The 2024 Sustainable LA Grand Challenge Undergraduate Research Scholars Program Los Angeles County Transportation Energy Report

By Jane Zou, Charlie Gravereaux, Landon Park, Jack Barber, Brenda Macuil

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Introduction

This report expands upon the 2017 Sustainable LA Grand Challenge Environmental Report Card for LA County Energy and Air Quality. While it leverages the insights from the 2017 Report Card, this document presents an updated, comprehensive analysis that can stand alone, offering readers the context and data necessary without requiring prior knowledge of the 2017 findings. Local actions in LA County's diverse transportation system are crucial for sustainable mobility solutions. We aim to update the transportation assessment of LA County with a focus on sustainability, equity, and public health, guiding strategic decisions for future transportation planning. The analysis spans from 2005 to 2023, using data from sources like the Federal Transit Administration’s National Transit Database and other datasets to evaluate trends in passenger miles traveled, unlinked passenger trips, and electric vehicle adoption. The report updates and expands the six indicators from the 2017 Report Card and introduces new categories, such as PEV affordability and micro-mobility. It involves a comprehensive review of data sets and expert consultations to ensure a data-driven approach. The report is organized into sections on Transportation Use, Infrastructure, Equity, and Health, each providing insights and recommendations for LA County's transportation future. Each section not only updates the historical data but also integrates insights from the 2017 Report Card, making it accessible to both new readers and those familiar with the earlier work.

Transportation Use

LA County, known for its heavy cultural reliance on car travel, continues to navigate challenges and opportunities for transforming its transportation systems. We explored trends in gasoline consumption and pricing, shifts in commuting habits driven by societal changes like the COVID-19 pandemic, and the rising adoption of electric vehicles (EVs). We also highlighted the impact of these trends on public policy, urban planning, and the broader goal of achieving a sustainable and efficient transportation network. As LA County moves towards a future of greater sustainability and accessibility, understanding these dynamics is essential for shaping the city’s transportation policies and infrastructure investments.

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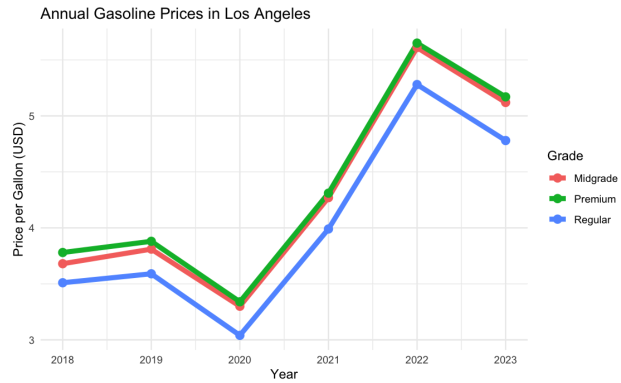
Price of Gas, Gas Sold for Transportation

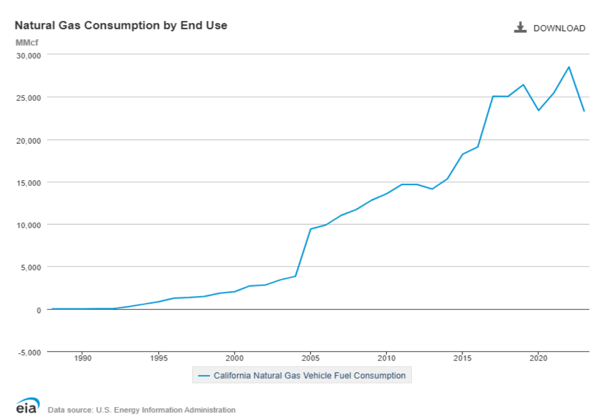
Data from the U.S. Energy Information Administration[1] reveals a steep decline in prices of regular, midgrade, and premium gasoline due to a sharp decline in demand for gas in Los Angeles in 2020, during the height of the COVID-19 pandemic. These are classifications of gasoline based on their octane ratings, with premium having the highest octane level, indicating how much the fuel can be compressed before it ignites. In 2021, gas prices rebounded, spiking higher than pre-pandemic levels to an average of more than $4/gallon.



Annual Gasoline Prices in Los Angeles: Trends in gasoline prices by grade, 2018-2023.

In 2022, prices fluctuated above $5, due to high inflation and limited supply. By 2023, prices remained high but declined modestly due to higher supply, and, we predict an increase in the adoption of electric vehicles and corresponding charging infrastructure as well as an uptick in the use of public transit as the buildout of LA Metro rail stations progresses.

The 2017 Sustainable LA Environmental Report Card measured natural gas consumption for transportation through 2015 in LA County. Our updated data comes from the U.S. Energy Information Administration[2] and measures natural gas consumption specifically for transportation use across California. In 2018, gas consumption for vehicles in California was 25 billion cubic feet (25,0053 MMcf). It increased modestly to 26.4 billion cubic feet (26,427 MMcf) in 2019, before dropping to 23.4 billion cubic feet (23,390 MMcf) in 2020 due to the COVID-19 pandemic.



Natural Gas Consumption by End Use in California: California vehicle fuel natural gas consumption, 1990-2020.

In 2021, consumption across the state rose beyond pre-pandemic levels, at 25.4 billion cubic feet (25,449 MMcf) and up to 28.5 billion cubic feet (28,523 MMcf) in 2022. In 2023, we observe a resounding decline in gas use, back down to 23.3 billion cubic feet (23,325 MMcf), below pre-pandemic levels. We hypothesize that this decline was due to a combination of factors, including sustained high prices, affecting consumer decision-making, reducing demand due to perceived sentiment of a poor economy, the continuing trend of remote work, and increased EV sales. Yet, these values are much higher than found in the previous report from 2010-2015, as the EIA data indicates that gas use for transportation in California rose sharply after 2015, from 18.2 billion cubic feet (18,225 MMcf) to 25 billion cubic feet in 2017 (25,070 MMcf).

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[1] *Los Angeles Gasoline and Diesel Retail Prices*. www.eia.gov/dnav/pet/pet_pri_gnd_dcus_y05la_a.htm.
[2] *California Natural Gas Consumption by End Use*. www.eia.gov/dnav/ng/ng_cons_sum_dcu_SCA_a.htm.

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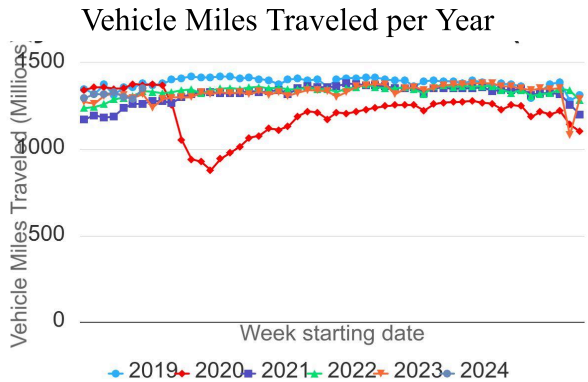
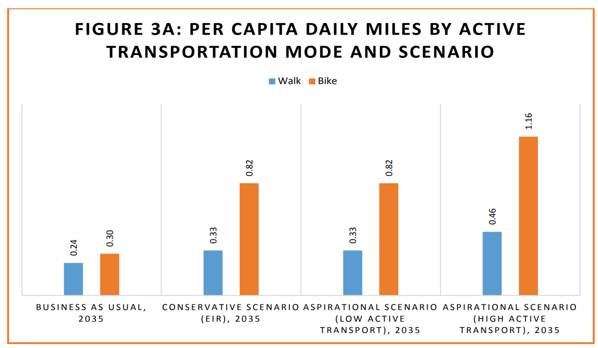
Vehicle Miles Traveled (VMT)

According to data from the Transportation Injury Mapping System at UC Berkeley[3], Vehicle Miles Traveled (VMT) exhibited a sharp decline in 2020 and was still relatively low in early 2021, likely due to the COVID-19 pandemic. VMT is a transportation planning metric that measures the total distance traveled by all vehicles within a specific area over a given period of time. In 2020, VMT declined approximately 200 million miles in Los Angeles from pre-pandemic levels. In the years since the pandemic, VMT has recovered to about 1.3 billion miles in Los Angeles, but has not experienced large increases relative to the pre-pandemic baseline.



Vehicle Miles Traveled per Year: Weekly vehicle miles traveled in Los Angeles, 2019-2024.

In LA County Department of Health's Mobility Plan, the Department predicted per capita daily miles of transportation by transportation modes in different scenarios in 2035. In the figure to the left from the California Air Resources Board[4], there is a direct predicted tradeoff between active transportation and mobility by car. They modeled different "active transportation scenarios": "business as usual," a "conservative scenario", "low" and "high active transportation scenarios." In the "business as usual," Angelenos are predicted to walk an average of 0.24 miles and bike 0.30 miles per day by 2035. In the "high, aspirational scenario," Angelenos would walk 0.46 miles per day and bike 1.16 miles per day in 2035.



Per Capita Daily Miles by Transportation Mode and Scenario for 2035: Predicted daily miles by transportation mode and scenario, 2035.

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[3] *TIMS - Transportation Injury Mapping System*. tims.berkeley.edu/help/Safety_PM.php.
[4] CALIFORNIA AIR RESOURCES BOARD. *CARB 2017 Scoping Plan-Identified VMT Reductions and Relationship to State Climate Goals*. Jan. 2019, dpw.lacounty.gov/traffic/docs/CARB-Report.pdf.

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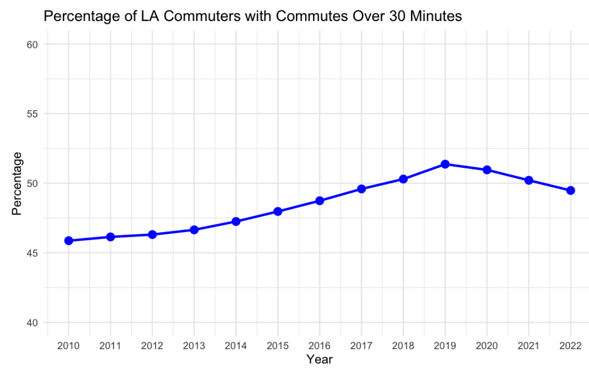
Commute Times

Based on the 5-year estimates from the American Community Survey[5] in 2022, roughly half of Los Angeles workers have commute times exceeding 30 minutes, indicating ongoing traffic challenges. However, the percentage of workers with commutes of 30 minutes or more has declined since 2019, possibly due to COVID-19. During 2020-2022, many industries shifted to remote or hybrid work setups, with 13.22% of the workforce predominantly working remotely in 2022, a significant increase from 2019.

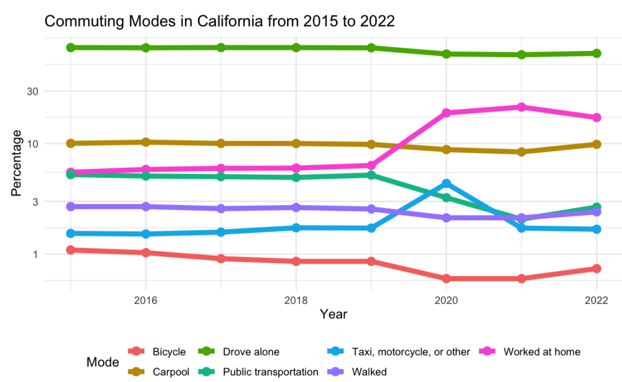


Percentage of LA Commuters with Commutes Over 30 Minutes: Trend in long commutes in Los Angeles, 2010-2022.

With fewer people commuting, there was likely reduced traffic and shorter commute times for those who still needed to travel.

Commute Modes

According to data from the Bureau of Transportation Statistics[6], California continues its strong preference for driving alone, despite efforts to promote public transit and other commuting modes. Public transit use increased from 2005 to 2011 but decreased from 2011 to 2015. Overall, nearly 6% fewer people reported using public transit in 2015 compared to 2005. Slightly more people were taking taxis, motorcycles, or other modes in the past couple of years, perhaps due to the expansion of car-sharing services.



Commuting Modes in California (2015-2022): Trends in transportation modes used for commuting in California.

Reduced usage of public transport and carpooling during the pandemic helped mitigate the spread of COVID-19 by limiting close contact in enclosed spaces. The rise in working from home could influence future decisions on infrastructure spending and development, which may also influence trends in commercial real estate, and reduce demand for office space. In 2015, the majority of LA County commuters (78%) drove alone, which is associated with higher energy consumption and emissions when compared to carpooling or public transportation. Given that driving alone was the predominant mode of commuting in 2015, any reductions in this figure in later years could signal improvements in energy efficiency and a potential reduction in carbon emissions. 10% carpooled, 6% took public transportation, and 6% walked,

[5] Kane, Kevin, et al. "AMERICAN COMMUNITY SURVEY DATA IN SOUTHERN CALIFORNIA." *A First Look at 2016-2020*, SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS, 17 Mar. 2022, scag.ca.gov/sites/main/files/file-attachments/scag-first-look-acs-report-final.pdf?1648507480.
[6] "Commute Mode." Bureau of Transportation Statistics, www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/commute-mode.

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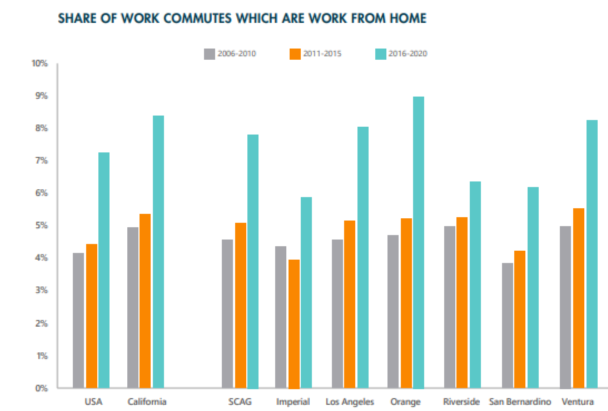
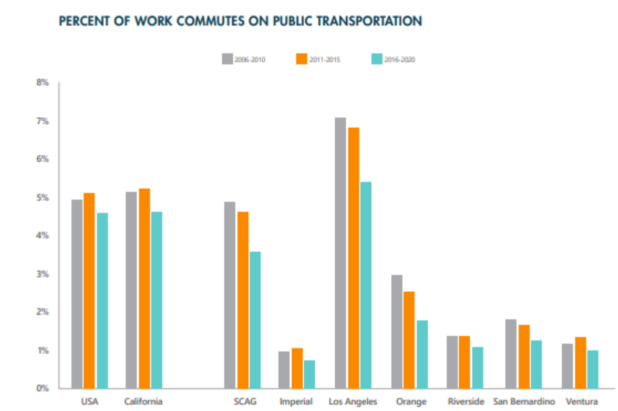
biked, motorcycled, or took a taxi to work in LA County in 2015. However, in 2022, carpooling was found to decrease by 9.29%, contrary to in 2017. From over 70% of commuters driving alone in 2015, there is a noticeable dip in 2020, followed by a slight recovery by 2022, coinciding with the COVID-19 pandemic, which likely reduced commuting due to social distancing and the increase in remote work. In contrast, the percentage of workers who drove alone to and from work accounted for more than half, reaching 68.19% in 2022.

Data from INRIX[7], a location-based mobility data research institution, demonstrated that working from home in Los Angeles rose from 5% in 2011-2015 to 8% from 2016-2020. Noticeably, there was an uptick in the rate of working from home across the U.S. and California due to the COVID-19 pandemic. This trend, an increase in the percentage of people working from home, began in 2020, peaked in 2021, and then began to decrease slightly in 2022.



Work From Home Commutes: Comparison of work from home rates across different periods and regions.

Additionally, we predict that these work from home trends will persist, leaving rates persistently higher than pre-pandemic levels. We also observe that work from home averages in California and Los Angeles are both markedly higher than U.S. averages. We predict this is because of stricter pandemic restrictions, more globalized workforce, and an overall cultural attitude more favorable to working from home. INRIX data indicates a decline (from 7% to 5%) in reliance on public transportation for work commutes in LA from 2011-2015 (orange bars) compared to 2016-2020 (blue bars).



Public Transportation Usage: Share of work commutes on public transportation over different periods.

This decline began in 2010, raising questions about the effectiveness of initiatives aimed at increasing accessibility and improving public transportation infrastructure.

[7] Inrix. "Leading Transportation Analytics Solutions | INRIX." *Inrix*, 22 Feb. 2024, inrix.com.

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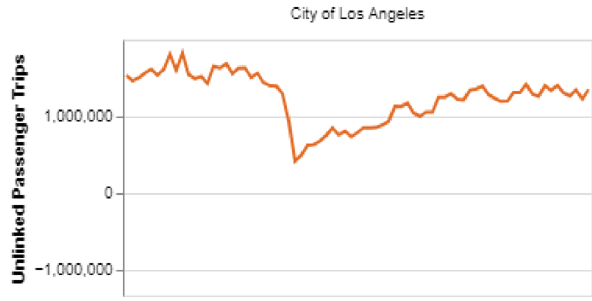
Transit Passenger Miles Traveled, Unlinked Passenger Trips

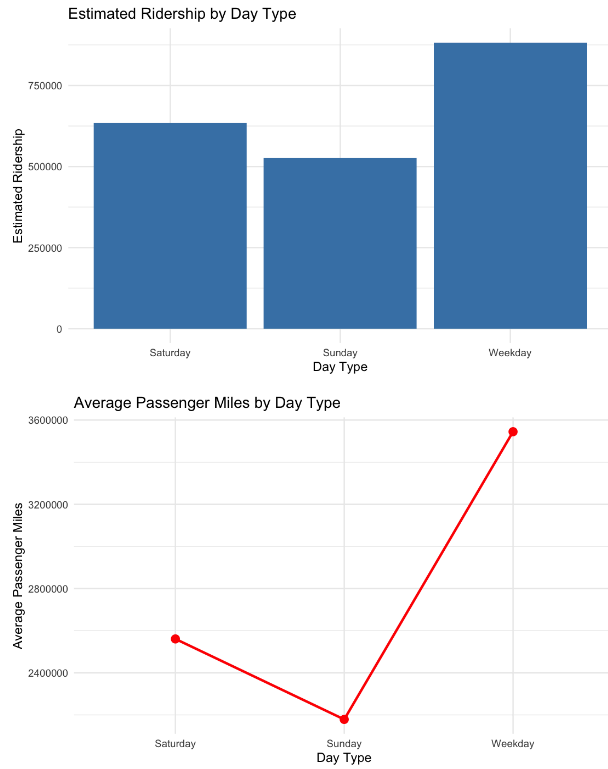
These two primary metrics, unlinked passenger trips (UPT), and passenger miles traveled (PMT), serve as pivotal benchmarks for evaluating public transportation usage and assessing the efficacy of transit systems in meeting commuter demands. UPT refers to each instance a passenger boards a public transit vehicle. According to the Federal Transit Administration (FTA), Transit Passenger Miles (PMT) represents the cumulative distances traveled by each passenger while utilizing transit services. LA Metro proactively worked towards bolstering PMT by prioritizing transportation services, notably through the expansion of rail networks and accessibility to public transit options.



Unlinked Passenger Trips in Los Angeles: Fluctuations in unlinked passenger trips over time.

The observed uptick in PMT, as evidenced by the comprehensive LA Metro ridership data encompassing both bus and rail usage on weekdays, signifies a notable surge in public transit utilization, particularly during work commutes, with an average of 20 million miles logged.

Systemwide (Bus and Rail)



Ridership and Miles by Day Type: Comparisons of ridership and passenger miles on different days of the week.

Conversely, this increase might also indicate that existing LA Metro passengers are undertaking lengthier journeys, possibly attributable to broader coverage of public transit services across a more extensive geographic area. Moreover, UPT, representing each instance a passenger boards a public transit vehicle, offers valuable insights into overall ridership trends by helping transit authorities and planners understand the volume of use for each segment of the transit system.

While the figure indicates approximately one million unlinked passenger trips, recent data suggests a decline in this metric, although the extent of this decrease remains unspecified in the LA Metro source.[8]

[8] "Metro Ridership." *Opa.metro.net*, opa.metro.net/MetroRidership/.

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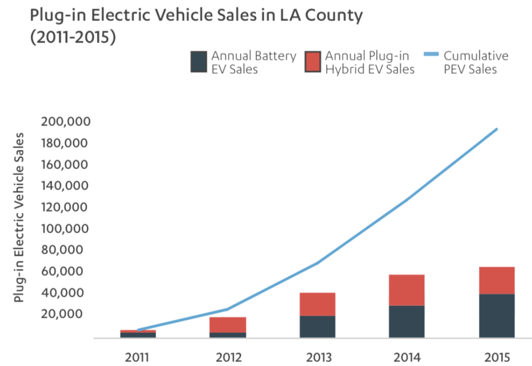
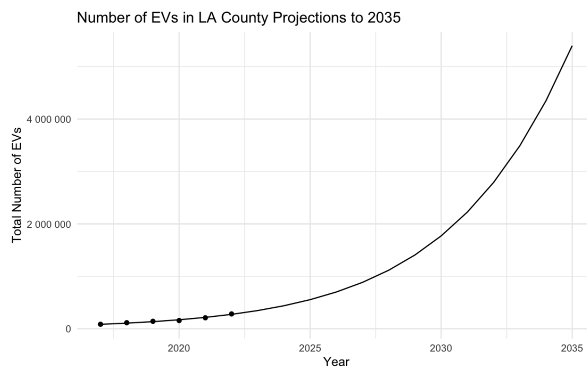
Electric Vehicle Sales, Number of Electric Vehicles

The EV market in LA County is growing rapidly. The cumulative number of sales from 2011 to 2014 (excluding 2015), as shown to the left and derived from the 2017 report, is now less than the number of annual sales since 2023 according to the Department of Motor Vehicles (DMV). In addition to sales, the number of electric vehicles (EVs) registered with the Department of Motor Vehicles (DMV) appears to be following an exponential growth curve.[9]



EV Sales in LA County (2011-2015): Growth in electric vehicle sales by type over time.

By 2035, the target year for California Governor Newsom's administration's zero-emissions vehicle policy, our own logistic modeling demonstrates that EV counts may exceed 5 million vehicles. In R, we created a logistic model for projecting EV counts by 2035 using the `glm` function, fitting it to historical EV adoption data to estimate future EV counts. However, this is more idealistic than other models, which state that there will be around half that number of registered EVs in 2035.[10] The number of gasoline and diesel vehicles have remained relatively constant from 2017 to 2022, while all categories of EVs are increasing in number. Policy implications such as state[11] and federal subsidies[12] for EV purchases and increasing charger stations[13] may be important in influencing EV sales and ownership, as well as phasing out gas-powered vehicles.



EV Projections to 2035 in LA County: Future projections of electric vehicle numbers in LA County.

[9] "New Zev Sales in California." *California Energy Commission*, California Energy Commission, www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/new-zev. Accessed 7 May 2024.
[10] "LOS ANGELES ELECTRIC VEHICLE CHARGING INFRASTRUCTURE NEEDS AND IMPLICATIONS FOR ZERO-EMISSION AREA PLANNING." *WHITE PAPER*, International Council on Clean Transportation, 2021, theicct.org/wp-content/uploads/2021/06/LA-charging-infra-feb2021.pdf.
[11] *Alternative Fuels Data Center: California Laws and Incentives*. afdc.energy.gov/laws/all?state=CA.
[12] *Tax Incentives*. www.fueleconomy.gov/Feg/taxcenter.shtml.
[13] "LOS ANGELES ELECTRIC VEHICLE CHARGING INFRASTRUCTURE NEEDS AND IMPLICATIONS FOR ZERO-EMISSION AREA PLANNING." *WHITE PAPER*, International Council on Clean Transportation, 2021, theicct.org/wp-content/uploads/2021/06/LA-charging-infra-feb2021.pdf.

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Takeaways

1. **Variable Gasoline Consumption and Prices**:
    a. ***Gasoline prices*** in LA County have experienced significant fluctuations due to factors like the COVID-19 pandemic and inflation, reflecting changing economic conditions.
    b. Natural gas consumption for transportation has varied, showing a consistent yet costly reliance, despite its environmental impacts.
2. **Shifts in Commuting Patterns**:
    a. There has been a noticeable reduction in ***vehicle miles traveled (VMT)*** during the pandemic with a moderate recovery post-pandemic. The prevalence of remote work has shortened ***commute times*** and reduced the frequency of daily commuting, which has led to changes in ***commuting modes***, notably a decrease in public transit usage.
3. **Increasing Adoption of Electric Vehicles (EVs)**:
    a. ***EV sales*** in LA County are on the rise, indicating a significant shift towards more sustainable transportation options. This increase is supported by state policies aimed at promoting the adoption of zero-emissions vehicles by 2035, suggesting a trend towards reduced reliance on traditional gasoline-powered vehicles.

Recommendations

1. **Enhance Public Transit and Active Transportation Infrastructure**:
    - Improve existing ***public transit systems*** to make them more safe and accessible.
    - Expand the ***number of Metro rail stations*** and promote ***micro-mobility*** transportation options like biking and walking through safer cycle tracks and pedestrian paths.
2. **Promote Electric Vehicle Adoption**:
    - Support the transition to ***electric vehicles*** through incentives such as tax breaks, rebates, and expanding ***charging*** infrastructure, and promote the phasing out of gasoline vehicles to meet future zero-emissions goals.
3. **Adapt to Changing Work Patterns**:
    - Reevaluate urban planning and transportation needs from a ***remote and work-from-home*** workforce's perspective.
    - Some suggestions may include ***updating public transit schedules*** and routes to adapt for employees who may no longer need to commute daily.
    - Develop more co-working spaces to reduce commute times and support hybrid work models.

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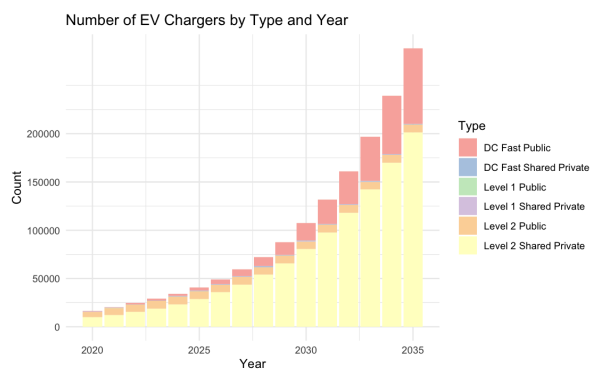
Infrastructure

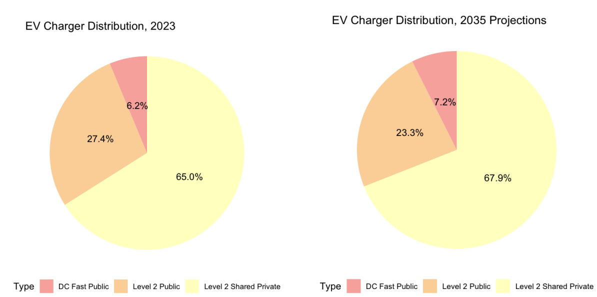
We explored the current state and future potential of transportation infrastructure in LA County, focusing on developments in electric vehicle (EV) charging facilities, the utilization of parking spaces, the expansion of ridesharing options, and the growth of bike lanes. These elements are integral to LA's ongoing efforts to create a more sustainable and efficient transportation ecosystem. We assessed the growth in infrastructure that supports alternative transportation methods and the challenges that accompany these changes, from ensuring adequate EV charging to promoting cycling and ridesharing in an urban environment historically dominated by car travel.

Electric Vehicle Charging Facilities

Although Level 1 chargers are still rare in LA County, DC Fast chargers are being built rapidly and Level 2 chargers are quite commonplace. DC Fast chargers are high-power charging stations that use direct current (DC) to rapidly charge EVs.[14] Meanwhile, Level 1 and 2 chargers are charging stations that use alternating current (AC) and are installed in residential complexes, workplaces, or shared private areas with either 120 or 240 volts, respectively, of output.[14] Both public and shared private chargers have been projected to grow rapidly according to data from the California Department of Motor Vehicles, and we used this data to generate logistic projections for all types of chargers by 2035. Yet, the composition of chargers may not be able to accommodate a growing population of personal electric vehicles unless drivers have EV chargers at their homes. The proportions of EV chargers in 2023 and in 2025 are predicted to remain constant.



Number of EV Chargers by Type and Year: Growth of EV charger types from 2020 to 2035.



EV Charger Distribution (2023 vs. 2035): Comparison of EV charger type distributions in 2023 and projected for 2035.

The total we predict by 2035 is around 75,000 chargers in LA County, yet the modeling is limited since the Level 2 shared private chargers are predicted to have a faster growth rate than all of the chargers combined.

Realistic estimates also account for home chargers, which combined with publicly available or shared chargers, should number above 500,000.[15] The number of chargers has increased drastically from 2011 onward, which is the year when chargers were first counted in the previous

[14] "Electric Vehicle Charging Stations." *Alternative Fuels Data Center: Electric Vehicle Charging Stations*, afdc.energy.gov/fuels/electricity-stations. Accessed 13 June 2024.
[15] Bui, Anh, et al. "LOS ANGELES ELECTRIC VEHICLE CHARGING INFRASTRUCTURE NEEDS AND IMPLICATIONS FOR ZERO-EMISSION AREA PLANNING." *WHITE PAPER*, International Council on Clean Transportation, 2021, theicct.org/wp-content/uploads/2021/06/LA-charging-infra-feb2021.pdf.

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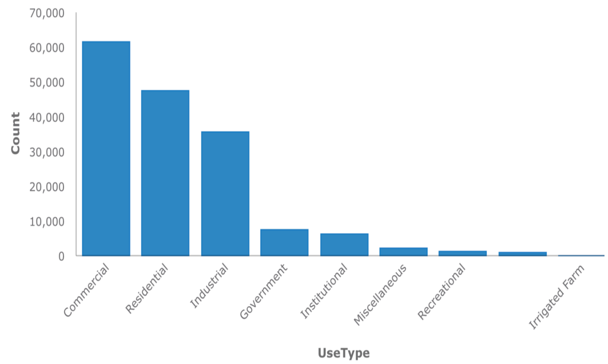
2017 report.[16] Further research should be conducted to determine major obstacles in the implementation of charging networks and identify if chargers can meet demand by the target year of 2035 for EVs set by the California Governor's Office.

Parking Space Construction and Utilization

Parking spaces and lots in LA County have the capacity for solar storage and EV charging infrastructure, and must be utilized as such to support the growing number of EVs. Updated as of July 2023, this GIS parking space areas dataset was constructed by the Internal Services Department Enterprise GIS Section in 2014[17] and contracted by the LA County Office of Sustainability in order to understand and support the possible locations for solar photovoltaic canopy module installations.[18]



Use Type for Commercial Properties: Distribution of parking space property use types in commercial sectors.

The data only provides information on parking lots with areas of 5,000 square feet or greater, and did not factor in roof-top parking or non-paved lots. Lots of 5,000 square feet or greater are used for this dataset as they are deemed to have the capability to support larger solar photovoltaic canopy modules, which smaller lots may not have the ability to do. Solar photovoltaic canopy modules are structures that combine solar panels with a canopy design. The majority of parking lots with the size-ability to have solar installation are either commercial, residential, or industrial use lots, with over 30,000 of each type of lot currently in use. With the rise in investments of renewable energy and electric vehicles, it is necessary that current and newly constructed parking lots in LA county are electrified in order to support the growing number of EVs.

Metro Bike Sharing

In 2022, the LA County Metro Bike Share program[19] was expanded to include 221 stations and 1,800 bikes, with over 290,000 bike trips taken that year, demonstrating LA County's commitment to enhancing sustainable transportation options. The ride-sharing initiative launched in 2020 by Metro Micro saw over 600,000 travelers utilize the program.[20] The number of Metro BikeHubs also indicates that there are designated areas that support bike commuters. While the percentage of residents who walked or cycled to work in 2015 was relatively small, there has been a notable increase in cycling and cycling interest since 2015, likely due to the Metro Bike Share program inception in 2016. LimeBikes are subsidized by LADOT to allow for affordable 30-minute rides and reflect policy efforts to make eco-friendly transportation options more accessible to the public.[21] A decrease in single-occupancy vehicle trips and an increase in shared or human-powered commuting could lead to reduced traffic congestion and improved air quality.

[16] Federico, Felicia, et al. *2017 Sustainable LA Grand Challenge Environmental Report Card for LA County Energy and Air Quality*. 27 Apr. 2017, escholarship.org/uc/item/6xj45381.
[17] *County of Los Angeles Enterprise GIS*. egis-lacounty.hub.arcgis.com.
[18] LA County Planning. "GIS Data - LA County Planning." *LA County Planning*, 15 May 2024, planning.lacounty.gov/maps-and-gis/gis-data.
[19] *Home*. bikeshare.metro.net.
[20] "ISD Rideshare LA County – Take Pride. Share the Ride." *ISD Rideshare LA County*, rideshare.lacounty.gov.
[21] "Shared Mobility." *LADOT*, ladot.lacity.gov/projects/transportation-services/shared-mobility. Accessed 14 May 2024.

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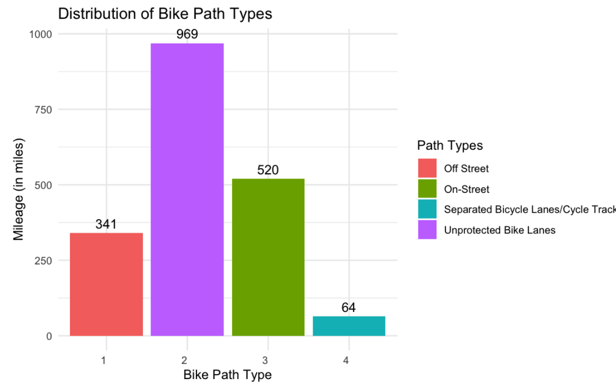
Bike Lanes



Distribution of Bike Path Types: Miles of different types of bike paths available.

As of June 2023, LA County boasts 1,894 miles of bike pathways, with a substantial portion still being unprotected lanes. However, compared to the data presented in the 2017 LA Energy Report Card, there has been a notable shift towards an increased number of protected bike lanes and off-street paths. This shift not only aims to protect cyclists but also encourages more residents to consider cycling as a regular commuting option. These changes could be due to financial limitations or opposition from the local population to modifications in traffic patterns, as seen by Playa del Rey's restoration of vehicle lanes.[22] The future growth of multi-use corridors such as the High Desert Multi-Purpose Corridor points to a trend towards more integrated transit options that will likely balance affordability, public opinion, and the need to ensure safety for cyclists.[23]

Takeaways

1. **Expansion of EV Charging Infrastructure**:
    - There has been a significant increase in the construction of ***DC Fast chargers*** and the prevalence of Level 2 chargers, essential to support the growing number of EVs. However, widespread ***EV adoption*** by 2035 may still be insufficient without the widespread installation of home chargers.
2. **Potential for Solar Integration in Parking Spaces**:
    - Categorizing and compiling area data of large parking lots for potential ***solar photovoltaic installation points*** may enhance renewable energy generation and accommodate the electrical needs of EVs. This initiative reflects a starting point toward identifying where infrastructure improvements could be made, in an attempt to move towards integrating sustainable practices into everyday infrastructure.
3. **Growth in Ridesharing and Cycling Infrastructure**:
    - The ***Metro Bike Share*** program's expansion and designated ***bike lanes*** highlight LA's commitment to promoting more sustainable commuting options by reducing reliance on single-occupancy vehicle trips, which can alleviate traffic congestion and improve air quality.

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[22] "Vista Del Mar Is a Sad, but Instructive Lesson for Los Angeles." *Los Angeles Walks*, www.losangeleswalks.org/vista_del_mar_lesson_for_los_angeles.
[23] *Metro Moves to Revive Canceled High Desert Freeway Project - Streetsblog Los Angeles*. 13 June 2023, la.streetsblog.org/2021/07/30/metro-moves-to-revive-canceled-high-desert-freeway-project.

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Recommendations

1. **Accelerate Home and Public EV Charger Installations**:
    - Encourage the installation of home ***EV chargers*** through incentives such as tax rebates and streamlining the home and public charger installation permissions.
2. **Enhance Solar Infrastructure in Parking Areas**:
    - Invest in ***solar canopy installations*** over parking lots, particularly in commercial, residential, and industrial areas, to support the power requirements of EVs.
3. **Expand and Protect Bike Lane Infrastructure**:
    - Expand the ***bike lane network***, enhancing safety through constructing protected bike lanes and cycle tracks, encouraging more residents to consider biking a safe and viable alternative to driving, especially for shorter commutes.

Equity

In LA County, our examination of transportation infrastructure highlights the necessity of enhancing connectivity and accessibility, particularly for low-income residents who depend more on automobiles than public transit. Central to our analysis is the Universal Basic Mobility program and the Mobility Wallet initiative, which allocate financial resources to low-income travelers, enabling them to select the transportation mode, whether transit, ride-hail, or car share, that best suits their daily needs. This strategy underscores the community's preference for access to more efficient and flexible transportation options over lower transit fares. Although affordable, lowering transit fares is a less valued solution than service improvements and reductions in travel times. By prioritizing these programs, our approach addresses the immediate transportation needs of LA County's diverse population, aligning with the region's broader environmental objectives, and ensuring a sustainable and equitable transportation framework.

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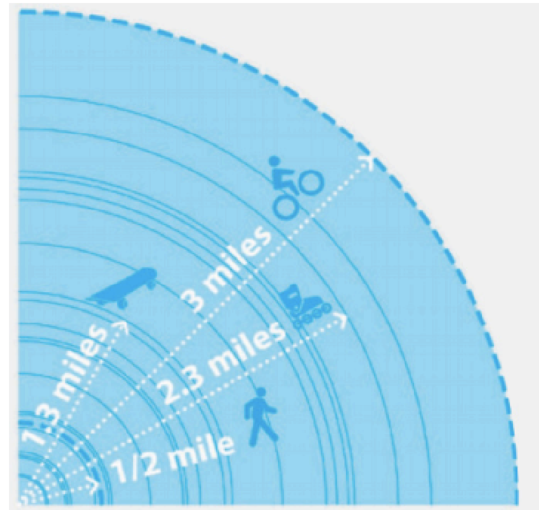
First and Last Mile Connectivity

Bus and rail services are often the backbone of a journey, with riders completing the first and last portions using other modes of transportation. Typically, they rely on “active transportation” like walking, biking, or using mobility devices to reach the nearest station from their home or workplace. This is known as the first and last mile (FLM) of the trip.



Access Sheds for Different Forms of Active Transportation: Illustrates the ideal range of distances typically traveled via various active transportation modes.

Since most trips start or end on foot, streets and sidewalks must be safe and accessible to facilitate easy connections to transit. In addition to walking, people might also cycle or use micro-mobility options, like e-scooters or wheelchairs. However, challenges such as busy intersections or the absence of bike lanes can make accessing transit difficult. Metro aims for the nearest transit stop to be accessible within about half a mile, promoting walking as the primary ode of the first/last mile connection.[24] It is a key component of LA Metro's strategy to enhance overall transit experiences and foster Transit-Oriented Communities (TOCs), which are designed round transit stations to support diverse income groups and sustainable living.

[24] Los Angeles County Metropolitan Transportation Authority. First Last Mile Strategic Plan & Planning Guidelines. Mar. 2014, https://libraryarchives.metro.net/dpgtl/scag/2014-first-last-mile-strategic-plan-final-march.pdf.

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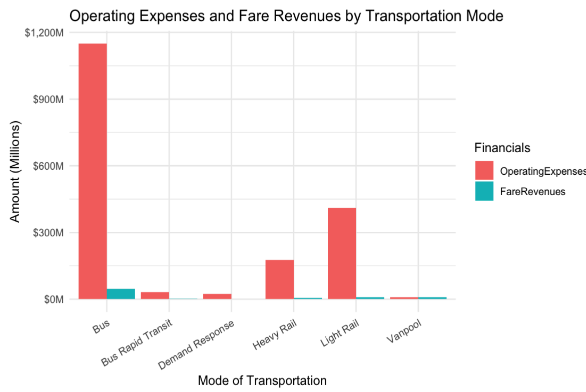
Fare Affordability

With an emphasis on sustainability and addressing the varied needs of its citizens, the Los Angeles Department of Transportation (LADOT) has made progress toward achieving its Universal Basic Mobility (UBM) goals. The Mobility Wallet provides financial assistance to low-income travelers for their choice of mobility form, such as car-sharing, ride-hailing, and public transportation. By updating its buses and other transportation services to electric vehicles (EVs) and improving EV infrastructure, LADOT intends to transform its transit services to be all-electric by 2030. [25] These initiatives align with LADOT's contribution to LA's Green New Deal[26], which aims to convert every city vehicle to zero-emission technology by 2050.

Each transportation mode incurs higher operating expenses than the fare revenues it generates, indicating that these systems are subsidized by government funds due to their role in providing essential public services. Buses, which have the highest operating expenses ($1.1B), also generate the most fare revenue ($47M). This suggests that buses are a vital mode of public transportation, especially for lower-income riders, justifying their operating costs. In contrast, rail services, often utilized by higher-income individuals, receive greater subsidies. Demand Response and Vanpool services, which target specific groups such as the elderly or disabled, have lower operating costs but also generate minimal fare revenue, with Demand Response services often offering free rides to these populations. This financial structure necessitates considerable subsidies to balance the provision of essential services with budget limitations.



Operating Expenses and Fare Revenues by Transportation Mode: Compares operating expenses and fare revenues across different modes of transportation.

Projected fare revenues for FY24 are $146.8 million, hinting at possible increases in ridership, fare adjustments, or a combination of both. Metro also supports other local bus operators and transportation projects within the county to enhance sustainability and improve infrastructure for biking and walking for the over 10 million residents of the county. Fare prices are influenced by the variety of services offered, including the use of high-occupancy toll lanes for some bus services, and by Metro's subsidized fare programs, such as the LIFE program for low-income riders.

[25] Bates, Michael. "LADOT Orders 130 Zero-Emission Battery-Electric Buses." *NGT News*, 20 Nov. 2019, ngtnews.com/ladot-orders-130-zero-emission-battery-electric-buses.
[26] *Home | Plan.lamayor.org*. plan.mayor.lacity.gov.

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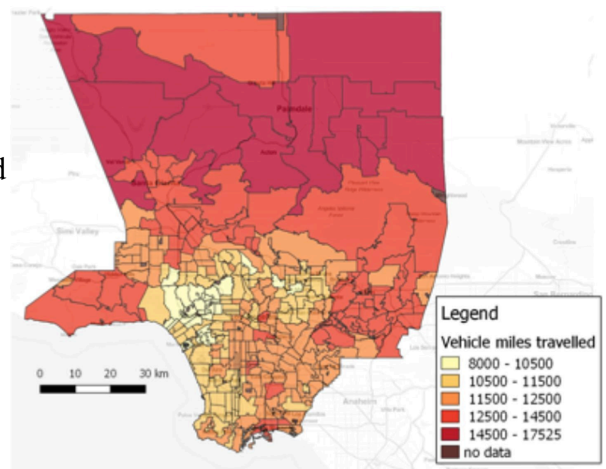
Access Services

Accessibility services support equal access to travel for people with accessibility needs, such as disabled individuals, for social, educational, medical, and employment purposes.[27] Shared rides and the necessity that journeys be booked a day in advance highlight the preparation and coordination required to provide specialized transit services, which aids in effective resource management. The LA County Access Rider ID Card tracks ridership inconspicuously, guards against fraud, and guarantees that only legitimate users of the service utilize it. The information on how to utilize Flex coupons, payment for fares, and purchase them via mail helps passengers manage their budgets and provides openness regarding the financial side of the service. The possibility of requesting reasonable modifications and the recommendations for a Personal Care Attendant (PCA) illustrate the personalized approach to accommodate individual needs. The system of rider feedback, complaints, and the ability to review complaint history suggests an openness to improvement and accountability.

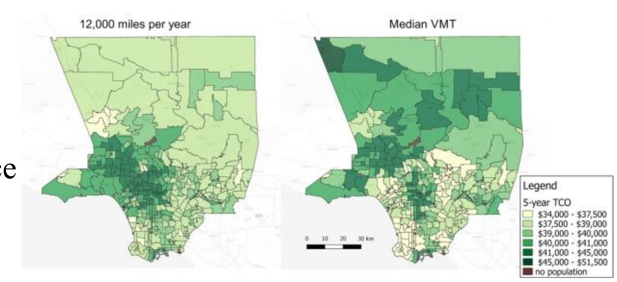
Equity and Affordability of Electric Vehicles

Electric vehicles are not only used variably in different communities in LA County, but they also sustain different costs across neighborhoods based on factors such as electricity rates, utility rebates, insurance rates, median vehicle miles traveled, and sales tax.[28] The three figures to the right, from "Who saves money buying electric vehicles? Heterogeneity in total cost of ownership" published in *Transportation Research Part D: Transport and Environment*, demonstrate this conclusion.



Annual Average Electric Vehicle Miles Traveled by Zip Code: Map estimating levels of median vehicle miles traveled per electric vehicle annually across different zip codes in LA County.

For one, the figure to the top right models annual median vehicle miles traveled (VMT) per electric vehicle by zip code. More vehicle miles are traveled per vehicle in the northern parts of the county, exceeding 15000 miles per year, while median VMT in areas closest to downtown Los Angeles is closer to around 8000 miles per year. The study attributes the trend of higher VMT in suburban and exurban areas due to further distance from jobs and amenities, lesser access to public transit, reduced population density, and road infrastructure possibly adapted for longer commutes.[28] Evidently, EV usage varies by community, not accounting for differing rates of



5-Year Total Cost of Ownership (TCO) for the Tesla Model 3: Maps showing the 5-year TCO by zip code for the Tesla Model 3, modeled either by assuming 12,000 miles driven in an electric vehicle per year in all neighborhoods (to the left) or using the median

[27] *Access Services*. accessla.org.
[28] Parker, Nathan, et al. "Who Saves Money Buying Electric Vehicles? Heterogeneity in Total Cost of Ownership." *Transportation Research. Part D, Transport and Environment*, vol. 96, July 2021, p. 102893. https://doi.org/10.1016/j.trd.2021.102893.

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ownership discussed later. vehicle miles traveled model in the previous figure (to the right)

Additionally, the figures to the bottom right of the last page demonstrate the total cost of ownership of the Tesla Model 3 in two scenarios, one where there is a standard VMT in every zip code and one where there is a variety of vehicle miles traveled across zip codes. Clearly, affordability differs by location.

In the median VMT scenario, costs are lower in Los Angeles and become higher to the north. There is a noticeable ring of suburbs around central Los Angeles that have the lowest costs of ownership, perhaps because of relatively low VMT, insurance rates, and electricity rates. Meanwhile, in the scenario where all zip codes are assumed to have a VMT per vehicle of 12,000 miles per year, central Los Angeles maintains the highest ownership costs due to high insurance and electricity costs.[28] Accordingly, it can be seen that driving behavior highly modulates EV costs, and that if driving behavior is assumed to be constant, centralized urban communities in Los Angeles tend to have the highest cost burden. This holds equity implications for communities near and around downtown Los Angeles. In fact, the study found that the cost of EVs are likely to be most economically efficient in outer ring suburbs in LA County for 17% of total drivers, ignoring the vast majority living in the city.[28]

Regarding the geographical distribution of EV ownership, EVs are primarily owned by those who are wealthy in neighborhoods with White and Asian majorities. These are reflected by the zip codes with the highest number of EV ownership with between 10.9% to 14.2% of all vehicles in those communities being EVs (such as Santa Monica, Bel-Air, Pacific Palisades, and Playa Vista).[29] Meanwhile, LA County zip codes with the largest proportion of Latino and Black residents have the lowest percentages of EV ownership.[29]

Further, costs for EV-related infrastructure are the focus of other equity research. More specifically, the infrastructure required to operate EVs in a "clean" and self-sufficient manner, with solar panels and at-home chargers, requires significant funding. Approximately 20% of EV owners are predicted to lack at-home charging by 2035, and of those 80% will be in multifamily buildings.[30]

For one, the article "Public Electric Vehicle Charger Access Disparities across race and income in California," published in *Transport Policy*, demonstrates that chargers are also a technology that is available in an inequitable way, with sociodemographic factors partially determining availability.[31]

Most notably, the article involves two sets of figures (shown in the next page) assessing the impacts of two variables on access to a public charger in communities across California: the distance to the nearest highway and the proportion of multi-unit dwelling (MUD) housing (residential buildings that contain multiple separate housing units), respectively. The figures also indicate how residents of the communities are impacted differently by these variables based on household income and race/ethnicity.

[29] Lopez, Nadia, and Erica Yee. "Who Buys Electric Cars in California - and Who Doesn't?" CalMatters, 22 Mar. 2023, calmatters.org/environment/2023/03/california-electric-cars-demographics/.
[30] Smith, Hayley. "L.A. Is Going Electric. Can It Do so Equitably?" Los Angeles Times, 20 Nov. 2023, www.latimes.com/environment/story/2023-11-20/l-a-is-going-electric-can-it-do-it-equitably.
[31] Hsu, Chih-Wei, and Kevin Fingerman. "Public electric vehicle charger access disparities across race and income in California." Transport Policy, vol. 100, Jan. 2021, pp. 59–67, https://doi.org/10.1016/j.tranpol.2020.10.003.

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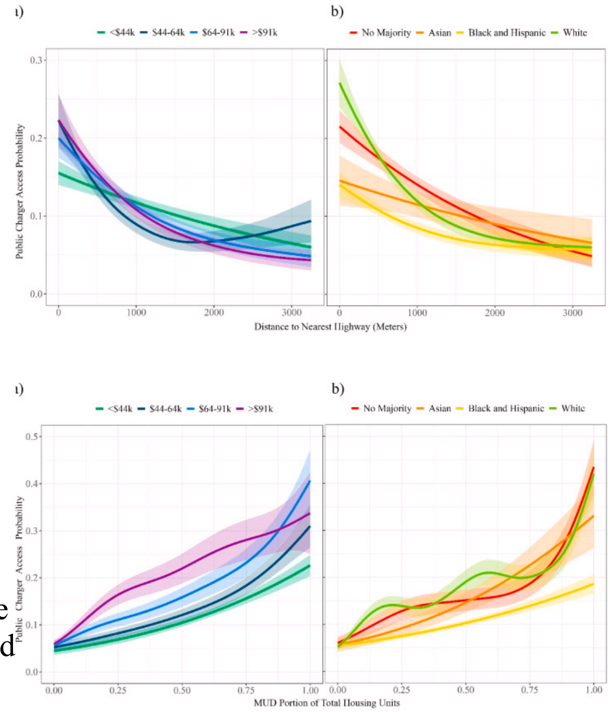
The top two figures demonstrate the effect of distance from the nearest highway on public charger access. Generally, proximity to highways or freeways is positively correlated with the presence of at least one public charging station, likely because these are where charging infrastructure needs to be utilized. Yet, communities with the lowest median household income in the study (less than $44,000 a year) do not exhibit nearly as much of a public charger access "boost" from highway proximity as do communities in higher-income groups.

Additionally, the bottom set of figures show that public charger access probability increases as the percentage of multi-unit dwellings increases. However, increases are experienced at a lower rate for communities with the lowest median household incomes. As observed in the first pair of figures, Black and Hispanic residents experience a lesser probability of public charger access regardless of highway proximity or MUD housing proportions.



Public Charger Access Probability by Income and Ethnicity: Graphs showing the probability of access to public EV chargers based on income levels and ethnicity, relative to the distance from highways and MUD housing proportions.

The same study also established that Black and Hispanic majority communities have significantly lower odds of public charger access relative to non-majority, white-majority, and Asian-majority communities. White majority communities are found to have the highest access to public chargers, with 1.5-times increased probabilities relative to Black and Hispanic majority communities when incomes, highway distances, and MUD housing units rates are kept constant. This confirms the conclusions earlier that find a disparity in EV ownership, with white and Asian communities having higher rates than Black and Hispanic communities in California.

There are programs meant to address inequities in EV ownership and usage. For instance, the California Air Resources Board (CARB) has held a clean vehicle rebate project, offering partial refunds to low-income consumers of electric vehicles starting from 2016.[32] As of June 1, 2024, cumulative outcomes from this project included over $1.49 billion invested in over 594,000 vehicles, totaling more than 456 million gallons of fuel use avoided and more than 3.9 million metric tons of carbon dioxide equivalent greenhouse gases reduced. Most importantly, 42% of funding has benefited priority populations, which include residents of census tracts identified as disadvantaged by Senate Bill 535 and those of census tracts or households identified as low-income per Assembly Bill 1550. The rebate appears to be mostly effective in increasing ownership, as a survey from CARB asking how important the rebate was in making it possible to acquire a plug-in electric vehicle shows that over 75% of participants in SB 535 disadvantaged census tracts reported that it was important.[33]

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[32] *Outcomes and Results for Clean Vehicle Rebate Project*, California Air Resources Board, ww2.arb.ca.gov/our-work/programs/clean-vehicle-rebate-project-cvrp/outcomes-and-results-clean-vehicle-rebate. Accessed 13 June 2024.

[33] "Rebate Survey Dashboard." *Clean Vehicle Rebate Project*, California Air Resources Board, cleanvehiclerebate.org/en/rebate-survey-dashboard. Accessed 13 June 2024.

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Use of Transit by Demographic Groups

Metro's 2022 Customer Experience Survey was conducted between March and May 2022. A total of 12,239 surveys were completed on board Metro buses, trains, and Metro Micro vehicles, achieving a 63 percent response rate. Latinx/Hispanic individuals are the largest ethnic group among the riders, representing 58 percent (compared to 59% in 2019); Black/African American riders make up 14 percent (down from 16% in 2019), followed by White/Caucasian riders at 12 percent (up from 11% in 2019). Notably, 49 percent of bus riders and 44 percent of rail riders identify as female, which is a decrease from 53 percent and 46 percent, respectively, in Metro's 2019 survey. Approximately 83 percent of riders reported a household income of under $50,000 a year, compared to 81 percent in 2019. Additionally, the Neighborhood Data for Social Change (NDSC) platform, a project of the USC Lusk Center for Real Estate, reports that the top five neighborhoods with the highest number of transit riders have an average median household income of $31,490, significantly lower than the median LA County household income of $56,196. This highlights the demographic makeup of transit riders in Los Angeles, with a majority belonging to non-white and low-income groups. Despite higher transit usage among non-white individuals compared to their white counterparts, a substantial portion of all demographics still predominantly rely on cars for transportation.

Takeaways

1. **First and Last Mile Connectivity**:
   - Enhancing connectivity to and from ***bus and rail services*** is crucial, emphasizing safe and accessible pathways for walking, biking, and other ***micro-mobility*** options. This ensures that transit systems are effectively utilized by more segments of the population.
2. **Challenges in Fare Affordability and Operating Costs**:
   - ***Public transit systems***, although necessary for much of the population, operate at a financial loss and rely heavily on subsidies. Services like buses may cater to a broader user base, highlighting the need for continued financial support to maintain and improve these services.
3. **Equity Concerns in EV Infrastructure**:
   - The distribution of ***EV chargers*** and the ***ownership of EVs*** are heavily skewed toward wealthier White and Asian neighborhoods, raising concerns about racial and income disparities in access to emerging green technologies. This inequity poses a challenge to the universal adoption of EVs.

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Recommendations

1. **Invest in Comprehensive First and Last Mile Solutions**:
   - Fund ***infrastructure improvements*** that enhance safety and accessibility around transit hubs, including better lighting, safer crosswalks, protected bike lanes, and expanded micro-mobility options such as e-scooters and bike-share programs.
2. **Subsidize and Strategically Expand EV Charging Stations**:
   - Invest in ***EV charging infrastructure*** in underserved and lower-income areas to promote broader access, which may include initiatives like rebates and incentives that encourage EV adoption across all demographic groups.
3. **Ensure Fare Equity and Accessibility**:
   - Develop and implement ***fare policies*** for diverse populations, such as a sliding scale for fares based on income, offering discounts for seniors, students, and disabled individuals, and increasing the transparency of fare structures.

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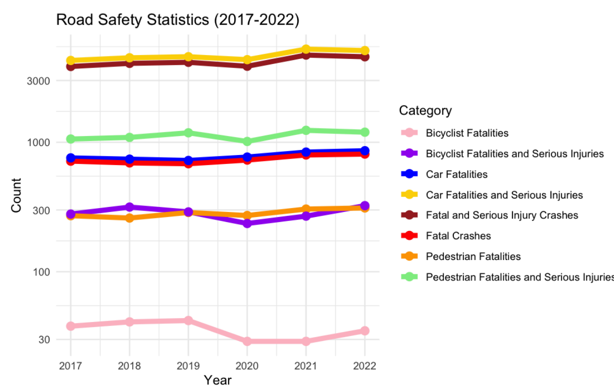
Health

Transportation infrastructure impacts public health and safety, shaping the daily lives of LA County residents. We examined the consequences of transportation in LA, focusing on traffic-related injuries and fatalities, the distribution and health impacts of traffic-related emissions, and the strategies outlined in the LA County Department of Public Health's Mobility Plan 2035 to mitigate these effects. By exploring data on traffic injuries, emissions, and public health projections, we gained insights into the critical areas in need of improvement to ensure a safer and healthier environment for all Angelnos.

Traffic-Related Injuries and Fatalities

Data from the Transportation Injury Mapping System[34] shows a concerning increase in major injuries and fatalities among bikers in LA County, which is likely related to the expansion of unprotected bike lanes. Despite the increased popularity of cycling in urban settings, this pattern shows that cyclists are at greater risk in the absence of adequate protective infrastructure. In light of these trends, it is imperative that future investments be made in safer bike lanes. Such initiatives would be consistent with the High Desert Multi-Purpose Corridor's goals, which prioritize effective traffic management and a balanced approach to road safety.[35] The High Desert Multi-Purpose Corridor was a proposed California infrastructure project intended to connect regions in the high desert areas.



Road Safety Statistics (2017-2022): Trends in road safety, detailing fatalities and serious injuries for various categories.

Of note is the observation that all categories except for car fatalities and fatal crashes experienced slight decreases in 2020. Perhaps this is due to the lasting impacts of the pandemic, whereby car travel was encouraged over walking and bicycle travel due to stay-at-home orders. There have been relatively steady increases in all categories since 2020.

In any case, it is important to note that incidents involving cars were the highest from 2017 to 2022, with over 3000 counts per category, above pedestrian fatalities and serious injuries. Categories involving cyclists were the lowest. It can be inferred that this is based on the prevalence of each class of individual (drivers being the most common, then pedestrians, and then cyclists), although there are no statistics to date that track all three.

[34] "TIMS - Transportation Injury Mapping System." *Tims.berkeley.edu*, tims.berkeley.edu/.
[35] Morrison, Jacob. "Home - High Desert Corridor JPA." *High Desert Corridor JPA* -, 10 May 2024, highdesertcorridor.org.

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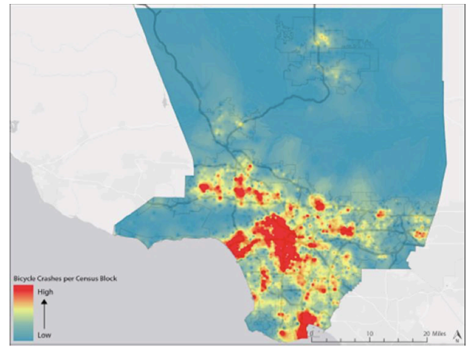
Reflecting on cyclists in LA County, an often overlooked group in transportation studies, the heat map illustrates the frequency of injury-causing bicycle accidents in LA County between 2003 and 2014 from the 2018 LA County Transportation Briefing.[36] The red-colored locations indicate hotspots where riding is riskiest. These hotspots tend to be in the most dense, urbanized areas of the county. The information from this older time frame (2003-2014) could be helpful in shaping the planning of the current infrastructure, emphasizing the need for focused increases in biker road safety, particularly in light of the recent rise in unprotected bike lanes as reported in the Metro data. It highlights the potential advantages and efficiency of projects which aim to include bike-only areas that are safer, lowering the number of accidents and injuries observed in these hotspots.



Heat Map of Cyclist-Involved Crashes in L.A. County: Visualization of areas with high incidents of cyclist-involved crashes resulting in injuries.

There are equity concerns when discussing traffic-related injuries. A report, published in September 2021 from Pacific Southwest Region UTC in collaboration with UCLA Lewis Center for Regional Policy Studies, demonstrates data from 2013-2017 gathered from the Transportation Injury Mapping System and American Community Survey.[37] In this report, it was found that intersectional factors, such as age, gender, and racial and ethnic identity, led to differential impacts of traffic-related injury on communities.

These tables derived from the report show the number of traffic collision victims in LA County by year per grouping and the number and percentage of traffic collisions by mode (walking, biking, car, motorcycle, and other). The groups indicated from top to bottom are:

- Women of color
- Youth of color
- Residents of priority population areas, representing the top 25% disadvantaged communities in the county
- The overall population in LA County

	Fatality		Injury		No Injury		Total	
Walk	241	59.1%	5,862	7.5%	0	0.0%	6,103	7.8%
Bike	3	0.7%	1462	1.9%	0	0.0%	1,465	1.9%
Car	156	38.2%	69,680	89.6%	224	98.7%	70,060	89.3%
Motorcycle	6	1.5%	528	0.7%	1	0.4%	535	0.7%
Other	2	0.5%	273	0.4%	2	0.9%	277	0.4%
	408		**77,805**		**227**		**78,440**	**100.%**

Table 6: Number and percentage of traffic collision victims by mode, women of color

	Fatality		Injury		No Injury		Total	
Walk	50	51.5%	4,276	36.6%	0	0.0%	4,326	36.4%
Bike	9	9.3%	2,995	25.7%	0	0.0%	3,004	25.3%
Car	27	27.8%	4,060	34.8%	121	100.0%	4,208	35.4%
Motorcycle	10	10.3%	311	2.7%	0	0.0%	321	2.7%
Other	1	1.0%	28	0.2%	0	0.0%	29	0.2%
	97		**11,670**		**121**		**11,888**	**100.0%**

Table 11: Number and percentage of traffic collision victims by mode, youth of color

	Fatality		Injury		No Injury		Total	
Walk	654	42.1%	14,153	7.8%	3	0.0%	14,810	6.2%
Bike	98	6.3%	10,253	5.7%	90	0.2%	10,441	4.4%
Car	570	36.7%	145,636	80.5%	51,651	94.0%	197,857	83.4%
Motorcycle	223	14.3%	8,117	4.5%	160	0.3%	8,500	3.6%
Other	10	0.6%	2,734	1.5%	3,016	5.5%	5,760	2.4%
	1,555		**180,893**		**54,920**		**237,368**	

Table 30: Number of traffic collision victims by mode, people living in priority population

	Fatality		Injury		No Injury		Total	
Walk	1,211	34.6%	26,828	6.8%	4	0.0%	28,043	5.5%
Bike	172	4.9%	20,473	5.2%	159	0.1%	20,804	4.1%
Car	1,480	42.2%	324,244	81.8%	107,808	94.9%	433,532	84.4%
Motorcycle	625	17.8%	19,706	5.0%	351	0.3%	20,682	4.0%
Other	17	0.5%	5224	1.3%	5,305	4.7%	10,546	2.1%
	3,505		**396,475**		**113,627**		**513,607**	

Table 36: Traffic collision victims by mode, LA County

[36] Our County. "Our County." *lacounty.gov/sustainabilityplan*, July 2018, ourcountyla.lacounty.gov/wp-content/uploads/2018/08/Our-County-Transportation-Briefing_For-Web.pdf.
[37] Brozen, Madeline, et al. *Intersectional Transportation Trends in Los Angeles County*, UCLA Lewis Center for Regional Policy Studies and Pacific Southwest Region UTC, Sept. 2021, www.metrans.org/assets/research/psr-19-60_brozen_final-report_jw.pdf.

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	Fatality	Valid %	Total %	Injury	Valid %	Total %	No Injury	Valid %	Total %
Asian	157	5.8%	4.4%	18,513	7.4%	4.5%	88	9.1%	0.1%
Black	356	13.1%	10.1%	33,306	13.3%	8.1%	95	9.9%	0.1%
Hispanic	1,243	45.9%	35.1%	111,429	44.4%	27.1%	412	42.8%	0.3%
Other	160	5.9%	4.5%	22,041	8.8%	5.4%	94	9.8%	0.1%
White	794	29.3%	22.4%	65,895	26.2%	16.0%	274	28.5%	0.2%
No race	830		23.4%	160,638	64.0%	39.0%	117,781		99.2%
Total (valid)	2,710			251,184			963		
Total (all)	**3,540**			**411,822**			**118,744**		

Table 37: Traffic collision victims by race/ethnicity, Los Angeles County

These four tables show that the top three groups, compared to the population overall in LA County, are disproportionately affected by walking (pedestrian) fatalities and injuries. More so, youth of color have higher rates of biking injuries and fatalities than the rest of the county. Lastly, the three aforementioned groups have lower rates of car fatalities and injuries than the rest of the county, especially youth of color.

These results are notable, given the report's finding that women of color tend to use cars more than other groups, and Black people use public transit more and walk less than people on average in LA County. Also, the report declares that the priority population areas involve 50% of all reported traffic collision incidents in LA County, despite representing only 11% of the county land area. More so, people in priority population areas have been found to take trips that are 1.2 miles shorter on average than those outside of these communities.

Race and ethnicity data figured prominently in the report. It was found that Black individuals were more highly represented in injuries and fatalities than their population in LA County, considering they make up only 8% of the population but 13% of deaths and injuries due to traffic collisions in the county.

Policy efforts are underway to attempt to reduce traffic-related fatalities and injuries. For example, healthy Streets LA is part of the proposed new Los Angeles Department of Public Health Mobility Plan 2035,[38] and it has proposed the addition of pedestrian safety measures such as wider sidewalks, protected bike/bus lanes, road elements to prevent speeding/increase traffic safety. It remains to be seen if this will decrease injuries and fatalities among those involved in traffic collisions.

Traffic-Related Emission Health Effects

Traffic emissions, a primary contributor of certain air pollutants, significantly contribute to respiratory and cardiovascular diseases[39]. These pollutants include the following: 1) fine particulate matter;[39] 2) nitrogen oxides from fuel combustion[39]; 3) carbon monoxide from incomplete combustion[40]; and 4) ozone when byproducts of internal combustion engine exhaust undergo reactions in the presence of sunlight.[40] All of these have been linked to respiratory health impact, such as nasal irritation at low levels, and some have been associated with heart-related conditions.[40] Accordingly, a body of studies have associated proximity to heavily-traveled roads with adverse health outcomes including asthma attacks, decreases in lung function, heart attacks, and low birth weight[41]. More specific to Los Angeles, a study in 2000 concluded that atmospheric stagnation with high levels of carbon monoxide, nitrogen oxides, and particulate matter, which could result from traffic, increased the risk of cardiovascular-related

[38] *Los Angeles Department of City Planning Mobility Plan 2035 an Element of the General Plan*.
[39] "Health and Environmental Effects of Particulate Matter (PM) | US EPA." *US EPA*, 23 Aug. 2023, www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.
[40] *Air Quality and Health Effects*, City of Los Angeles, Oct. 2019, planning.lacity.gov/odocument/e1a00fbf-6134-4fa9-b6fd-54eee631effb/City_of_LA_-_Air_Quality_and_Health_Effects_and_Attachments.pdf.
[41] *Health Studies of Traffic Exposure*, California Office of Environmental Health Hazard Assessment, oehha.ca.gov/air/residential-traffic-studies. Accessed 26 May 2024.

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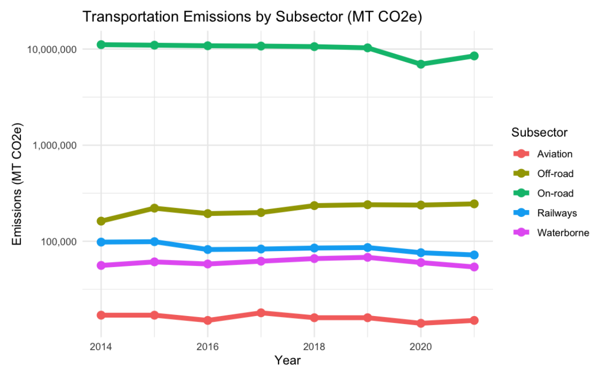
hospitalizations.[42] In analyzing the impact of traffic-related emissions on community health, it is also crucial to consider the broader environmental and socioeconomic context. For example, a study confirmed that asthma emergency department visits occur disproportionately in communities with low public parks and open space, which tend to be low-income communities of color.[43] By integrating data from multiple climate and public health publications, which assess the cumulative impact of pollutants and vulnerabilities across California communities, we can discern how traffic pollution interacts with other environmental stressors and socioeconomic factors to exacerbate health disparities. This approach, as highlighted by the CalEnviroScreen framework,[44] is crucial for identifying at-risk communities and developing targeted interventions to mitigate the compounded effects of pollution and vulnerability.

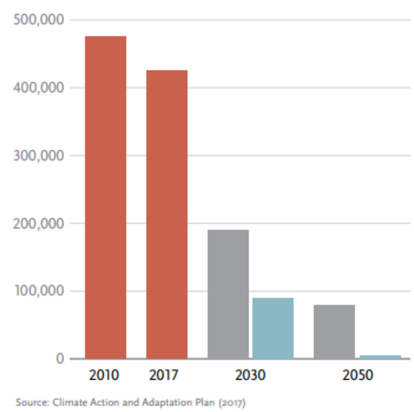
So far, emissions of carbon dioxide measured in metric tons from stationary energy, transportation, and waste seem to be decreasing in LA, confirming what is reported by LA Metro.[45] The transportation sector had a historical reduction by 15% from 1990 to 2021, though this does not account for the fact that transportation emissions in 2019 were approximately the same as 1990 levels. During 2020 and 2021, as compared to 2014-2019, there was a sudden drop in total transportation emissions, notably from on-road transportation, perhaps due to the pandemic.



Transportation Emissions by Subsector (2014-2020): Trends in CO2 emissions from different transportation subsectors.

Indeed, even between 2020 to 2021 there was a 15% increase in carbon dioxide emissions, implying an increase from the initial year of the pandemic. It remains to be seen what data up until 2024 looks like.

LA Metro also follows this decreasing emissions narrative, predicting that emissions from Metro operations will reduce greatly in the near future, going on to about half of 2017 levels in 2030 and a quarter of 2017 levels in 2050 if business continues as usual. [46] LA Metro programs involve greater reductions than this "business as usual" category, including four targets by 2030: displacing 903,000 metric tons of carbon dioxide emissions annually, reducing total greenhouse gas emissions by 79% from 2017 baseline, reducing total nitrogen oxides emissions 54% from 2018 baseline, and



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[42] Linn, William S., et al. "Air pollution and Daily Hospital admissions in metropolitan Los Angeles." *Environmental Health Perspectives*, vol. 108, no. 5, May 2000, p. 427, https://doi.org/10.2307/3454383.
[43] Douglas, Jason A., et al. "Ecological determinants of respiratory health: Examining associations between asthma emergency department visits, Diesel Particulate Matter, and Public Parks and open space in Los Angeles, California." *Preventive Medicine Reports*, vol. 14, June 2019, p. 100855, https://doi.org/10.1016/j.pmedr.2019.100855.
[44] "CalEnviroScreen." *Ca.gov*, 2020, oehha.ca.gov/calenviroscreen.
[45] City of Los Angeles – 2021 Community Greenhouse Gas Inventory, Department of Public Works LA Sanitation & Environment Regulatory Affairs Division, Mar. 2023, www.lacitysan.org/cs/groups/public/documents/document/y250/mdg4/~edisp/cnt088358.pdf.
[46] "2020 Long Range Transportation Plan (LRTP) Final Document : Los Angeles County Metropolitan Transportation Authority : Free Download, Borrow, and Streaming : Internet Archive." *Internet Archive*, 2020, archive.org/details/2020-long-range-transportation-plan-lrtp-final-document.

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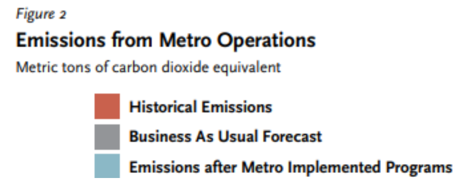
reducing total particulate matter emissions 62% from 2018 baseline.[47] Under the “emissions after Metro implemented Programs” scenario, in 2030 the emissions are predicted to be less than a quarter of 2017 baseline levels, and emissions are predicted to be minimal by 2050.



Emissions from Metro Operations (2010-2050): Forecast and impact of emission reduction measures on Metro operations.

In 2022, data from LA Metro showed that only 2 of the targets were being met. Namely, nitrogen oxide emissions were at 12.5% of the 2017 baseline at 46,812 pounds of nitrogen oxide emitted, and particulate matter emissions were at 29% of the 2017 baseline at 1,574 pounds of particulate matter emitted.

Greenhouse gas emissions for LA County during 2022 were estimated to be at 150,000 metric tons, well above the target goal of 87,000 metric tons of annual emissions by 2030, although they have been generally decreasing since 2017. Displaced greenhouse gas emissions have decreased since 2019, deviating from the goal of 903,000 displaced metric tons. In 2019, the goal was met at 918,076 metric tons, though it has since plummeted to 468,135 metric tons displaced in 2022. Interestingly, both measures that are not meeting their targets have increased since 2021 but have not returned to 2020 levels, indicating some level of progress despite a return from the pandemic.

Yet, this hopeful progress in reducing emissions, which was previously linked with negative health outcomes, ignores equity concerns. For example, the figure on the next page from the Union of Concerned Scientists (UCS) demonstrates that average annual concentration of particulate matter from on-road vehicles is greatest toward the center of Los Angeles, which includes populations in downtown and South LA.[48] Along the coastline, these particulate matter measurements are generally lower, incorporating wealthier and typically less marginalized communities. In general, LA County has a less stratified emissions profile compared to the area around San Francisco, where emissions are focused in population centers such as San Jose, the tip of the San Francisco peninsula, and Sacramento.

[47] Emissions and Pollution Control, LA Metro, sustainabilityreporting.metro.net/emissions-and-pollution-control#:~:text=In%202022%2C%20Metro’s%20market%20based,5.7%25%20rise%20from%202021%20levels. Accessed 7 May 2024.
[48] Inequitable Exposure to Air Pollution from Vehicles In California, Union of Concerned Scientists, Feb. 2019, www.ucsusa.org/sites/default/files/attach/2019/02/cv-air-pollution-CA-web.pdf.

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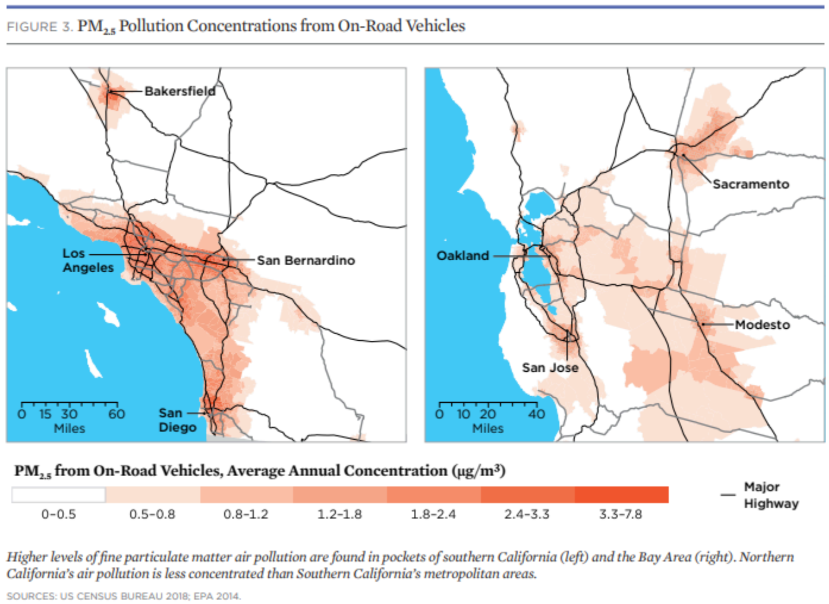
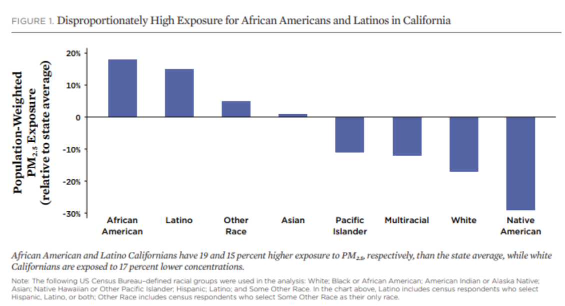


PM2.5 Pollution Concentrations from On-Road Vehicles: Maps showing the concentration of PM2.5 pollution from vehicles in major Californian cities.

The observed distribution of particulate matter, with higher concentrations in central Los Angeles and lower levels along wealthier coastal areas, may be influenced by historical factors such as wealth inequality, redlining, and segregation.[49] These practices have resulted in marginalized communities being located near sources of pollution and with fewer resources to mitigate environmental impacts, contributing to the uneven distribution of air quality across the city.

Additionally, the UCS released findings using 2018 United States Census data and 2014 EPA pollution measurements showing that emissions impacts from particulate matter are not equitable along ethnic/racial lines for California.[50] African-American and Latino communities are most exposed to particulate matter pollution by a factor of over 10% compared to the average baseline across ethnic/racial groups.



Disproportionate PM2.5 Exposure for African Americans and Latinos in California: Higher PM2.5 exposure rates among African Americans and Latinos compared to other groups.

[49] *Neighborhood Redlining, Racial Segregation, and Homeownership | St. Louis Fed*. 1 Sept. 2021, research.stlouisfed.org/publications/page1-econ/2021/09/01/neighborhood-redlining-racial-segregation-and-homeownership.
[50] Inequitable Exposure to Air Pollution from Vehicles In California, Union of Concerned Scientists, Feb. 2019, www.ucsusa.org/sites/default/files/attach/2019/02/cv-air-pollution-CA-web.pdf.

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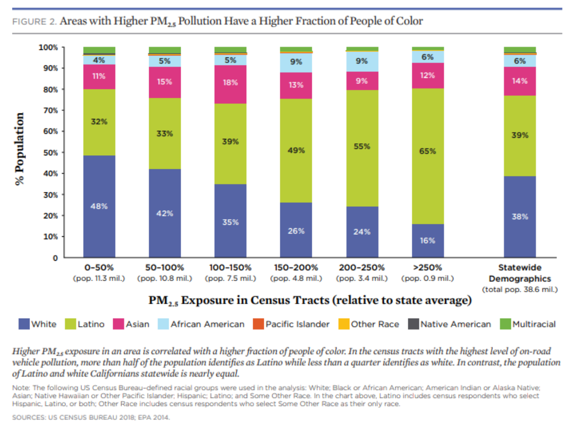
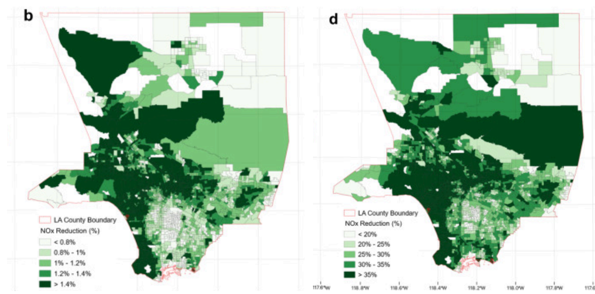
Lastly, as shown in the second figure to the left from the UCS, areas with higher particulate matter pollution tended to include progressively higher populations of people of color, namely Latinx populations. A clear correlation can be observed between ethnic and racial identification and increased exposure to PM 2.5. Areas with larger populations of Latino residents tend to have higher levels of PM 2.5 exposure. As observed in the figure, despite the overall population of Latinos and Whites in California being nearly equal, Latinos face disproportionate levels of exposure to particulate matter.



PM2.5 Exposure and Population Composition by Race: Correlation between PM2.5 exposure relative to state average and ethnic and racial composition of populations in census tracts across California.

EVs have been established as a way to reduce emissions. In the near future, it is probable that there will be more electric vehicle usage, with zero-emissions vehicles being the only options for new cars in California starting in 2035. As such, reductions in nitric oxide transportation emissions by using electric vehicles in 2035 are predicted to increase from 2020 reductions, though a study by researchers from UCLA shows benefits will be distributed inequitably.[51]



NOx Reduction Across L.A. County: NOx reduction percentages across LA County under different conditions.

The study's figures show that communities to the north and west of the city of Los Angeles, and in non-central points of the county, such as the western coastline, eastern suburbs, and northern deserts demonstrate the greatest reductions in emissions. Looking from graph B (2020 projected reductions) to graph D (2035 projected reductions), darker green areas mark greater magnitudes of reduction. It can be seen that parts of South LA still remain light green or white, indicating far fewer reductions than coastal and inland areas that become dark green in graph.

As such, there is concern over stagnant reductions in nitric oxide emissions as electric vehicle (EV) usage increases, especially in areas like South Los Angeles with high concentrations of low-income communities of color. Despite these concerns, findings from research show significant improvements in near-roadway air quality from nitric oxide reductions since 2020, with further benefits expected by 2035. This highlights the potential of EVs to enhance air quality for diverse communities.

Even though EVs have been represented as an effective way of reducing emissions, they may contribute to other modes of non-exhaust emissions. Namely, the increased weight of electric vehicles, due to the inclusion of batteries that weigh 1000 pounds on average[52], has been shown to contribute to increased particulate emissions from tire and brake wear.[53] Most notably, it has

[51] Yu, Qiao, et al. "California's zero-emission vehicle adoption brings air quality benefits yet equity gaps persist." Nature Communications, vol. 14, no. 1, 12 Dec. 2023, https://doi.org/10.1038/s41467-023-43309-9.
[52] *Heaviest Electric Vehicles of 2024*, Kelly Blue Book, www.kbb.com/car-advice/heaviest-electric-vehicles/. Accessed 13 June 2024.
[53] User, Guest. "Tyres Not Tailpipe." *Emissions Analytics*, Emissions Analytics, 12 May 2023, www.emissionsanalytics.com/news/2020/1/28/tyres-not-tailpipe.

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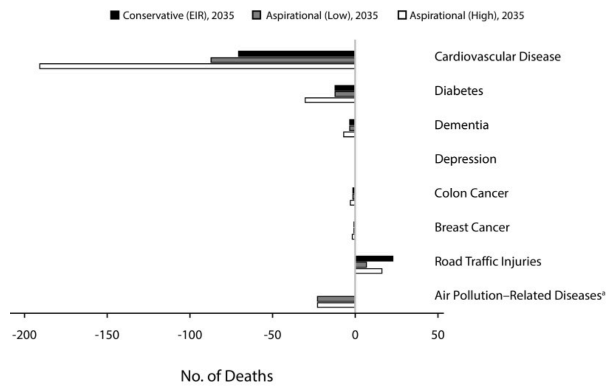
been found that tire and brake wear can result in 1000 times more cumulative emissions versus regulated levels of exhaust emissions.[53] A study has found that tire- and brake-related emissions are associated with autism spectrum disorder diagnosis, especially among Black and Hispanic children and in neighborhoods with low socioeconomic status (SES).[54] Additionally, research has estimated increased risks for adverse birth outcomes, including preterm birth and low birth weight, caused by exposure to particulate matter emitted by tire- and brake-related wear, with stronger impacts among Hispanic, Black, and Indigenous women.[55] Hopefully, regulations are implemented and low-wear tires are required so that EVs do not contribute to further environmental degradation and adverse health outcomes from particulate matter emissions.

In general, policymakers should prioritize equity in zero-emission vehicle policies by addressing historical injustices in investment practices, transportation policies, and urban planning. These practices disproportionately expose residents of disadvantaged communities to traffic-related air pollutants. It is crucial to integrate capacity building and procedural equity into these efforts.[51]

Looking ahead to the future, the "2019 Routine Assessment of Health Impacts of Local Transportation Plans: A Case Study From the City of Los Angeles" projects the predicted health outcomes from on-road traffic by 2035. This health impact assessment utilizes the City of Los Angeles Mobility Plan 2035 as a case study to quantify the health impacts of local transportation plans in California.Traffic injuries are predicted to decrease, while air pollution-related diseases and cardiovascular disease are expected to face major increases. It is crucial to analyze how these health outcomes will be affected by changes in public transit ridership, fluctuations in driving patterns, and the expansion of infrastructure, such as the addition of bike lanes.[56]



Impact of Transportation Scenarios on Health Outcomes by 2035: Potential reduction in deaths from various diseases under different transportation scenarios. There is a conservative scenario whereby business continues as usual from the 2019 baseline, and two aspirational scenarios whereby on-road

Overall, the report recommends increasing active transportation by prioritizing the expansion of active transport networks and enhancing connectivity with public transit, particularly through first- and last-mile connections, given the significant associated health benefits. Recognizing the heightened risk of traffic injuries, efforts to promote active transport should be accompanied by improvements in roadway safety measures that effectively reduce traffic collisions. While the Mobility Plan alone yields modest reductions in air pollution-related illnesses, the report suggests that the city should explore broader regional rail expansion initiatives to achieve more substantial impacts on air pollution-related health outcomes. Together, these strategies aim to create a comprehensive approach to improving public health.

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[54] O'Sharkey, Karl, et al. "Associations between brake and tire wear-related PM2.5 metal components, particulate oxidative stress potential, and autism spectrum disorder in Southern California." *Environment International*, vol. 185, Mar. 2024, p. 108573, https://doi.org/10.1016/j.envint.2024.108573.
[55] Meng, Qi, et al. "Fine particulate matter metal composition, oxidative potential, and adverse birth outcomes in Los Angeles." *Environmental Health Perspectives*, vol. 131, no. 10, Oct. 2023, https://doi.org/10.1289/ehp12196.
[56] National Center for Biotechnology Information. (2019). Traffic-related air pollution: Exposure and health effects. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6366482/

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Takeaways

1. **Increase in Traffic-Related Injuries Among Cyclists**:
    - There has been a rise in ***injuries*** and fatalities among bikers, especially in areas with unprotected bike lanes. Thus, there is an urgent need for ***enhanced safety measures***, such as the development of segregated bike lanes, to protect cyclists in urban settings.
2. **Disproportionate Impact of Traffic-Related Emissions on Minority Communities**:
    - ***Traffic emissions*** disproportionately affect African American and Latino communities, and these communities suffer from higher exposure to ***pollutants***, which contributes to a range of adverse health outcomes.
3. **Predicted Health Impacts from Traffic by 2035**:
    - Projections suggest that while traffic injuries might decrease, diseases related to air pollution, including respiratory and cardiovascular diseases, are expected to rise significantly by 2035, emphasizing the need for aggressive ***pollution control*** and ***traffic management strategies***. This is despite a reported decrease in transportations emissions, most likely from the temporary effects of the pandemic.

Recommendations

1. **Expand and Enhance Bike Infrastructure**:
    - Expand ***protected bike lanes*** and other safety features in high-risk areas to reduce the frequency and severity of cycling accidents.
2. **Target Emission Reductions in Vulnerable Communities**:
    - Implement ***targeted emission reduction programs*** in communities most affected by traffic-related pollution, such as increasing green spaces, enhancing public transit options, and encouraging the use of electric vehicles in these areas.
3. **Incorporate Health Impact Assessments in Transportation Planning**:
    - Conduct more regular ***health impact assessments*** to guide the development of transportation infrastructure to minimize negative health impacts, particularly in disadvantaged communities.

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Conclusion

The Sustainable LA Grand Challenge Undergraduate Research Scholars Program's report on LA County's transportation system emphasizes the progress and challenges in achieving sustainability, equity, and improved public health. The study highlights shifts in commuting patterns, with reduced vehicle miles traveled during the pandemic and increased adoption of electric vehicles (EVs) supported by policies promoting zero-emission vehicles. However, it also reveals disparities in EV infrastructure and ownership, concentrated in wealthier neighborhoods, and the disproportionate impact of traffic-related emissions on marginalized communities. To address these issues, we recommend expanding EV charging infrastructure, enhancing first and last-mile connectivity, and implementing targeted emission reduction programs in vulnerable areas. For future work, focus on understanding barriers to EV adoption in underserved communities, conduct longitudinal health impact studies to monitor changes in public health due to transportation infrastructure, and develop inclusive policies that improve socioeconomic conditions while promoting existing green transportation. The impact of this research serves as a blueprint for policymakers, urban planners, and community stakeholders to collaboratively develop strategies that ensure a sustainable, equitable, and healthy transportation ecosystem in LA County.

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