley, refers to the combination of fixed and flexible routes, availability of requesting starting and stopping points, and on-demand services (Shaheen, et al.). These factors in a public transit setting allow for riders' greater flexibility, as they are able to incorporate their desired destination on a fixed route. This option is particularly useful for solving the first and last mile issue, which occurs when commuters have difficulty getting from their starting point to their bus stop or train station, or from the public transit stop to the final destination. In addition, microtransit uses fleets of shuttles or vans, instead of large buses.

In the Bay Area, considering the potential for microtransit as a more prominent aspect of the public transportation system is worthwhile, especially as ridership in the Bay Area has declined by 70% as of August 2020 (SF Chronicle). With the future of public transportation seeming to be dominated by riders who are essential workers without access to cars or remote work, an equity-based approach is also essential when considering public transit. Microtransit can be a viable option because pilot programs in other cities have proven to be effective and accessible for riders. Compared to large empty buses, smaller but fuller microtransit vehicles could potentially be more sustainable as well.

CASE STUDY 1: AC Transit Flex

Newark and Castro Valley, CA

In order to analyze the potential for successful and accessible microtransit in the Bay Area, we considered three case studies in which publicly managed microtransit was implemented in other cities. The first is AC Transit's Flex program, which was piloted in Newark and Castro Valley, CA in 2017 ("AC TRANSIT"). The service included fleets of 12-seater vehicles and replaced a low-performing bus line (Line 275) that ran through Castro Valley and Newark. Riders were able to book a ride 30 minutes in advance via phone call or the Internet, or if they were departing from a BART station, they could board without booking a reservation every 60 minutes. Prices to ride remained the same as regular local bus fares: \$2.10 for adults and \$1.05 for youth ages 5-18, passengers with disabilities, and seniors. To pay, riders could use their pre-loaded Clipper Card or simply insert cash to the vehicle's standard fare boxes ("AC TRANSIT"). They then travelled along the old bus route and used the same bus stations as pick-up and drop-off spots, but unlike traditional buses, riders were in direct control of deciding where the van would begin and end its trip.

The year-long pilot program, which began in March 2017, was intended to serve areas with low-demand ridership and proved to be very successful, as it had a 92% trip success rate out of 25,000 total trips and 600 individual riders, 70% of which were returning, consistent riders ("AC TRANSIT," Hursch). In terms of accessibility and convenience, 77% of Newark trips and 69% of Castro Valley trips began or ended at a BART station.

Flex was created with the goals of increasing public transit in a low-demand area, responding to difficulties posed for certain populations by the increasing use of rideshare services, like Uber, and maintaining a focus on equity and accessibility (Hursch). The emphasis on equity is evident in the way the program was implemented: all vehicles were fully compliant with the Americans with Disabilities Act (ADA), and prices were kept the same as regular bus fares. This meant that the use of microtransit was kept accessible to anyone who would have previously used standard bus routes. Further, there were multiple ways to book and pay for the ride, ensuring that riders who were without smartphones, Internet access, or bank accounts would not be disproportionately excluded.

CASE STUDY 2: Metro Micro

Los Angeles, CA

The second microtransit case study examined was Metro Micro, a three-year project piloted by LA Metro in Los Angeles, CA beginning October 2020 (“Say Hello”). Intended for short, on-demand solo trips that connected various high-density areas in LA County, riders have been able to book rides via mobile app, Internet, or phone call, and they pay a comparably low introductory rate of \$1 per ride using prepaid TAP, debit, or credit cards (“Say Hello,” “Metro Micro”). Using 10-seater vehicles, the project has been implemented with the intention of using microtransit, not as a replacement of an existing bus route, but as a complementary service that connects riders to existing public transit options in LA, including Metro rail and bus lines.

The project’s goal is to offer commuting Los Angeles citizens the “convenience of ride-share technology at a fraction of the cost,” and this would reduce traffic congestion and the resulting emissions, thus improving air quality (“Say Hello”). Currently, Metro Micro operates in multiple zones throughout LA County, such as El Monte, LAX, Compton, and North Hollywood/Burbank (“Metro Micro”). These areas vary greatly in population demographics, especially income level, reflecting Metro’s intent to serve people of all income-levels in LA County. Furthermore, Metro Micro has assisted in connecting people to “priority destinations,” such as universities and major hospital, indicating Metro Micro’s ability to address the first and last mile gap, as people are more easily able to get to their destinations more easily (“Metro Micro”).



Figure 25: A Metro Micro shuttle, equipped with a bike rack and wheelchair accessibility.

Source: Joshua Minchin, Intelligent Transport

CASE STUDY 3: Gatra Go On-Demand Plymouth, MA

The third case study was the use of Gatra Go in Plymouth, Massachusetts. Since September 2019, Gatra Go On-Demand has been used to “fill the gaps in service,” as riders could use a smartphone mobile app or phone call to schedule a pick up and drop off at any destination they wanted within the South Plymouth service region (Kindy). This method of implementing microtransit has provided the most flexibility, as it mirrors rideshare services the most. Yet, the prices have remained very affordable compared to regular rideshare, at only \$2 per ride. Similar to Metro Micro, microtransit services in Plymouth have been intended to complement current modes of transit (Kindy).

Gatra Go On-Demand was created as a means of accessible and affordable transportation for individuals who do not live close to predetermined bus routes, aiding those who have had difficulty with first and last mile gaps. In addition, the vehicles are all wheelchair accessible and ADA compliant, further ensuring equity in the program. In terms of sustainability, over one-third of individual trips using Gatra Go microtransit had train stations as end destinations, reflecting how microtransit promotes the use of other modes of public transit, therefore giving commuters more sustainable options of transportation (Kindy).

Table 2: Summary of Three Microtransit Case Studies

Case Study	Accessibility	Sustainability
AC Transit Flex	<ul style="list-style-type: none"> • ADA Compliant • \$1.05 or \$2.10/ride • Multilingual information • Standard fare boxes • Phone or Internet scheduling 	<ul style="list-style-type: none"> • Replaced low-performing bus • 30% fewer miles than fixed route
Metro Micro	<ul style="list-style-type: none"> • ADA Compliant • \$1/ride • Helps with first/last mile • App, phone, or Internet scheduling 	<ul style="list-style-type: none"> • Connect riders to bus and train • Encourages more public transit usage
Gatra Go On-Demand	<ul style="list-style-type: none"> • ADA Compliant • \$2/ride • Helps with first/last mile • App or phone call scheduling 	<ul style="list-style-type: none"> • Over 1/3 of trips taken to train stations

Based on these three cases studies, further implementing microtransit in the Bay Area would be most accessible and sustainable when historically underserved communities are prioritized in the planning and implementation of the program.

Aspects of an accessible microtransit program include ADA compliance in all vehicles to accommodate riders with disabilities, multiple methods of payment, including a standard fare box to accommodate unbanked riders, and multiple methods of booking a ride to accommodate riders without access to a smartphone or the Internet. Keeping prices the same as local bus fares is another crucial aspect that retains accessibility to all populations when introducing microtransit. Further, an emphasis on implementing microtransit in communities where ridership has been low due to difficulties with first and last mile gaps would provide underserved commuters with affordable, convenient public transit. Providing informational material about using local microtransit in various languages, as AC Transit Flex did, would also promote ridership and ensure equity to people not fluent in English (Hursch).

In terms of sustainability, there was not much data that quantified the decrease in carbon and greenhouse gas emissions microtransit would cause. However, the three case studies have shown that introducing microtransit encourages the use of bus and train options among riders, which is more sustainable overall. This is because microtransit aids with the first and last mile gap in riders' commutes, meaning riders who were hindered by these gaps, and consequently avoided the use of public transit, are now more able to use public transportation. This reduces the need for personal vehicles, which is also in line with sustainability. Furthermore, as in the case of AC Transit Flex, microtransit replaced low-performing buses, meaning each microtransit vehicle was only driven when needed, instead of a large, mostly empty bus driving its route unnecessarily. Evidently, microtransit shows much potential for reducing emissions caused by various modes of transportation, especially personal cars and rideshare, and future quantitative research into the effects of microtransit on emissions would help corroborate this possibility.

COVID-19 IMPACTS ON TRANSPORTATION

Looking at how Covid-19 has impacted public transportation in the Bay Area and what the future may entail

Covid-19 emerged in December 2019 to become a global pandemic due to its contagious nature and lack of treatments. In March 2020 when Covid-19 cases in the U.S. began climbing at an alarming rate, many states and cities began imposing shelter in place orders. Along with the shut-down of the economy came the stagnation of public transportation. Nationwide, public transportation ridership dropped by about 80% in April and remained 60% lower compared to 2019 levels (APTA). Similar trends occurred in the Bay Area. Even in February of 2021, Bart states that on weekends it serves only 15% of its pre-pandemic commuters (Savidge). While ridership has been slowly climbing back up in recent months, it still remains at levels much lower than business as usual. The lack of ridership quickly put agencies at a deficit and forced them to consider which services and workers to keep. This has forced questions about when we can expect ridership to return and how funding should be covered until then.

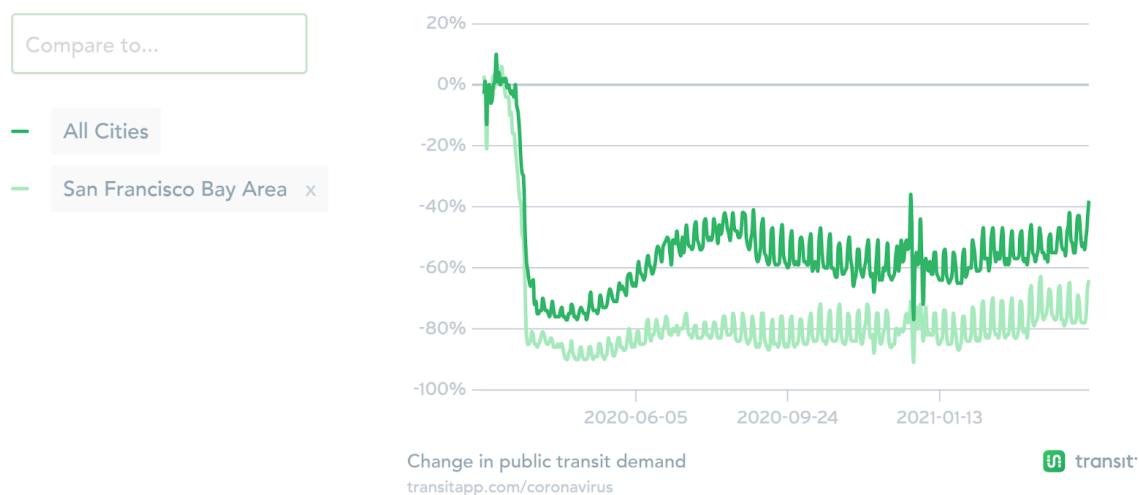


Figure 26: This data from Transit tracking the frequency that the Transit app was opened. Mapping app usage can give a proxy of overall ridership demand. ("How Coronavirus Is Disrupting Public Transit")

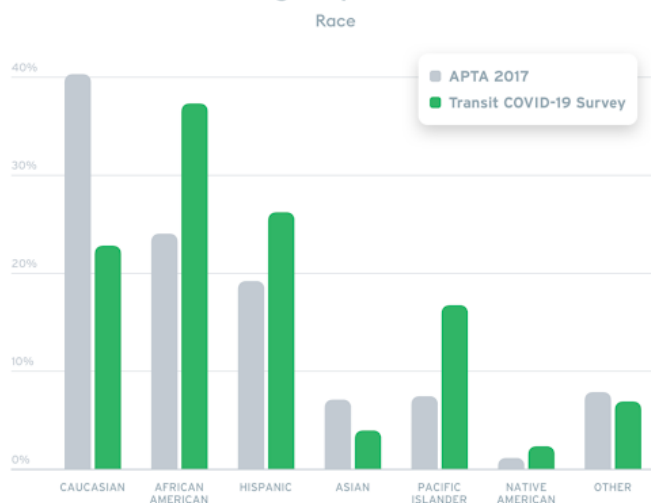
Who Is Impacted

Current data points toward disproportionate outcomes across society. One source of ridership data is the usage of Transit, a popular app used by commuters. By tracking the frequency that the Transit app was opened, we can use this as a proxy for overall ridership demand. Along with their app data, Transit also initiated a survey asking their remaining app users questions to determine who is still using their app in April 2020 (“Who’s left riding public transit?”). Findings include:

- The people still riding are majority female. 56% of riders identified as female, while just 40% identified as male.
- Black and Latino riders now make up the majority of riders. While the proportion of white ridership has decreased by about half, black and latino proportions have increased, suggesting a “white flight” over the makeup of commuters.
- People still riding are poorer, essential workers. 70% make less than \$50,000 annually. Higher income white collar workers were more likely to be able to work from home.
- 85% of respondents said they had no reliable access to a car. Unsurprisingly, this rate is higher amongst poorer riders.

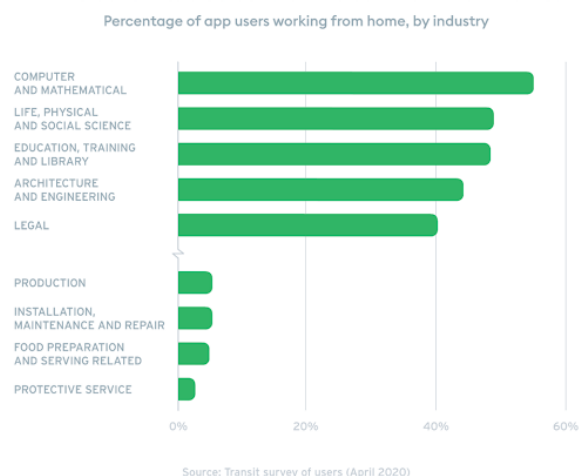
Public transit has highlighted the racial and income inequalities American cities faced during the pandemic. The commuters still using transit are more socially vulnerable and don’t share the luxury of staying at home or driving despite the pandemic, leaving them reliant on public transit. Since ridership numbers remain comparable to the time of this study, it is reasonable to assume these trends are still somewhat relevant. These findings highlight that transit should be considered as a piece of critical infrastructure for a community, not simply an alternate mode of transportation.

People of colour are a greater share of riders during the pandemic



Sources: APTA “Who Rides Public Transportation” (2017), Transit survey of US users (April 2020)

White collar vs. blue collar: Who can work from home?



Source: Transit survey of users (April 2020)

Figures 27 & 28 Survey results initiated by Transit to gather data on commuters still using app (“Who’s left riding public transit?”)

Government Funding

When the pandemic first hit, Congress quickly passed a stimulus package known as the **CARES Act** in April. This 2 trillion dollar package included 25 billion for public transit in response to the steep declines in ridership and revenue (Cabanatuan). 1.3 billion was allocated to Bay Area transit agencies, about three times as much as they usually receive annually from the federal government. Bart received 377 million, followed by 373 million for SFMTA amongst other agencies.

In December 2020, the government passed as a second stimulus bill. The **Coronavirus Response and Relief Supplemental Appropriations Act** came with much more partisan debate in Congress, and it's smaller size of \$14 billion was meant to act as a bridge stimulus before the CARES act ran out. \$975 million went to Bay Area transit. This timing once again allowed agencies from making drastic cuts to services and payroll (Moench). The stimulus helped close the projected deficits of \$33 million for Bart and \$68 for SFMTA this year(Graf).

In March of 2021, the new Biden administration's much anticipated stimulus package was signed into law. Known as the **American Rescue Plan**, it provides the largest sum of money so far with \$30.5 billion for operating costs such as payroll and PPE expenses. As with the previous bills, stated priorities included keeping services afloat to support the workers still reliant on public transportation, as well as preventing layoffs.(US Department of Transportation)

These several stimulus bills were crucial in keeping essential services running despite the huge deficits agencies face. But while these bills spare dramatic cuts and layoffs, it does not offer a solution to revenue issues. Until ridership returns to normal and agencies have a reliable source of revenue, federal funding only serves as temporary lifelines to the looming financial issues agencies are facing. Given the political nature of stimulus bills, there exists a level of uncertainty over whether the next bill will be large enough or timely enough to sufficiently support transportation agencies.

Future Projections and Concerns

Driving Vs Transit

While Covid-19 circumstances are continually evolving, some general predictions and concerns about the future can still be made. One concerning development is whether commuters will choose to drive instead of using transit. As of March 2021, bridge traffic is back to 85% of pre-pandemic levels, allowing us to infer that traffic in the Bay Area is roughly that same amount (Redell). This trend poses a number of concerns, including air pollution, congestion, greenhouse gas emissions, and safety. Fears of public safety in transportation have driven this shift. Public transit is ultimately about utilizing density, juxtaposing it with physical distancing measures. People have been naturally worried with the prospect of staying in an enclosed public space with close proximity to other riders.

In response, agencies have stepped up sanitary measures. Epidemiologists say that the main danger from public transportation depends on whether masks are used and how crowded vehicles are, rather than viruses living on surfaces. With mask mandates and capacity limits, public transportation is considered to be much lower risk than activities like exercising indoors. But despite this, commuters are still skeptical and think public transportation is unsafe. In response, transit agencies like BART have advertised and invested in their disinfection measures, even though the science suggests this is not a significant risk. While Muni's director Jeffrey Tumlin admits spending resources on disinfection can be considered "Covid theater", it is still an important step in regaining the trust of the public and of essential workers who are traumatized by the pandemic. (Savidge)

Figure 29: BART employee sanitizing a train. Despite sanitation measures being relatively ineffective in reducing transmission risk, it is still being done to convey BART's commitment to safety and regain public trust (Savidge)



Economic Concerns

Reduced ridership has put immense pressure on transportation agencies as they try to adapt to a smaller budget. A report in January from the American Public Transportation Association (APTA) states that even after the first two rounds of emergency funding in 2020, public transit agencies across the U.S. still face a projected shortfall of \$39.3 billion through the end of calendar year 2023. This accounts for an economic projection of 9% unemployment through the end of 2021.

Agencies such as Bart have stated that they intend to keep their most essential services running. (Moench) But while stimulus bills may have prevented the worst of layoffs, other cost-cutting measures such as reducing services and delaying projects were unavoidable for many agencies. For instance, the Metropolitan Transportation Commission has been criticized for considering laying off workers and services rather than tapping into funding for capital projects, such as the construction of a new ferry. Advocacy groups such as the Voices for Public Transportation Coalition argue that these projects should be delayed in order to support short-term payroll issues for workers and riders (Moench)

Which of the following actions have you already taken due to the COVID-19 pandemic?

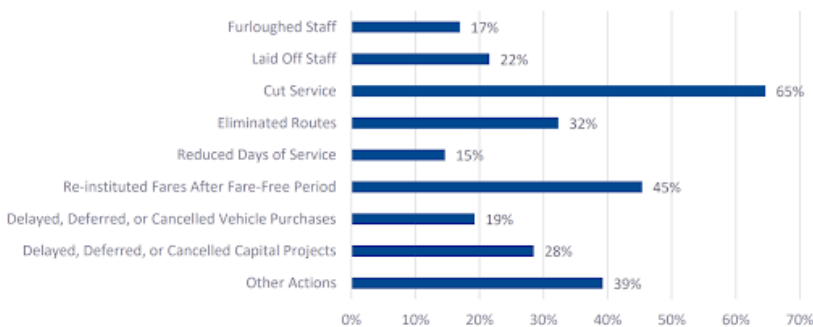


Figure 30: Data on actions taken by transit agencies across the US (APTA)



Figure 31: US Unemployment Rates and their projections (APTA)

Alternate Sources of Revenue

If a slower recovery in ridership does occur, agencies may have to explore alternate sources of revenue. One proposal gaining traction is a **Vehicles Miles Tax (VMT)**. With pilot programs being considered, California may adopt the idea from states like Oregon and replace their state gasoline tax of 53.9 cents per gallon with roughly a \$0.05 cents per mile driven. This idea began gaining traction before the pandemic as an alternate source of funding for roads, since revenues from gas taxes have decreased due to more fuel efficient cars being used. As a newer idea, it draws concerns over which stakeholders are affected, something researchers should emphasize if pilot programs proceed. (“Analysis: Vehicles Miles Traveled Tax”)

Another proposal is **congestion pricing** which charges a fee similar to a toll for driving in designated hot zones. Projected benefits include reduced congestion, safer streets, decreased vehicle emissions and air pollution, and more incentives for commuters to use alternate modes of transportation. The plan has already shown success in cities such as London and Singapore. For it to be politically feasible, other transportation options outside of driving should be accessible (Hawkins).

The third alternative is likely the least popular: **raising fares**. SFMTA has already made this move at the start of the pandemic in April, citing that it was scheduled to occur to match inflation and that it is needed to provide for services amidst the revenue crisis. Activists and a coalition of organizations have staunchly opposed the hike, stating that the people still using transit are essential workers or doing essential business like buying groceries. The decision to raise fares must also consider its effects on ridership numbers in a time when agencies need ridership to increase more than ever. BART’s board of directors have met to consider delaying its planned fare increase in 2022 to encourage ridership growth (BART).

All three proposals raise issues of fairness, especially in a state with higher than average tax rates. It will be up to policymakers and constituents which methods they prefer.

“The necessity of an equitable fare policy becomes even more apparent in the wake of this pandemic, and the last thing that we need right now is fare increases.” - Coalition of 24 SF organizations opposing the SFMTA fare increases (Rodriguez)

CONCLUSION

Through the integration of UN SDGs in speculating transportation justice and sustainability challenges in the Bay Area, potential areas of growth can be identified -- for the time being. As the Bay Area transportation sectors and residents adapt to more challenges in the future, the possibility of including more SDGs is possible.

In our efforts towards sustainability of the transport sector in the Bay Area, it is imperative that the government continues to invest in alternative modes of transportation to increase trips taken in sustainable modes. The government should also encourage the use of cleaner fuels and the deployment of electric vehicles through incentives, education, policies and programs.

Achieving sustainable and environmentally-friendly methods of public transportation is possible in the Bay Area through efficient energy choices. By transitioning from non-renewable to renewable energy, public transportation can become less carbon-intensive and more accessible in terms of costs. Political intervention and support from Bay Area countries would be necessary for sustainable public transportation to be a reality.

In order to progress towards a healthier future that utilizes low-carbon emission transportation and that promotes social diversity and inclusion, urban design for active transport is a crucial sector for future investments. Making cities walkable and bikeable not only promotes sustainability, but also promotes healthier and equitable cities. Currently, pedestrian infrastructure is poor and causes unequal transportation justice issues.

In the Bay Area, microtransit can potentially be a more prominent form of public transportation that centers accessibility and equity for historically marginalized communities by keeping prices low and incorporating features such as standard fare boxes. Microtransit also has much potential to promote sustainability by closing the first/last mile gap and making it easier to use other forms of public transit.

Public transportation is a critical piece of infrastructure our most vulnerable communities rely on. Investing in public transportation can be an investment in addressing income and racial inequalities, air pollution, climate change, and other problems highlighted during the pandemic. The Covid crisis has put public transit agencies at a real risk of being permanently damaged or reduced. How policymakers, agencies, and commuters respond will shape the future of public transportation.

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