DOCKETED	
Docket Number:	20-TRAN-02
Project Title:	SB 1000 Electric Vehicle Charging Infrastructure Deployment Assessment
TN #:	244067-1
Document Title:	2022 Senate Bill 1000 CA Electric Vehicle Infrastructure Deployment Assessment Drive Times to Direct Current Fast Chargers
Description:	N/A
Filer:	Spencer Kelley
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	7/14/2022 9:57:48 AM
Docketed Date:	7/14/2022

CALIFORNIA ENERGY COMMISSION

California Energy Commission

STAFF REPORT

2022 Senate Bill 1000 California Electric Vehicle Infrastructure Deployment Assessment

Drive Times to Direct-Current Fast Chargers

July 2022 | CEC-600-2022-059

California Energy Commission

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ACKNOWLEDGEMENTS

The following California Energy Commission staff members contributed to the development of this report: Jennifer Allen, Matt Alexander, Gabriel Blossom, Jonathan Bobadilla, Kyle Corrigan, Noel Crisostomo, Travis David, Thanh Lopez, Shaun Ransom, and Larry Rillera. The author values coordination on equity and charging infrastructure and appreciates input from Ashley Georgiou and Andrew Martinez (California Air Resources Board); Angela Islas, Roger Lin, Román Partida-López, and Adrian Martinez (Disadvantaged Communities Advisory Group); Dong-Yeon Lee and Eric Wood (National Renewable Energy Laboratory).

The author thanks various stakeholders for the comments and feedback provided on the analysis including stakeholders from Alliance for Automotive Innovation, Amply Power, Butte County Association of Governments, ChargePoint, City of Sacramento, Clean Power Alliance, Colusa County Transportation Commission, Del Norte Local Transportation Commission, East Bay Community Energy, EVgo, Flo, Glenn County Transportation Commission, Grid Alternatives, Humboldt County Association of Governments, Lake County Planning Commission, Lassen County Transportation Commission, Los Angeles Cleantech Incubator, Plug In America, Plumas County Transportation Commission, Mendocino Council of Governments, Modoc County Transportation Commission, Nevada County Transportation Commission, Natural Resources Defense Council, PG&E, Shasta Regional Transportation Agency, Siemens, Sierra Club, Sierra County Transportation Commission, Siskiyou County Local Transportation Commission, Tehama County Transportation Commission, The Greenlining Institute, Trinity County Transportation Commission, Union of Concerned Scientists, and Veloce Energy.

ABSTRACT

In order for California to meet its climate action and clean transportation goals, it needs to support the transition to zero emission vehicles (ZEVs) and provide adequate ZEV refueling infrastructure, including hydrogen stations for fuel cell electric vehicles and chargers for battery electric vehicles. The inclusion and participation of underserved communities in the state's zero emission transportation future is crucial to the achievement of California's climate action and clean transportation goals and the prevention of disparities in charging access. SB 1000 (Lara, Statutes of 2018, Chapter 368) requires that the California Energy Commission (CEC) consult with the State Air Resources Board to assess whether charging station infrastructure, including direct-current fast charging infrastructure, is disproportionately deployed, to inform the CEC's infrastructure investments. The CEC is required to evaluate charger deployment by population density, geographical area, and population income level, including low-, middle-, and high-income levels. In 2020, CEC staff analyzed public charger density and distribution by population density, geographical area, and income level.

This analysis evaluates drive times to public direct-current fast charging stations and identifies communities with sparse fast charging coverage, which this study defines as communities with average drive times of 10 minutes or more to a public station. The study finds that rural communities have less public fast charging station coverage than urban communities. Low-income rural communities have the least coverage among communities grouped by income and urban or rural area. Public fast charging station coverage among disadvantaged urban communities varies and gaps exist. CEC staff developed drive time maps and spreadsheets that identify communities with sparse public fast charging station coverage. These are available for download on the SB 1000 webpage.

Keywords: Fast charging infrastructure, charger coverage, drive time, transportation electrification, electric vehicle, transportation equity, rural community, low-income community, disadvantaged community

Please use the following citation for this report:

Hoang, Tiffany. 2022. *2022 Senate Bill 1000 California Electric Vehicle Infrastructure Deployment Assessment*. California Energy Commission. Publication Number: CEC-600-2022-059.

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EXECUTIVE SUMMARY

California's climate action and clean transportation goals necessitate the transition to zero emission vehicles and rapid but strategic deployment of charging infrastructure in communities, including rural, low-income, and disadvantaged communities. Electric vehicles (EVs) provide numerous benefits including pollution reduction in communities and lower refueling and vehicle maintenance costs for drivers. But historically EV adoption has been more common in affluent urban households and charger deployment has followed these EV drivers. Public charging gaps in rural, low-income, and disadvantaged communities could amplify disparities in EV adoption and the associated benefits. Access to public charging is critical to give current and future drivers, especially those unable to charge at home, confidence that EVs are a practical choice for meeting their mobility needs.

Senate Bill (SB) 1000 (Lara, Statutes of 2018, Chapter 368) requires the California Energy Commission (CEC) to assess whether EV charging station infrastructure, including direct-current fast chargers, is disproportionately deployed by population density, geographical area, or population income level. This analysis informs the CEC's Clean Transportation Program (CTP) investments in light-duty charging infrastructure.

The CEC issued the first SB 1000 report in 2020, and found that low-income communities, on average, have fewer public chargers per capita than middle- or high-income communities. The report also found that public chargers are unevenly distributed across state air districts and counties but collocated with county populations and plug-in electric vehicles. Informed by input from stakeholders, this report builds upon the 2020 SB 1000 assessment and identifies rural, low-income, and disadvantaged communities in California with sparse public fast charging station coverage.

Drive times to public fast charging stations are a measure of infrastructure coverage and access

Drive time is one way to measure access to public direct-current fast charging stations among communities and is complementary to the density metrics explored in the 2020 SB 1000 report. Drive time analysis allows for the identification of fast charging network gaps that discourage EV travel within California communities and travel to and from those communities. While the 2020 report identified chargers per capita averaged among communities characterized by population density and income level, this report explores access in more geographic detail. Staff used mapping software to identify the quickest drive time routes during peak traffic from census tract population centers to the nearest public direct-current fast charging station. Staff identified census tracts as urban or rural communities, low-, middle-, or high-income urban or rural communities, or disadvantaged or non-disadvantaged urban or rural communities.

About 81 percent of Californians live in census tracts with population centers that are within a 10-minute drive of a public direct-current fast charging station. About one in five communities

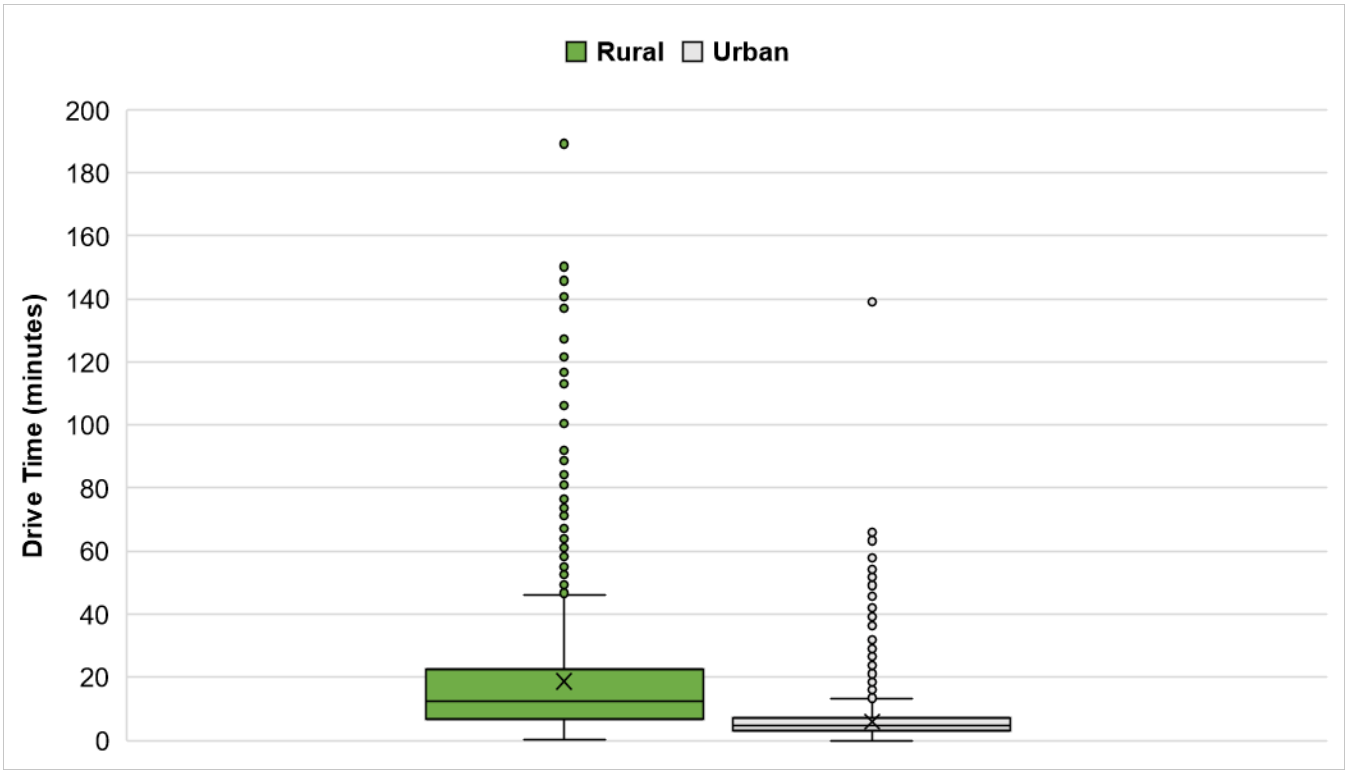
have sparse public fast charging station coverage, characterized in this report as census tracts with drive times of 10 minutes or more to a public fast charging station.

Rural communities have less public fast charging station coverage than urban communities: 60 percent have drive times of 10 minutes or more

The transition to EVs requires charging infrastructure to support all kinds of trips and drivers, including those in rural areas. Public charging, including direct-current fast charging, in rural areas can improve range confidence for rural drivers with longer daily travel, and support road trips and tourism in rural communities. But many rural communities have sparse public fast charging coverage.

About 60 percent of rural communities have drive times of 10 minutes or more to a public fast charging station. This represents about 8 percent of California's population and 84 percent of the state's geographic area. In contrast, 12 percent of urban communities have drive times of 10 minutes or more. Figure ES.1 shows high variability in drive times among urban and rural communities. Drive times from rural communities reach up to over 3 hours (189 minutes) with most under 2.5 hours (150 minutes), whereas drive times from urban communities reach up to over 2 hours (139 minutes) with most under 1.2 hours (66 minutes).

Figure ES.1: Drive Time to the Nearest DC Fast Charging Station by Urban and Rural Communities



Public direct-current fast charging station coverage is sparser in rural communities than urban communities. Drive times for rural communities range from less than 5 minutes to more than 3 hours. Drive times for urban communities range from less than 5 minutes to more than 2 hours.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, U.S. Department of Energy's Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Underlying data are available on the SB 1000 webpage at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

The CEC is committed to using CTP grant funding to increase public charging coverage, including fast charging coverage, for rural communities. The CEC's California Electric Vehicle Infrastructure Project (CALeVIP) provides funding for chargers in specific regions across the state and is a vehicle for both rapid charger deployment and addressing charger gaps. The CEC launched CALeVIP projects in the Sonoma Coast (July of 2020) and the Inland Counties (April 2021), both of which required a minimum of 25 percent of project funding in unincorporated areas of certain counties. At the end of 2021, the CEC released a grant funding opportunity for deployment of public chargers in rural communities and announced over $20 million of proposed awards in June of this year.

Low-income rural communities have the least public fast charging station coverage: 69 percent have drive times of 10 minutes or more

About 11 percent of low-income communities in California are rural; about 69 percent of low-income rural communities have drive times of 10 minutes or more to a public direct-current fast charging station, which is more than any other group. Table ES.1 shows the percentage of communities grouped by income level and urban or rural area with drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more to a public fast charging station.

Table ES.1: Drive Time Ranges by Income Level and Urban or Rural Area

	0 to 5 minutes	6 to 9 minutes	10 plus minutes	N/A	Total
Low-income Rural	16%	14%	69%	1%	100%
Low-income Urban	61%	28%	11%	0%	100%
Middle-income Rural	19%	22%	58%	1%	100%
Middle-income Urban	62%	24%	14%	0%	100%
High-income Rural	25%	29%	45%	1%	100%
High-income Urban	54%	32%	14%	0%	100%

Drive times from rural community population centers are long, especially for low-income rural communities. More than half of all low-income rural communities and more than half of all middle-income rural communities have drive times of 10 minutes or more to a public direct-current fast charging station.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2014-2018 American Community Survey Median Household Income and Average Household Size 5-Year Estimates, California Department of Housing and Community Development 2020 State Income Limits, U.S. Census Bureau 2010 Urban and Rural Classifications, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

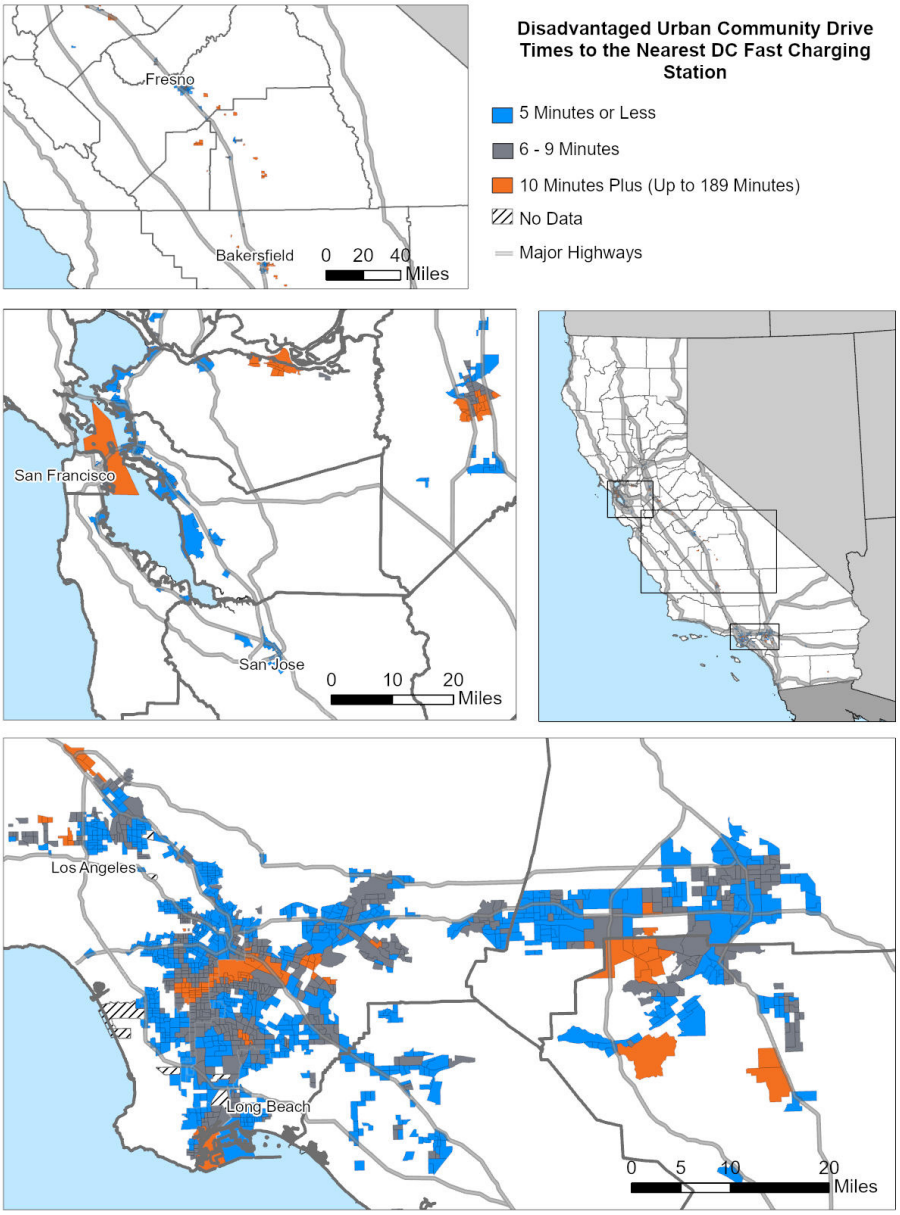
Low-income rural communities with drive times of 10 minutes or more make up about 4 percent of California's population and 64 percent of the state's geographic area. About 89 percent of low-income communities in California are urban; about 11 percent of low-income urban communities have drive times of 10 minutes or more. The 11 percent of low-income

urban communities with long drive times represents 6 percent of California's population and less than 1 percent of the state's geographic area.

Public fast charging station coverage among disadvantaged urban communities varies and gaps exist: 11 percent have drive times of 10 minutes or more

About 92 percent of disadvantaged communities in California are urban and tend to be close to major highways where public direct-current fast charging stations are more likely to be found. Despite greater average fast charging station coverage in disadvantaged urban communities than non-disadvantaged urban communities, gaps still exist. About 11 percent of disadvantaged urban communities have drive times of 10 minutes or more to a public fast charging station. This group makes up about 22 percent of California's population. Figure ES.2 shows drive times by disadvantaged urban communities grouped by drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more. Strategies to address these gaps will have to consider more geographic detail than whether a community is designated as disadvantaged. Sparse fast charging coverage also exists among disadvantaged rural communities where about 63 percent have drive times of 10 minutes or more.

Figure ES.2: Map of Disadvantaged Urban Community Drive Times to the Nearest DC Fast Charging Station



About 11 percent of disadvantaged urban communities have drive times 10 minutes or more to a public direct-current fast charging station. Of these, most are between 10 and 30 minutes; 7 are between 30 and 46 minutes.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, California Environmental Protection Agency disadvantaged community designations using the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 mapping tool, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

A high-resolution map and underlying data are available at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

The CEC's CTP commits at least 50 percent of its funding to low-income and/or disadvantaged communities, which includes funding for EV chargers, hydrogen fueling stations, and other projects. Drive time results indicate the need to focus efforts to a finer level of detail to reach all disadvantaged and low-income communities. The CEC will continue to prioritize low-income and disadvantaged communities, including communities with sparse public fast charging station coverage.

Conclusions

About 19 percent of census tracts in California are 10 minutes or more from a public fast charging station. This represents 19 percent of Californians and 85 percent of the state's geographic area and includes:

- 69 percent of low-income rural communities
- 63 percent of disadvantaged rural communities
- 60 percent of rural communities
- 12 percent of urban communities
- 11 percent of low-income urban communities
- 11 percent of disadvantaged urban communities.

Widespread EV adoption is essential for the state to reach its climate action and clean transportation goals. The CEC recognizes that access to charging infrastructure is a significant barrier to EV adoption and use. CEC staff will use these results to inform CTP funding decisions for fast chargers to improve charging coverage and access for rural, low-income, and disadvantaged communities. Drive time results will help inform new block grant programs for light-duty EV charging infrastructure (CALeVIP 2.0 and Communities in Charge) and future grant funding opportunities. Solutions to address charging access may vary depending on the intersecting characteristics of the community to be served, including whether a community is rural, urban, low-income, and/or disadvantaged. CEC staff will continue to refine and update the analysis to identify charging network gaps in underserved communities and build out charging infrastructure that serves all Californians. The CEC conducts workshops and solicits input on funding solicitations to effectively identify public infrastructure funding needs to maximize benefits to communities.

CHAPTER 1: Introduction

About 70 percent of greenhouse gas emissions from transportation come from light-duty passenger vehicles.[1] The transition to zero-emission vehicles (ZEVs) is crucial to bring down transportation-related emissions which have generally been on the rise since 2013.[2]

In September 2020, Governor Gavin Newsom signed Executive Order N-79-20,[3] which set ambitious targets for ZEVs in California, including that all new passenger car and truck sales must be zero-emission by 2035. Before N-79-20, former Governor Edmund G. Brown Jr. signed Executive Order B-48-18,[4] which called for the installation of 250,000 EV chargers including 10,000 direct-current fast chargers (DCFCs) by 2025 to support 5 million ZEVs on California roads by 2030. The CEC estimates that as of 2021, an additional 57,000 Level 2 chargers and 430 DCFCs are needed to achieve the 2025 charger goal.[5] To meet 2035 new vehicle sales targets, the California Air Resources Board (CARB) estimates that the state needs 8 million

[1] Gee, Quentin, Stephanie Bailey, Jane Berner, Michael Comiter, Jim McKinney, and Tim Olson. 2021. *Final 2020 Integrated Energy Policy Report Update.* California Energy Commission. Publication Number: CEC-100-2020-001-V1-CMF. Available at https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report.

[2] Ibid.

[3] Governor Gavin Newsom. Executive Order N-79-20. Issued September 23, 2020. Available at https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf.

[4] Governor Edmund G. Brown, Jr. Executive Order B-48-18. Issued January 26, 2018. Available at https://www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html.

[5] California Energy Commission staff combined existing and projected public and shared-private charger counts to determine progress toward achieving 2025 state charger goals. Existing charger counts come from the Alternative Fuels Data Center database and surveys with California's electric vehicle service providers, utilities, and public agencies. Projected charger installations through 2025 are based on funding allocated through state programs, ratepayer-funded programs, and settlement agreements.

Alexander, Matt, Noel Crisostomo, Wendell Krell, Jeffrey Lu, and Raja Ramesh. July 2021. *Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030 – Commision Report*. Publication Number: CEC-600-2021-001-CMR. Available at https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127.

ZEVs by 2030.[6] The CEC estimates that 1.2 million chargers, including 30,200 to 31,000 public DCFCs, are required to support this projection of 8 million ZEVs.[7]

Access to EV chargers by all Californians will give drivers greater confidence that plug-in electric vehicles (PEVs)[8] will meet their mobility needs. Public and private sector collaboration is necessary to deploy chargers rapidly, strategically, and equitably. The California Zero-Emission Vehicle Market Development Strategy[9] (ZEV Market Strategy), published in February 2021 by the Governor's Office of Business and Economic Development (GO-Biz), provides guidance on how state agencies and stakeholders can work together to move California collectively towards its 2035 ZEV goals. The strategy assigns accountability and builds on previous ZEV Action Plans.[10] Importantly, *Equity in every decision* is a core principle embedded throughout the ZEV Market Strategy.[11]

SB 1000 was enacted in 2018[12] and requires the CEC to assess whether EV charging station infrastructure[13] is disproportionately deployed by population density, geographical area, or

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[6] California Air Resources Board staff. 2021. Revised Draft 2020 Mobile Source Strategy. Available at https://ww2.arb.ca.gov/resources/documents/2020-mobile-source-strategy.

[7] Alexander, Matt, Noel Crisostomo, Wendell Krell, Jeffrey Lu, and Raja Ramesh. July 2021. *Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030 – Commision Report*. Publication Number: CEC-600-2021-001-CMR. Available at https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127.

[8] Vehicles fueled by electricity or hydrogen are considered ZEVs. This assessment focuses on PEVs, which include battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

[9] Governor's Office of Business and Economic Development staff. 2021. California Zero-Emission Vehicle Market Development Strategy. Available at https://business.ca.gov/industries/zero-emission-vehicles/zev-strategy/.

[10] Governor's Office of Business and Economic Development. ZEV Action Plan History. Available at https://business.ca.gov/industries/zero-emission-vehicles/zev-action-plan/.

[11] The ZEV Market Development Strategy defines equity as "actively empowering priority communities to thrive and reach their full environmental, economic, and social potential by transforming the behaviors, institutions and systems that are causing disproportionate harm. Decisions and processes that intentionally prioritize equity are inclusive across marginalized groups, increase access to a broad suite of clean transportation and mobility options and other critical resources, and maximize opportunities in priority communities."

[12] Senate Bill 1000 (Lara), Statutes of 2018, Chapter 368. Available at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1000.

Appendix A provides an excerpt from SB 1000 relevant to this report.

[13] SB 1000 defines charging station as "the removable equipment that provides alternating or direct current to the battery electric vehicle or plug-in hybrid electric vehicle, but does not include the supporting charging infrastructure, such as wiring, conduit, and electric panels."

population income level. This includes assessing whether direct-current (DC) fast charging stations are disproportionately distributed and whether access to these charging stations is disproportionately available. SB 1000 also requires that, upon making a finding that charging station infrastructure has been disproportionately deployed, the CEC shall use CTP funding to the extent authorized by law, and other mechanisms to deploy new charging station infrastructure more proportionately.[14]

CEC staff published the first SB 1000 report[15] in December 2020, concurrent with the 2020 – 2021 CTP Investment Plan Update.[16] The report focused on the geographic distribution and density of public Level 2 chargers and DCFCs by income and population density. At the county level, PEVs and public chargers are geographically collocated with populations. However, at the census tract level, public chargers are unevenly distributed by income and population density. Low-income communities, on average, have fewer public chargers per-capita than middle- or high-income communities. High-population-density areas have fewer public chargers than low-population-density areas, which could be because of the barriers associated with installing chargers in high-density residential and mixed-use residential areas. Public chargers are typically installed in areas zoned for public access, such as commercial areas, and factors such as public access (hours of operation and fences that prevent access outside of business hours), physical space constraints, and ease of parking influence where public chargers can be installed.

Humboldt State University researchers conducted an analysis on public charging access in California. According to their October 2020 study, access to public charging stations[17] in California is lower in low-income census block groups and in those with Black and Hispanic majority populations compared to other block groups.[18] The researchers found that communities that are high-income with a high density of multifamily housing (MFH) units are

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[14] With the exception where a finding is made that disproportionate deployment is reasonable and furthers state energy or environmental policy as articulated by the CEC. See Public Resources Code section 25231(a).

[15] Hoang, Tiffany. 2020. *California Electric Vehicle Infrastructure Deployment Assessment: Senate Bill 1000 Report.* California Energy Commission. Publication Number: CEC-600-2020-153. Available at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

[16] Brecht, Patrick. 2021. *2021-2023 Investment Plan Update for the Clean Transportation Program.* California Energy Commission. Publication Number: CEC-600-2021-038-CMF. Available at https://www.energy.ca.gov/publications/2021/2021-2023-investment-plan-update-clean-transportation-program.

[17] This research defined public charging stations as a location accessible to the public with one or more EV chargers and does not include private, residential, or workplace chargers.

[18] Hsu, Chih-Wei and Kevin Fingerman. 2020. *Schatz Energy Research Center.* "Public electric vehicle charger access disparities across race and income in California." Science Direct. Available at https://www.sciencedirect.com/science/article/pii/S0967070X20309021.

twice as likely to have access to public charging as low-income communities [19] They concluded that as the EV market matures and approaches price parity with conventional vehicles, limited access to charging infrastructure could become the primary barrier to EV adoption.

This report uses drive times to public DC fast charging stations to measure infrastructure coverage across communities in California. It compares drive times among communities grouped by urban or rural area, income level, and disadvantaged community status and identifies the rural, low-income, and disadvantaged communities with sparse public fast charging station coverage. Results, including drive time maps, will help inform DCFC investments under the CTP. High resolution drive time maps and the underlying data are available on the SB 1000 webpage at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

[19] The researchers controlled for community distance from a freeway or highway and multifamily housing rate before coming to this conclusion.

CHAPTER 2:
Analysis and Results

Methods: Drive times to public fast charging stations are a measure of infrastructure coverage and access

Drive time is one way to evaluate access to public DC fast charging stations and infrastructure coverage among communities. This report assesses drive times from census tract residential population centers to the nearest public fast charging station to identify communities that have sparse fast charging coverage, defined as a drive time of 10 minutes of more. This report does not assess infrastructure capacity, charging costs, or other charging access components or use cases.

Staff used mapping software to find the quickest drive time routes during peak traffic.[20] The sections below provide drive time results from urban and rural community population centers; communities that are low-income urban or rural, middle-income urban or rural, and high-income urban or rural; and communities that are urban or rural and disadvantaged[21], and urban or rural and not disadvantaged. High resolution drive time maps and individual community drive times are available for download on the SB 1000 webpage at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

Rural communities have less public fast charging station coverage than urban communities: 60 percent have drive times of 10 minutes or more

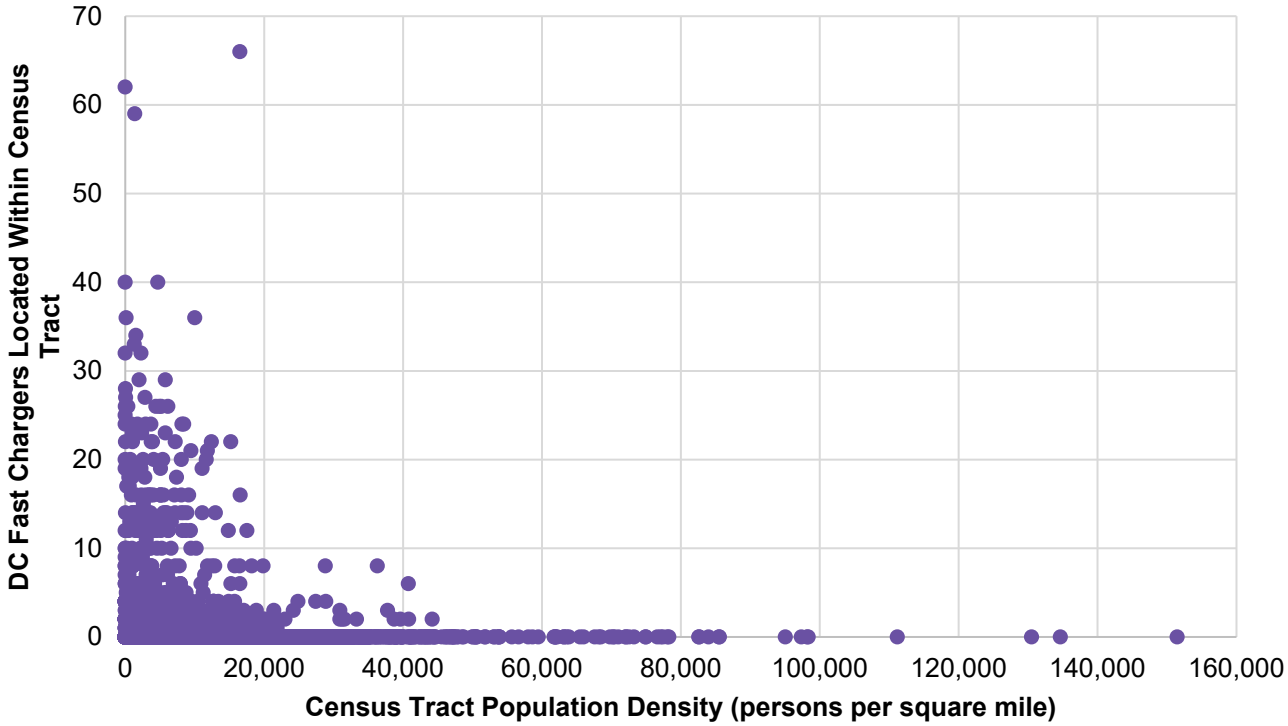
The 2020 analysis counted chargers located within a census tract and not those located outside of the census tract. To improve analysis of charging access, CEC staff evaluated drive times from census tract population centers to the nearest public DC fast charging station, which could be located inside or outside of that census tract.

[20] This analysis includes roadway data developed by CARB for the California Hydrogen Infrastructure Tool using high-resolution roadway geometry from the U.S. Census Bureau and traffic data from Metropolitan Planning Organization traffic models. The traffic model data includes weekday average pm peaks up to 2014. More information on CARB's methodology can be found in Annual Hydrogen Evaluation Reports, available at https://ww2.arb.ca.gov/resources/documents/annual-hydrogen-evaluation.

[21] California Energy Commission staff referred to the most recent final disadvantaged community designations from the California Environmental Protection Agency (CalEPA) using the California Office of Environmental Health Hazard Assessment's (OEHHA's) CalEnviroScreen 3.0 mapping tool. At the time of this analysis, disadvantaged community designations by CalEPA under CalEnviroScreen 4.0 had not been finalized.

In 2020, CEC staff found that there were generally fewer public DCFCs and Level 2 chargers combined in high-population-density census tracts than in low-population-density tracts.[22] Generally, as census tract population density (persons per square mile) increases, the number of public chargers located within the tract decreases (see Figure 2.1).[23]

Figure 2.1: DC Fast Chargers by Census Tract Population Density



The census tracts with highest population density tend to have fewer public DCFCs than those with lower population density. DCFCs tend to be absent or rare in dense urban residential areas where it may be more difficult to install public charging.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2014-2018 American Community Survey Total Population 5-Year Estimates and the U.S. Department of Energy's Alternative Fuels Data Center as of July 23, 2020.

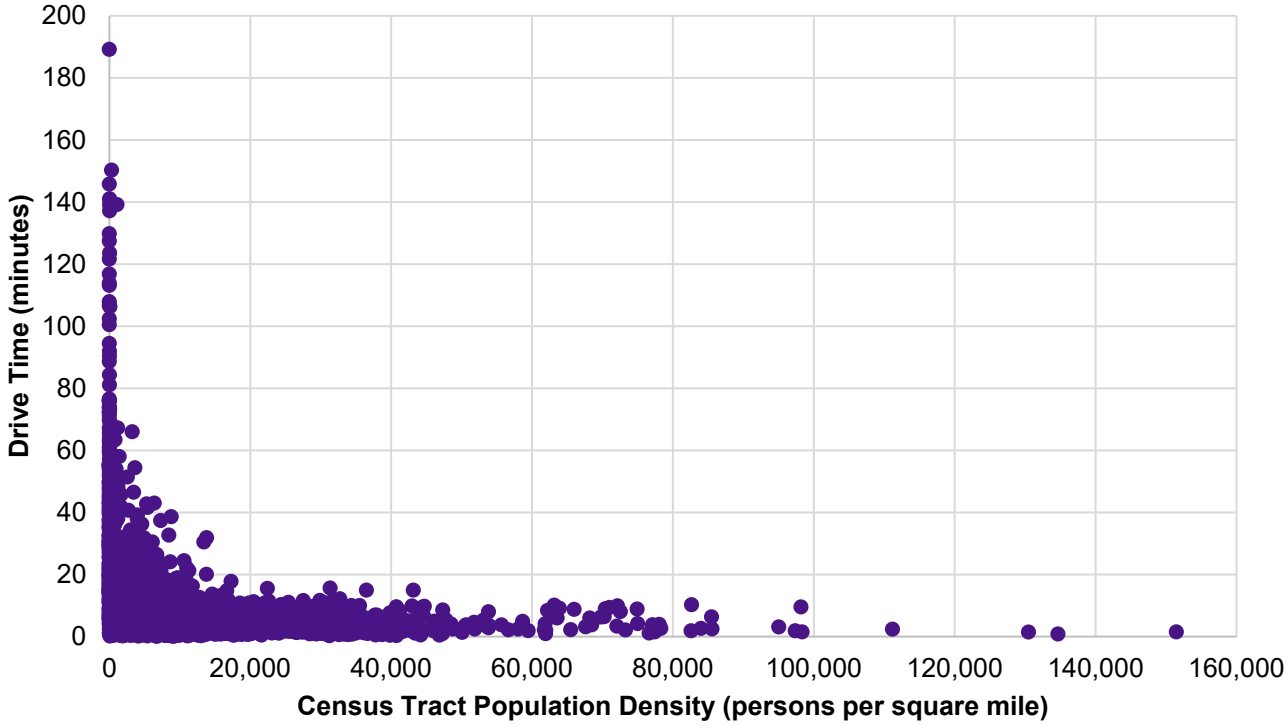
In contrast, drive time analysis shows that high-population-density census tracts generally have shorter drive times (greater coverage) to a public DC fast charging station than low-population-density census tracts. As census tract population density increases, the time it

[22] Hoang, Tiffany. 2020. *California Electric Vehicle Infrastructure Deployment Assessment: Senate Bill 1000 Report*. California Energy Commission. Publication Number: CEC-600-2020-153. Available at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

[23] Census tracts are defined by the U.S. Census Bureau. Tracts can vary in size, but each typically contains about 4,000 residents. Census tracts are usually smaller than 2 square miles in cities but are much larger in rural areas.

takes to reach the public DCFC station nearest to the census tract population center generally decreases (see Figure 2.2.). High-population-density census tracts have fewer public DCFCs but drive times from these census tracts to a public DC fast charging station are usually shorter than from low-population-density census tracts.

Figure 2.2: Drive Time to the Nearest DC Fast Charging Station by Census Tract Population Density



Average drive times from high-population-density census tracts to a public DC fast charging station tend to be shorter than drive times from low-population-density tracts.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2014-2018 American Community Survey Total Population 5-Year Estimates, the U.S. Department of Energy's Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data as of 2017.

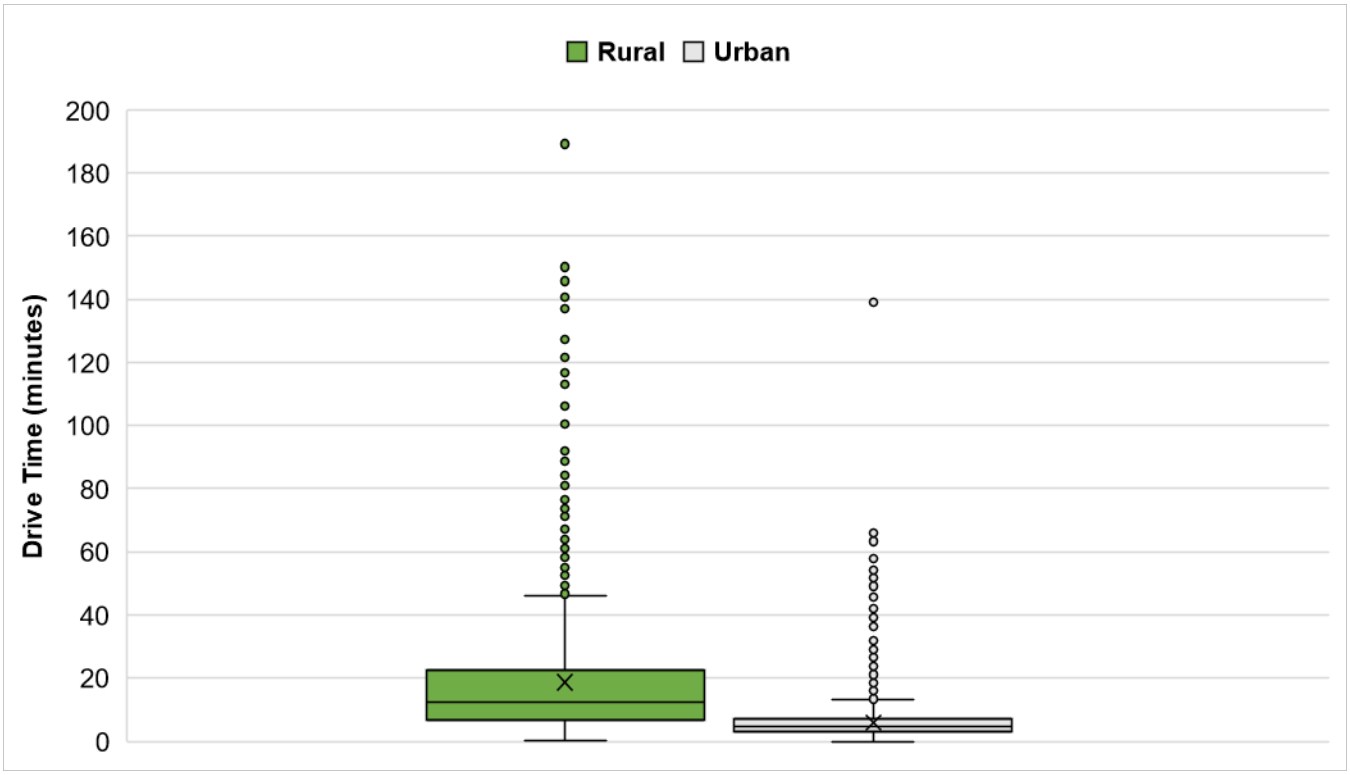
To build on the population density findings, CEC staff evaluated rural and urban community drive times. For this analysis, rural communities are defined as census tracts where at least 50 percent of the census tract's land area is designated as rural by the U.S. Census Bureau. Census tracts that do not fit this rural definition are considered urban communities in this analysis. To determine percent rural land area, staff summed the area of all rural census

blocks, which are designated by the U.S. Census Bureau, within a census tract and divided that number by the census tract's total land area.[24]

Charging in rural areas is important to serve local communities, and to facilitate economic development and tourism by connecting urban and rural regions. Rural communities make up 15 percent of California's population and 96 percent of California's geographic area. The average drive time to a public fast charging station for rural communities is about 19 minutes and about 6 minutes for urban communities, which means that the average drive time for rural communities is more than twice that of urban communities. Ungrouped, there is high variability in drive times among communities that are urban and rural as shown by Figure 2.3. Drive times from rural communities range from under 5 minutes to more than 3 hours (189 minutes); most rural communities have drive times under 2.5 hours (150 minutes). In contrast, drive times from urban communities range from under 5 minutes to more than 2 hours (139 minutes); most urban communities have drive times under 1.2 hours (66 minutes).

[24] The U.S. Census Bureau designates urban and rural census blocks every 10 years. Staff referred to the Census Bureau's 2010 urban and rural designations, which was the most recent data available for urban and rural areas at the time of this analysis. This data is available at https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2010&layergroup=Blocks.

Figure 2.3: Drive Time to the Nearest DC Fast Charging Station by Urban and Rural Communities



Rural communities average drive times of 19 minutes to reach a public DC fast charging station, while urban communities average about 6 minutes. Rural community drive times range from less than 5 minutes to more than 3 hours whereas urban community drive times range from less than 5 minutes to more than 2 hours.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, U.S. Department of Energy's Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

About 60 percent of rural communities have drive times of 10 minutes or more, while 12 percent of urban communities have drive times that long (see Table 2.1). More than half of urban communities have drive times of 5 minutes or less. Table 2.2 provides a breakdown of the percentage of urban and rural communities with long drive times (10 minutes or more).

Table 2.1: Drive Time Ranges by Urban and Rural Communities

	0 to 5 minutes	6 to 9 minutes	10 plus minutes	N/A*	Total
Rural Communities	19%	20%	60%	1%	100%
Urban Communities	60%	28%	12%	Less than 1%	100%

* Drive times were calculated for 7,995 of the 8,012 census tracts with population. Drive times could not be calculated for 17 census tracts because of roadways that were not connected to a census tract population center. 15 of these census tracts are rural communities.

Source: California Energy Commission staff

Table 2.2: Drive Times of 10 Minutes or More by Urban and Rural Communities

	10 to 29 minutes	30 to 59 minutes	60 plus minutes	Total*
Rural Communities	42%	13%	5%	60%
Urban Communities	12%	Less than 1%	Less than 1%	12%

*Column percentages do not add up to 100 since the table does not include drive times below 10 minutes.

Source: California Energy Commission staff

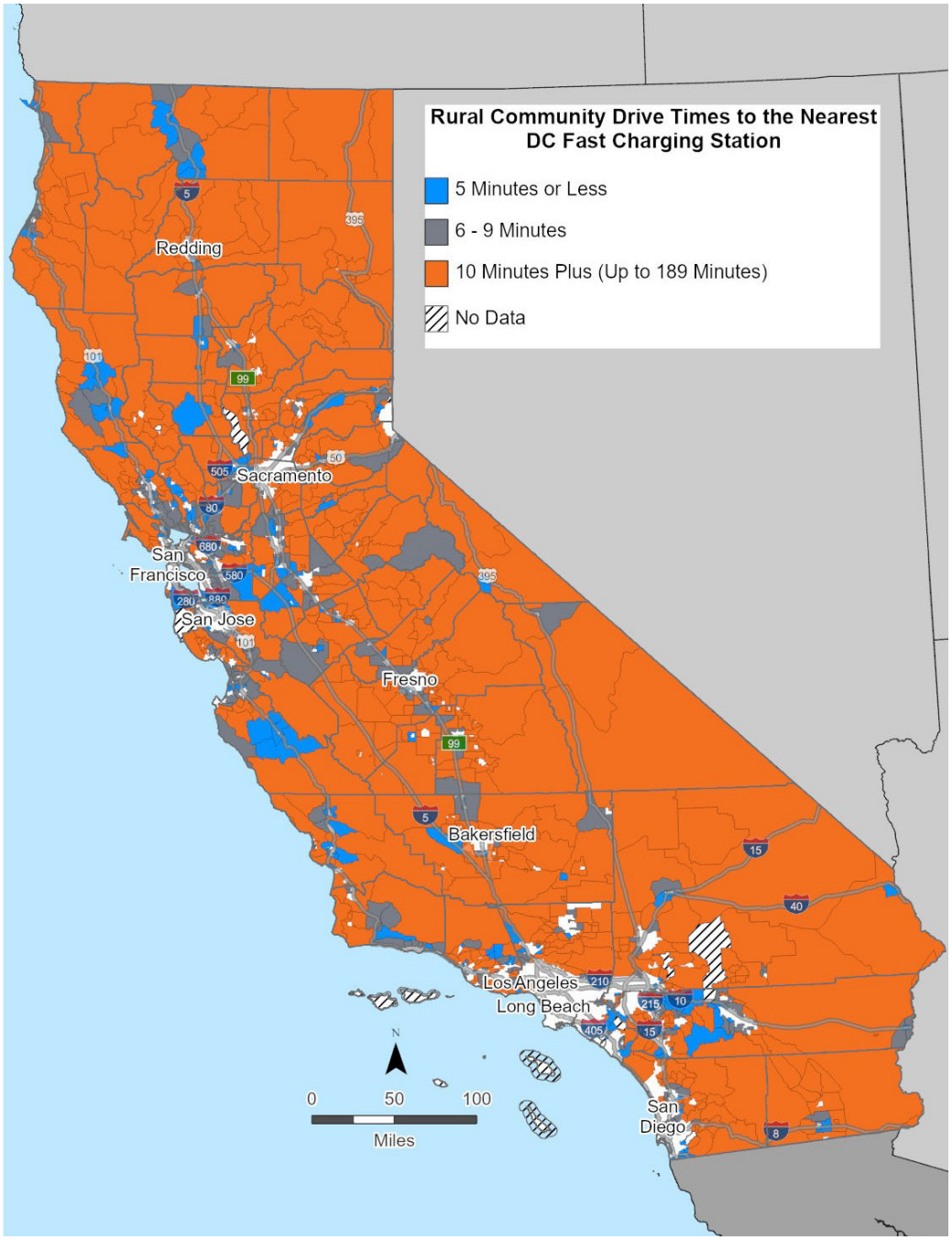
Of the rural communities with drive times of 10 minutes or more, about 13 percent are 30 to 59 minutes away and about 5 percent are an hour or more away. Whereas nearly all urban communities with drive times of 10 minutes or more are within 29 minutes of a public DC fast charging station.

Figure 2.4 shows rural community drive times to public DCFC stations grouped by those with drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more. More than half of rural communities are 10 minutes or more away from a public DC fast charging station. Rural communities with drive times of 10 minutes or more make up about 8 percent of California's population and 84 percent of the state's geographic area. Rural communities with drive times less than 10 minutes away are generally near highway corridors. This reflects investments in DCFCs along highway corridors. In 2015, the CEC deployed DCFCs along North-South highway

corridors for California's portion of the West Coast Electric Highway.[25] California then extended the DCFC network to allow travel to California's borders with Nevada and Arizona.

[25] The West Coast Electric Highway is an extensive network of EV DC fast charging stations along I-5, Highway 99, and other major roadways in British Columbia, Washington, Oregon, and California.

Figure 2.4: Map of Rural Community Drive Times to the Nearest DC Fast Charging Station

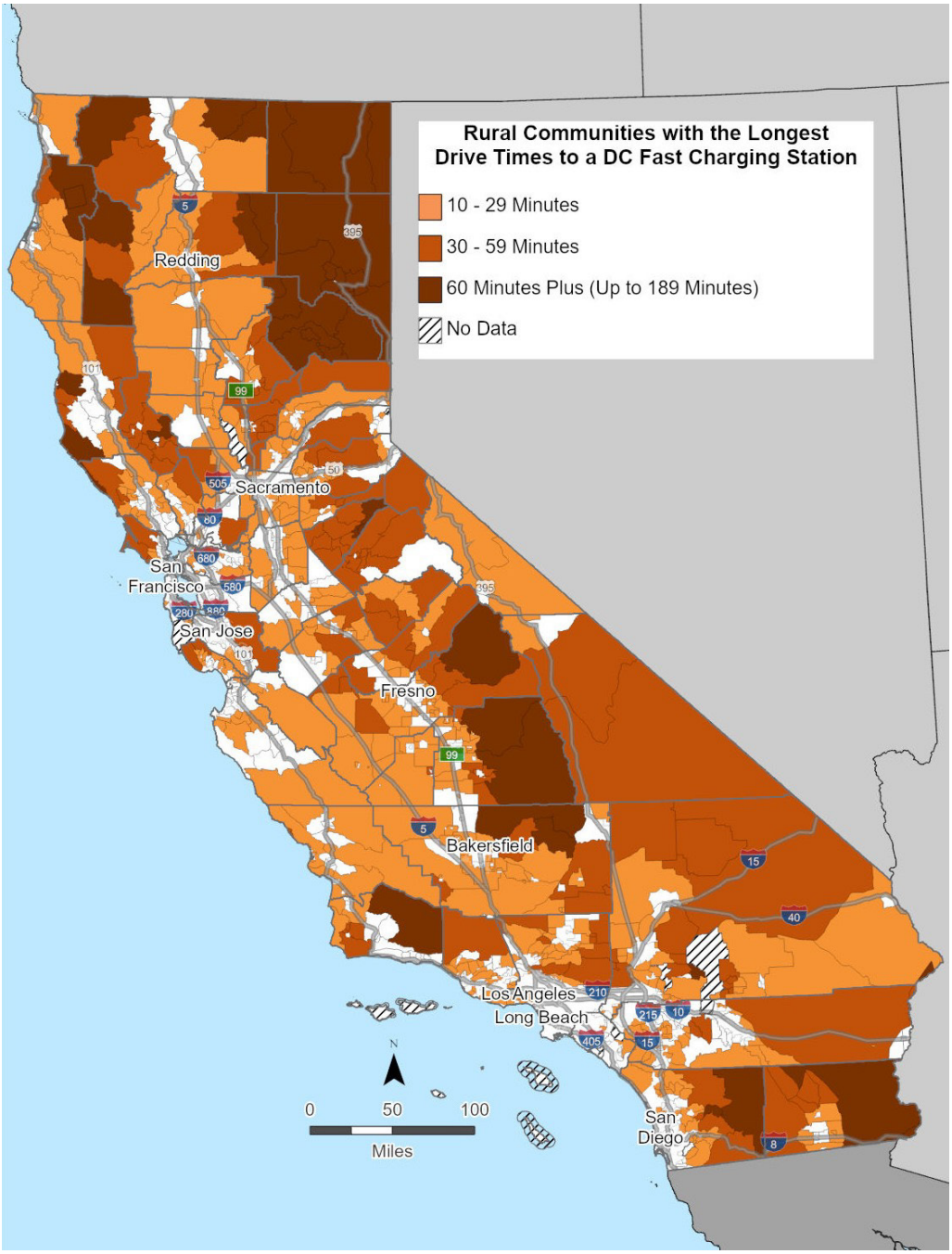


About 60 percent of rural communities have drive times of 10 minutes or more to a public DCFC station. Rural communities that are near a public DCFC station, with drive times under 10 minutes, tend to be located near highways.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, U.S. Department of Energy's Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Figure 2.5 shows the different degrees of public DC fast charging coverage gaps among rural communities statewide. Rural communities with long drive times are grouped by those with drive times of 10 to 29 minutes, 30 to 59 minutes, and 60 minutes or more, up to more than 3 hours. This analysis measures charging coverage and does not assess where public DC fast charging station deployment may be feasible in the identified rural communities with long drive times. Furthermore, this analysis does not measure charging density (chargers per capita), which is important in urban communities. Staff will assess ways to further evaluate charging coverage, and consider charging density, to improve understanding of community charging access.

Figure 2.5: Map of Rural Communities with the Longest Drive Times to a DC Fast Charging Station



Of the 60 percent of rural communities with long drive times, about 4 percent have drive times of more than an hour to a public DC fast charging station. About 13 percent have drive times between 30 and 60 minutes and about 42 percent have drive times of less than 30 minutes.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, U.S. Department of Energy's Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Low-income rural communities have the least public fast charging station coverage: 69 percent have drive times of 10 minutes or more

In addition to population density, SB 1000 further requires the CEC to assess charger deployment and access by income level, including low-, middle-, and high-income levels. Low-, middle-, and high-income communities were defined in the 2020 SB 1000 analysis. Appendix B provides definitions and the methodology used to identify communities by income level. In 2020, CEC staff found that high-income communities on average have the fewest public DCFCs per capita, followed by low-income communities. Middle-income communities on average had the highest. When public level 2 chargers were added, low-income communities on average had the fewest public DCFC and level 2 chargers combined per capita, followed by middle-income communities, and high-income communities on average had the highest. The differences in average per capita chargers across income levels were moderate.

Building on these findings, CEC staff evaluated drive times for communities that are low-income rural, low-income urban, middle-income rural, middle-income urban, high-income rural, and high-income urban. The average drive time for low-income rural communities is about 24 minutes, about 4 times longer than any urban community, regardless of income, and higher than any other group (Table 2.3).

Table 2.3: Average Drive Times to a Public Fast Charging Station by Income Level and Urban or Rural Area

	Average Drive Time (minutes)
Low-income Rural	24
Low-income Urban	6
Middle-income Rural	17
Middle-income Urban	6
High-income Rural	11
High-income Urban	6

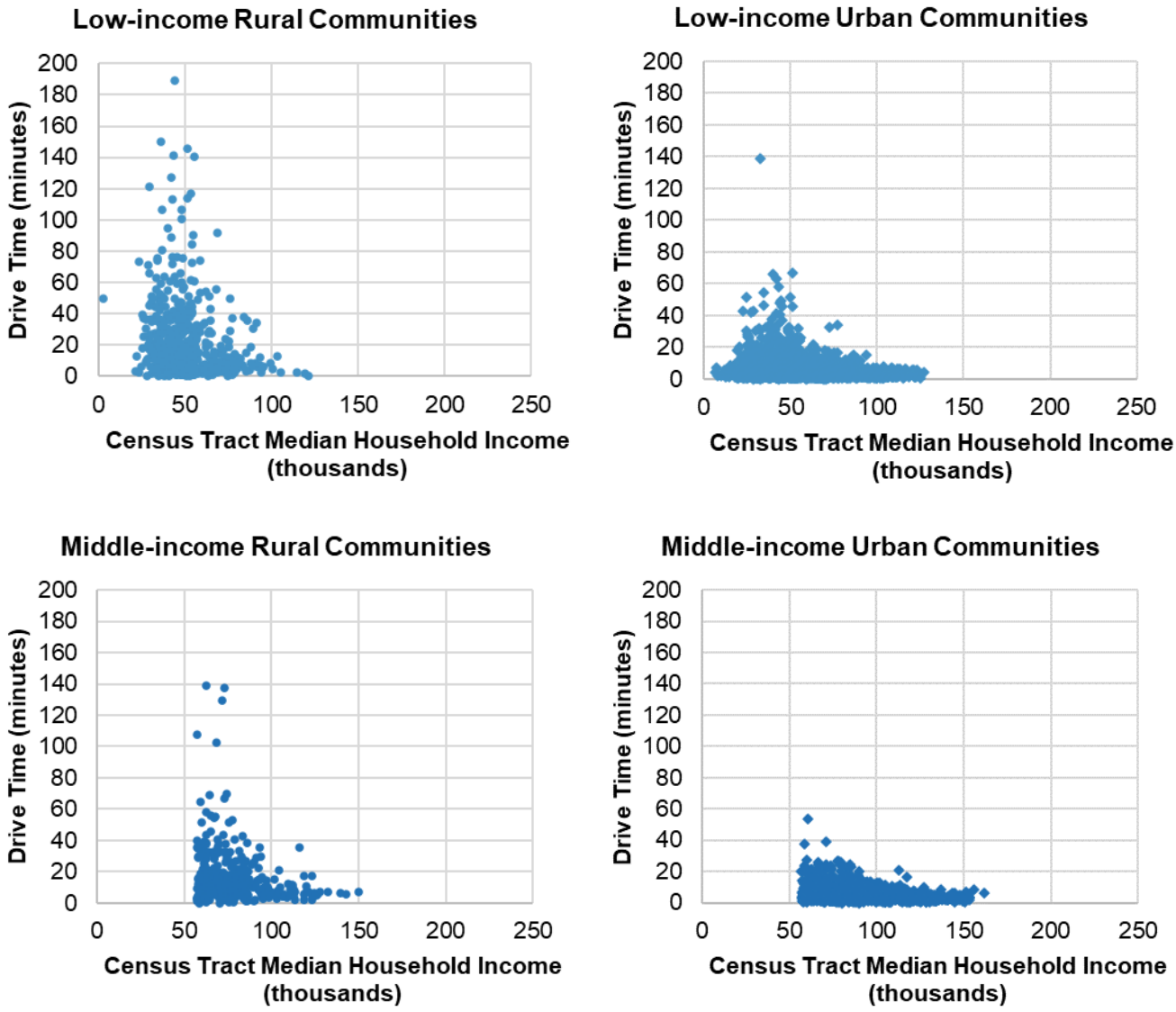
Communities grouped by income level and urban or rural area are census tracts that are identified by evaluating census tract median household income and urban and rural area within a census tract.

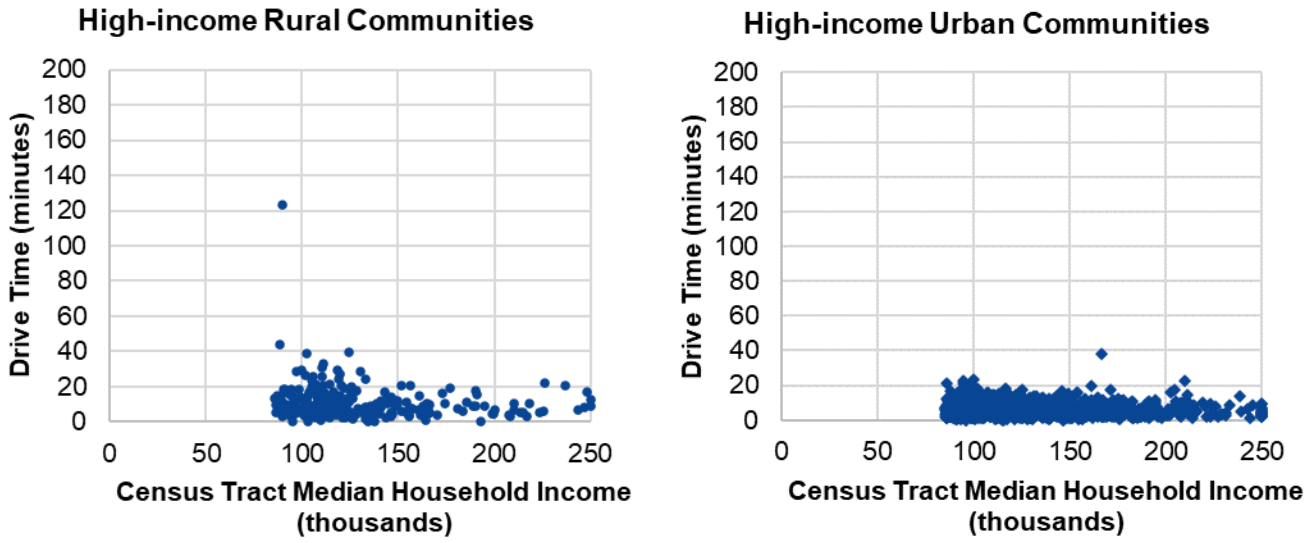
Source: California Energy Commission staff

Ungrouped, drive times range widely, especially among low-income rural and middle-income rural communities, as shown by Figure 2.6. More points spread across the vertical axis indicates more variable drive times for a group. More points spread horizontally but grouped vertically indicates more variable income levels within an income group but similar drive times.

Drive times for low-income rural communities range from under 5 minutes to more than 3 hours (189 minutes), longer than any other group.

Figure 2.6: Drive Time to the Nearest Public Fast Charging Station by Income Level and Urban or Rural Area





Low-income rural communities have some of the longest and most variable drive times to a public DC fast charging station. Middle-income rural communities also have variable and long drive times.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, the U.S. Census Bureau 2014-2018 American Community Survey Median Household Income and Average Household Size 5-Year Estimates, California Department of Housing and Community Development 2020 State Income Limits, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

About 69 percent of low-income rural communities have drive times of 10 minutes or more signifying the least public DC fast charging station coverage among all groups (Table 2.4). About 58 percent of middle-income rural communities have drive times of 10 minutes or more. More than half of all low-income urban and middle-income urban communities have drive times of 5 minutes or less. About 89 percent of all low-income communities are urban and about 11 percent of low-income urban communities are 10 minutes or more from a public DC fast charging station.

Table 2.4: Drive Time Ranges by Income Level and Urban or Rural Area

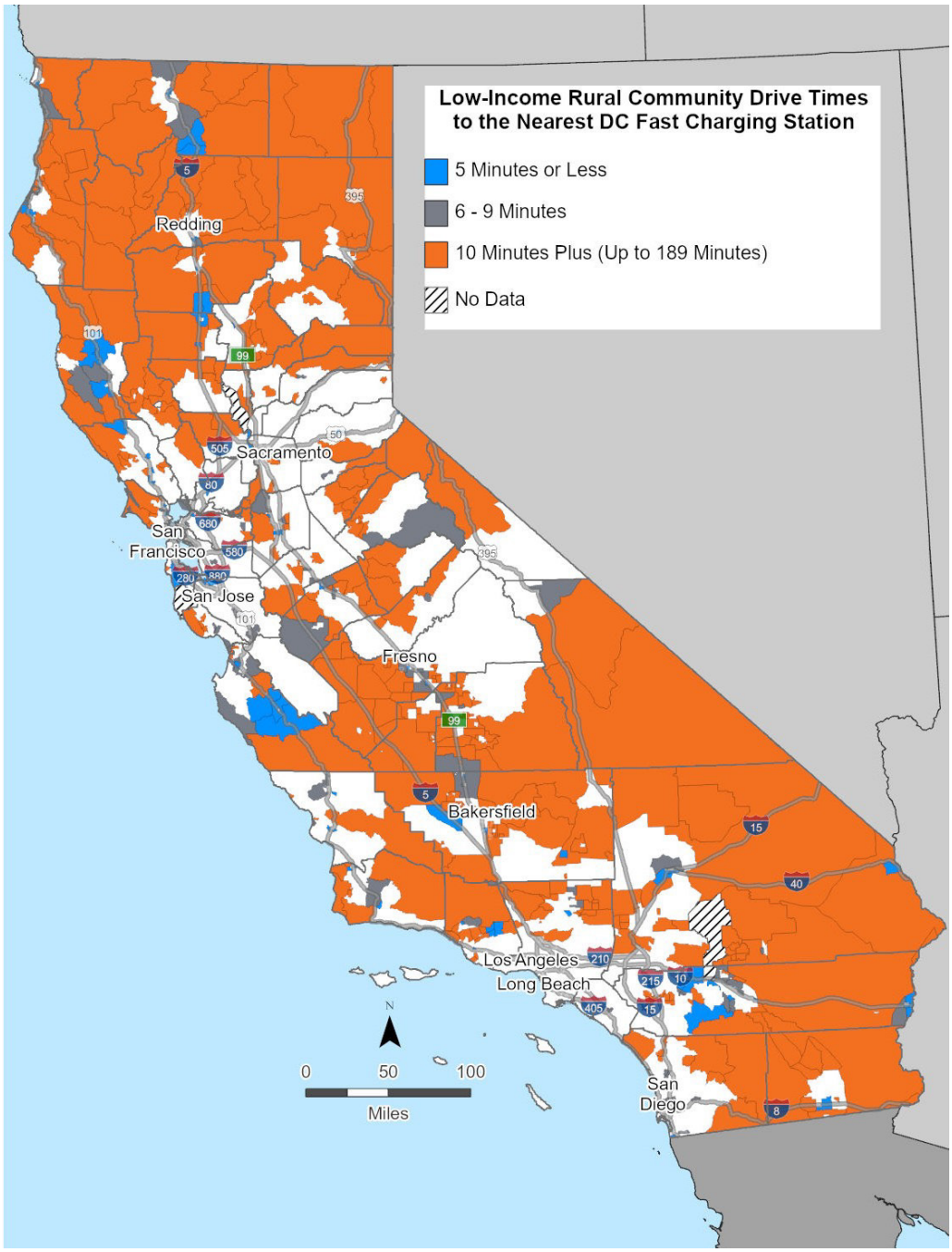
	0 to 5 minutes	6 to 9 minutes	10 plus minutes	N/A*	Total
Low-income Rural	16%	14%	69%	1%	100%
Low-income Urban	61%	28%	11%	Less than 1%	100%
Middle-income Rural	19%	22%	58%	1%	100%
Middle-income Urban	62%	24%	14%	0%	100%
High-income Rural	25%	29%	45%	1%	100%
High-income Urban	54%	32%	14%	Less than 1%	100%

* Drive times were calculated for 7,995 or the 8,012 census tracts with population. Drive times could not be calculated for 17 census tracts because of roadways not connected to a census tract population center. 5 of the 17 census tracts are low-income rural communities, 1 is low-income urban, 2 are middle-income rural, 4 are high-income rural, and 2 are high-income urban.

Source: California Energy Commission staff

Figure 2.7 shows low-income rural community drive times to a public DCFC station grouped by low-income rural communities with drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more. Low-income rural communities make up 6 percent of California's population and 70 percent of the state's geographic area. More than half of all low-income rural communities have drive times of 10 minutes or more. Low-income rural communities with drive times of 10 minutes or more make up about 4 percent of California's population and 64 percent of the state's geographic area.

Figure 2.7: Map of Low-income Rural Community Drive Times to the Nearest DC Fast Charging Station

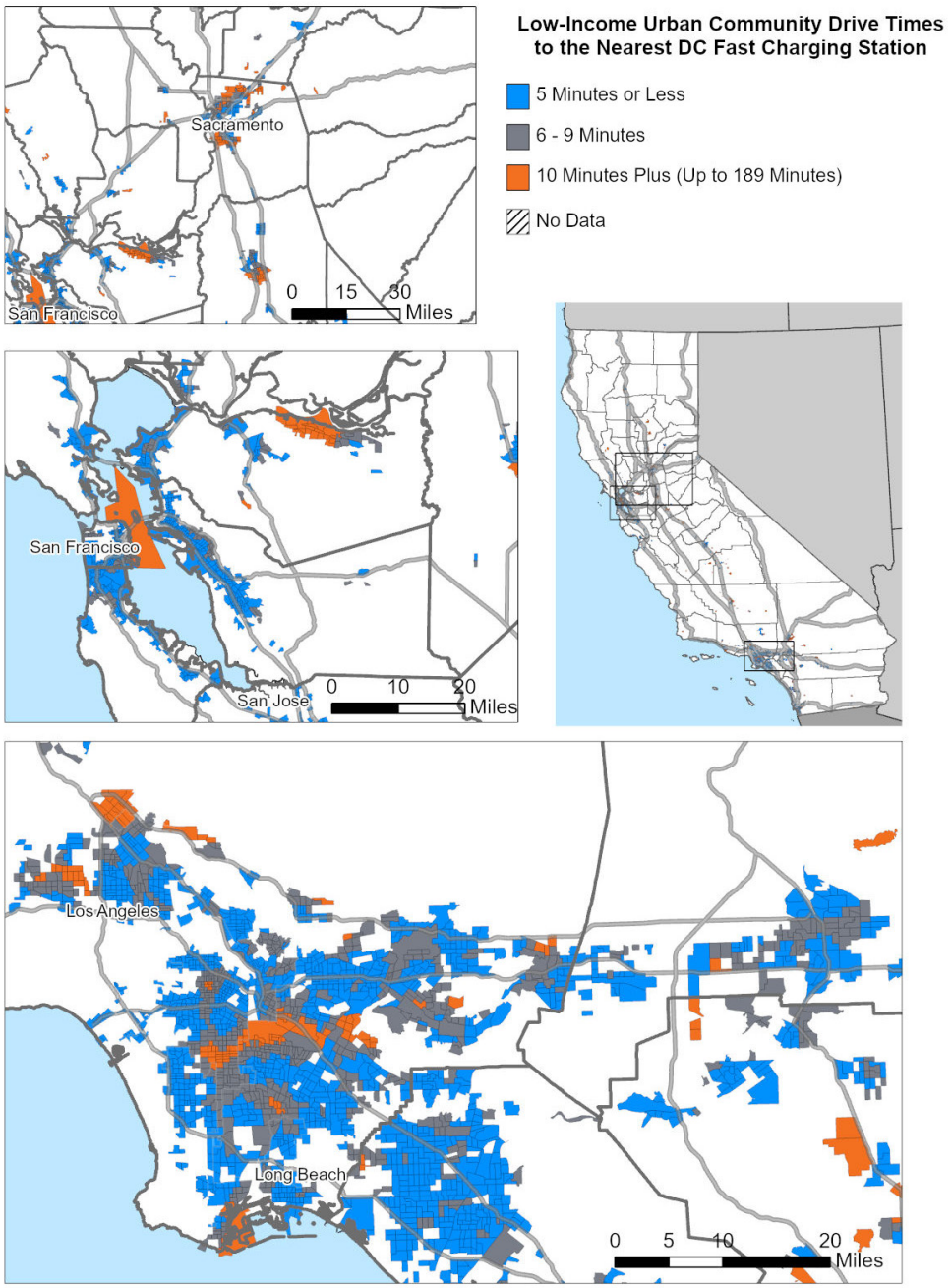


About 69 percent of low-income rural communities have drive times 10 minutes or more to a public DCFC station.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, the U.S. Census Bureau 2014-2018 American Community Survey Median Household Income and Average Household Size 5-Year Estimates, California Department of Housing and Community Development 2020 State Income Limits, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Figure 2.8 shows low-income urban community drive times grouped by those with drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more. Low-income urban communities make up about 50 percent of California's population and about 2 percent of the state's geographic area. Low-income urban communities with drive times of 10 minutes or more make up about 6 percent of California's population and less than 1 percent of the state's geographic area.

Figure 2.8: Map of Low-income Urban Community Drive Times to the Nearest DC Fast Charging Station



About 11 percent of low-income urban communities have drive times 10 minutes or more to a public DC fast charging station. Of these, most are between 10 and 30 minutes; less than 1 percent (34 census tracts) are between 30 and 60 minutes.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, the U.S. Census Bureau 2014-2018 American Community Survey Median Household Income and Average Household Size 5-Year Estimates, California Department of Housing and Community Development 2020 State Income Limits, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Staff examined the 19% of Californians who have the least public fast charging station coverage, defined as those who are more than 10 minutes away from the nearest DC fast charging station. Table 2.5 provides a breakdown of communities grouped by income level and urban or rural area with drive times of 10 to 29 minutes, 30 to 59 minutes, and 60 minutes or more. Of the low-income rural communities with drive times of 10 minutes or more, about 20 percent have drive times of 30 to 59 minutes and about 8 percent have drive times of 60 minutes or more. This is higher than any other community grouped by income level and urban or rural area. Most low-income urban communities with drive times of 10 minutes or more are in the 10-to-29-minute range. About 1 percent of low-income urban communities (34 census tracts) have drive times between 30 and 59 minutes. Figure 2.9 shows the degree of public fast charging gaps among low-income rural communities.

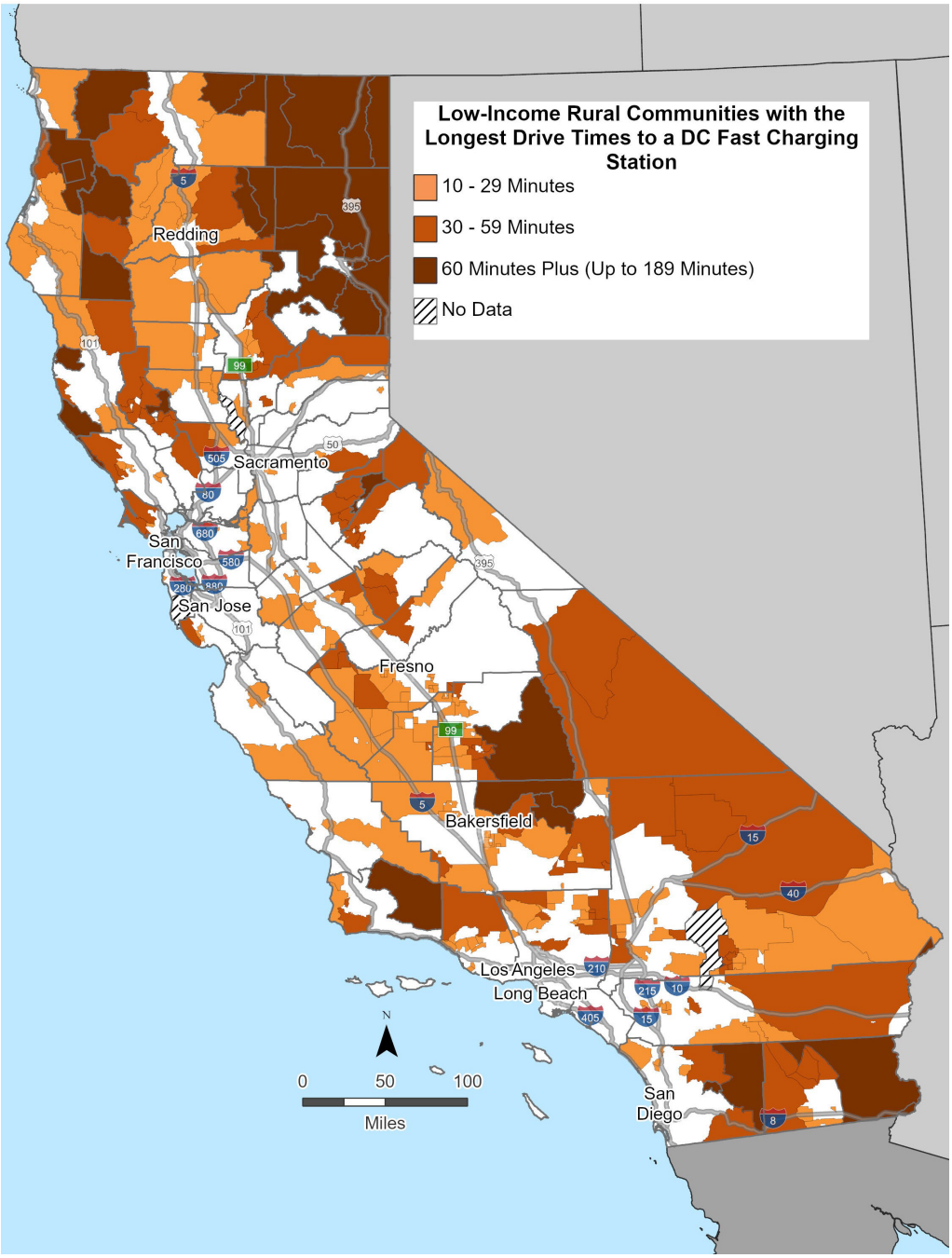
Table 2.5: Drive Times of 10 Minutes or More by Income Level and Urban or Rural Area

	10 to 29 mins	30 to 59 mins	60 plus mins	Total*
Low-income Rural	41%	20%	8%	69%
Low-income Urban	10%	1%	Less than 1%	11%
Middle-income Rural	44%	12%	2%	58%
Middle-income Urban	14%	0%	0%	14%
High-income Rural	43%	2%	Less than 1%	45%
High-income Urban	14%	0%	0%	14%

*Column percentages do not add up to 100 since drive times below 10 minutes are not included.

Source: California Energy Commission staff

Figure 2.9: Map of Low-income Rural Communities with the Longest Drive Times to a DC Fast Charging Station



Of the 69 percent of low-income rural communities with long drive times, about 8 percent have drive times 60 minutes or longer, about 20 percent have drive times between 30 and 60 minutes and about 41 percent have drive times of less than 30 minutes.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, the U.S. Census Bureau 2014-2018 American Community Survey Median Household Income and Average Household Size 5-Year Estimates, California Department of Housing and Community Development 2020 State Income Limits, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Public fast charging station coverage among disadvantaged urban communities varies and gaps exist: 11 percent have drive times of 10 minutes or more

The CEC is committed to investing in disadvantaged communities, which represent the most vulnerable and pollution-burden communities in California. At the time of this analysis, the California Environmental Protection Agency (CalEPA) identified disadvantaged communities as census tracts that score within the top 25th percentile of the California Office of Environmental Health Hazards Assessment's (OEHHA) California Communities Environmental Health Screening Tool (CalEnviroScreen) 3.0 scores, including census tracts with low population and high pollution burden, such as ports.[26] A census tract with a high score experiences much higher pollution burden and vulnerability than census tracts with low scores.

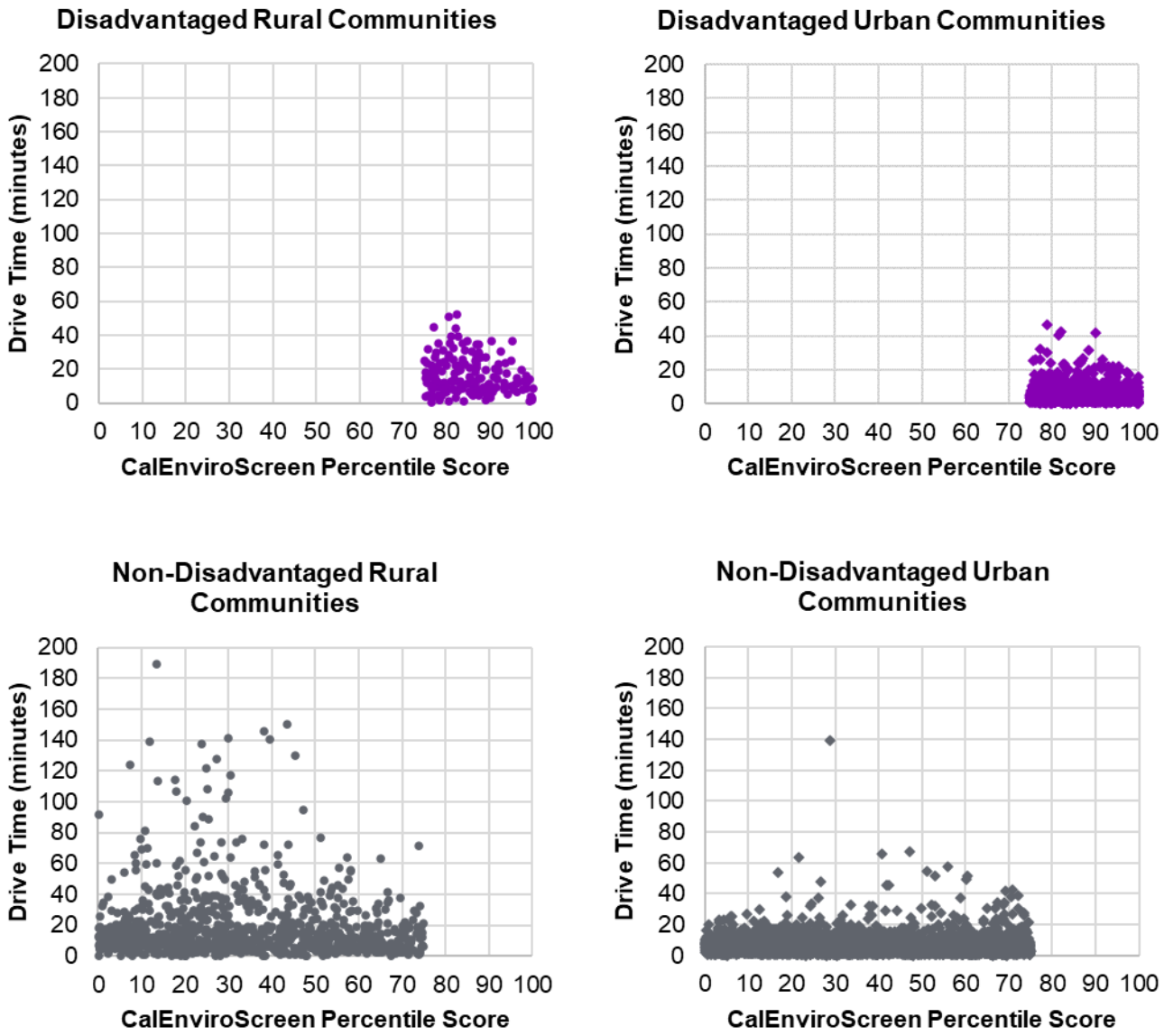
CEC staff evaluated drive times for communities that are disadvantaged rural, disadvantaged urban, communities not identified as disadvantaged by CalEPA using CalEnviroScreen 3.0 (non-disadvantaged) rural, and non-disadvantaged urban. About 15 percent of all disadvantaged communities have drive times of 10 minutes or more; about 20 percent of non-disadvantaged communities have drive times that long. In contrast, non-disadvantaged rural communities have the longest average drive time when grouped, followed closely by disadvantaged rural communities (19 and 16 minutes respectively). Disadvantaged urban and non-disadvantaged urban communities have average drive times of 6 minutes. Ungrouped, drive times vary greatly, especially among non-disadvantaged rural communities, which have drive times that range from under 5 minutes to more than 3 hours (Figure 2.10). Drive times for disadvantaged rural communities range from under 5 minutes to 52 minutes, and drive times for disadvantaged urban communities range from under 5 minutes to 46 minutes.

[26] Senate Bill 535 (De León, Chapter 830, Statutes of 2012) directs the California Environmental Protection Agency (CalEPA) to identify disadvantaged communities for investment opportunities. The California Office of Environmental Health Hazard Assessment (OEHHA) scores census tracts using indicators of pollution burden and community vulnerability.

California Environmental Protection Agency staff. January 2017. CalEnviroScreen 3.0. Available at https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30.

California Energy Commission staff referred to the most recent final disadvantaged community designations from CalEPA under CalEnviroScreen 3.0. At the time of this analysis, disadvantaged community designations by CalEPA under CalEnviroScreen 4.0 had not been finalized.

Figure 2.10: Drive Time to the Nearest DC Fast Charging Station by CalEnviroScreen 3.0 Percentile Score and Urban or Rural Area



Disadvantaged communities generally have shorter average drive times to a public DC fast charging station than non-disadvantaged communities and drive times are under an hour. Non-disadvantaged rural communities have the longest and most variable drive times. The CEC is committed to investing in disadvantaged communities, including urban disadvantaged communities and recognizes that charging access may be limited by other factors beyond drive time.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, California Environmental Protection Agency disadvantaged community designations using the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 mapping tool. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

About 63 percent of disadvantaged rural communities have drive times of 10 minutes or more (Table 2.6). In contrast, about 59 percent of non-disadvantaged rural communities have drive times of 10 minutes or more. More than half of all disadvantaged urban and non-disadvantaged urban communities have drive times of 5 minutes or less. About 92 percent of disadvantaged communities are urban and about 11 percent of disadvantaged urban communities have drive times of 10 minutes or more. CEC staff will continue to assess public charging access, including charging density in urban communities.

Table 2.6: Drive Time Ranges by Disadvantaged Community Designation and Urban or Rural Area

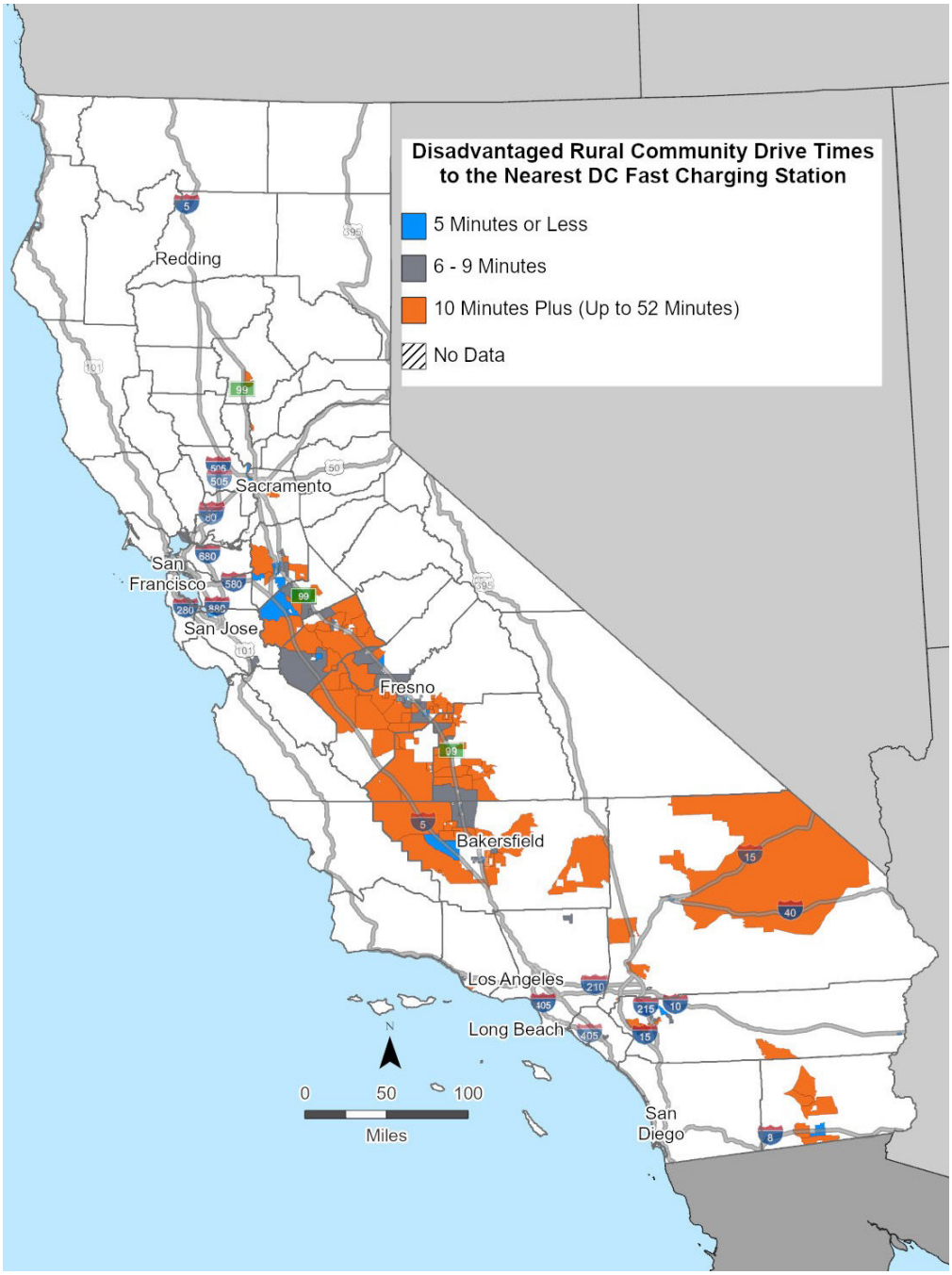
	0 to 5 minutes	6 to 9 minutes	10 plus minutes	N/A*	Total
Disadvantaged Rural	14%	23%	63%	Less than 1%	100%
Disadvantaged Urban	57%	32%	11%	Less than 1%	100%
Non-Disadvantaged Rural	20%	20%	59%	1%	100%
Non-Disadvantaged Urban	61%	26%	13%	Less than 1%	100%

* Drive times were calculated for 7,995 of the 8,012 census tracts with population. Drive times could not be calculated for 17 census tracts because of roadways not connected to a census tract population center. 14 of these census tracts are non-disadvantaged rural and 3 are non-disadvantaged urban.

Source: California Energy Commission staff

Figure 2.11 shows disadvantaged rural community drive times to a public DC fast charging station grouped by those with drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more. Disadvantaged rural communities make up 3 percent of the state's population and 13 percent of the state's geographic area. More than half of all disadvantaged rural communities have drive times of 10 minutes or more. Disadvantaged rural communities with drive times of 10 minutes or more make up about 1 percent of California's population and 11 percent of the state's geographic area. These communities are in the Central Valley, Inland Empire, and Imperial region.

Figure 2.11: Map of Disadvantaged Rural Community Drive Times to the Nearest DC Fast Charging Station

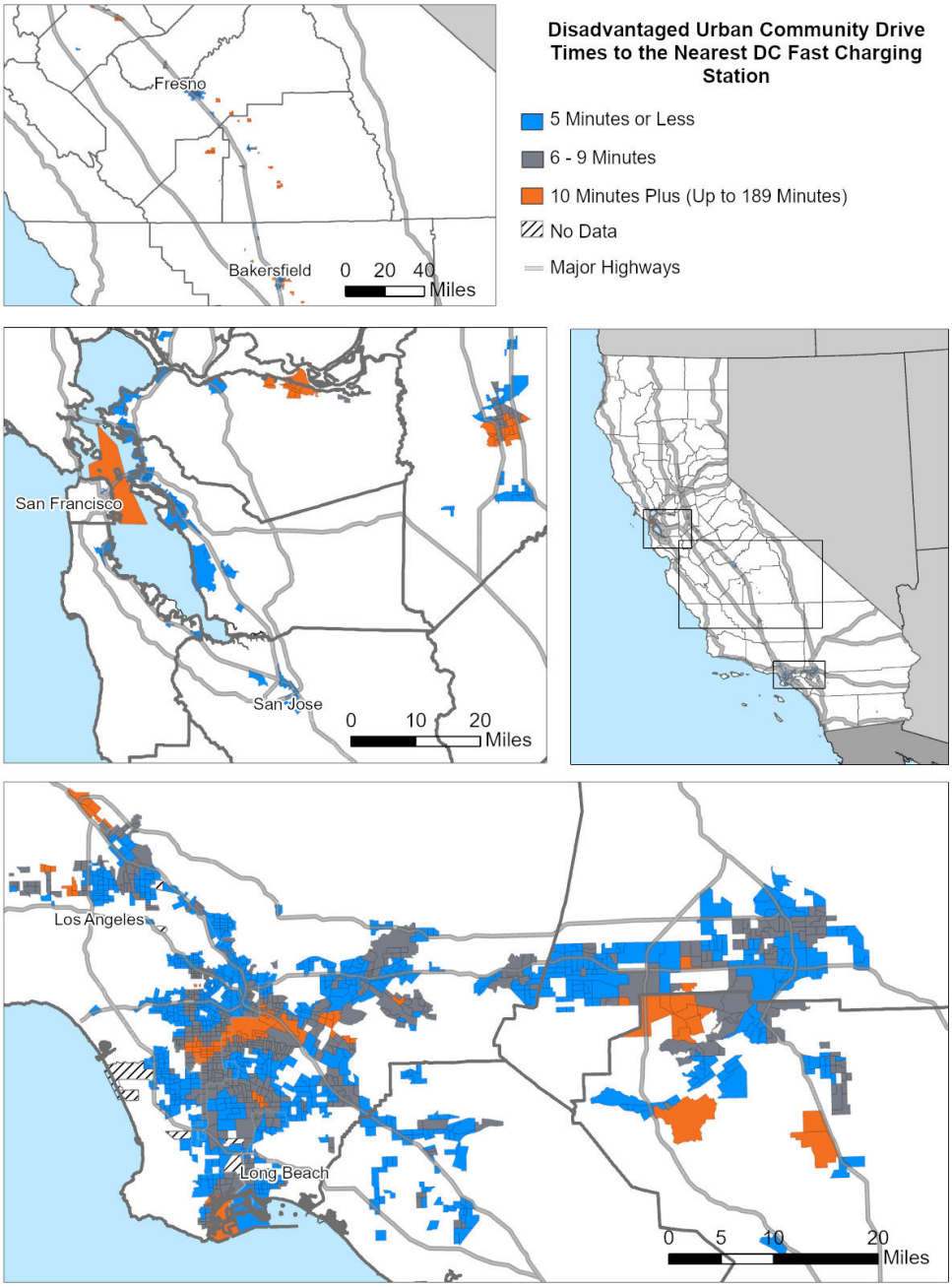


About 63 percent of disadvantaged rural communities have drive times of 10 minutes or more to a public DCFC station.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, California Environmental Protection Agency disadvantaged community designations using the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 mapping tool, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Figure 2.12 shows disadvantaged urban community drive times grouped by those with drive times of 5 minutes or less, 6 to 9 minutes, and 10 minutes or more. This group makes up about 22 percent of California's population and about 1 percent of the state's geographic area. Disadvantaged urban communities with drive times of 10 minutes or more make up about 3 percent of California's population and less than 1 percent of the state's geographic area.

Figure 2.12: Map of Disadvantaged Urban Community Drive Times to the Nearest DC Fast Charging Station



About 11 percent of disadvantaged urban communities have drive times 10 minutes or more to a public DC fast charging station. Of these, most are between 10 and 30 minutes; 7 are between 30 and 46 minutes.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, California Environmental Protection Agency disadvantaged community designations using the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 mapping tool, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Table 2.7 provides a breakdown of communities grouped by disadvantaged community designation and urban or rural area with drive times of 10 to 29 minutes, 30 to 59 minutes, and 60 minutes or more. Of the disadvantaged rural communities with drive times of 10 minutes or more, none has drive times of more than an hour, about 13 percent have drive times between 30 and 59 minutes, and about half have drive times between 10 and 29 minutes. Most disadvantaged urban communities with drive times of 10 minutes or more are in the 10 to 29 minute range. Less than 1 percent of disadvantaged urban communities (7 census tracts) have drive times between 30 and 59 minutes.

Table 2.7: Long Drive Time Ranges by Disadvantaged Community Designation and Urban or Rural Area

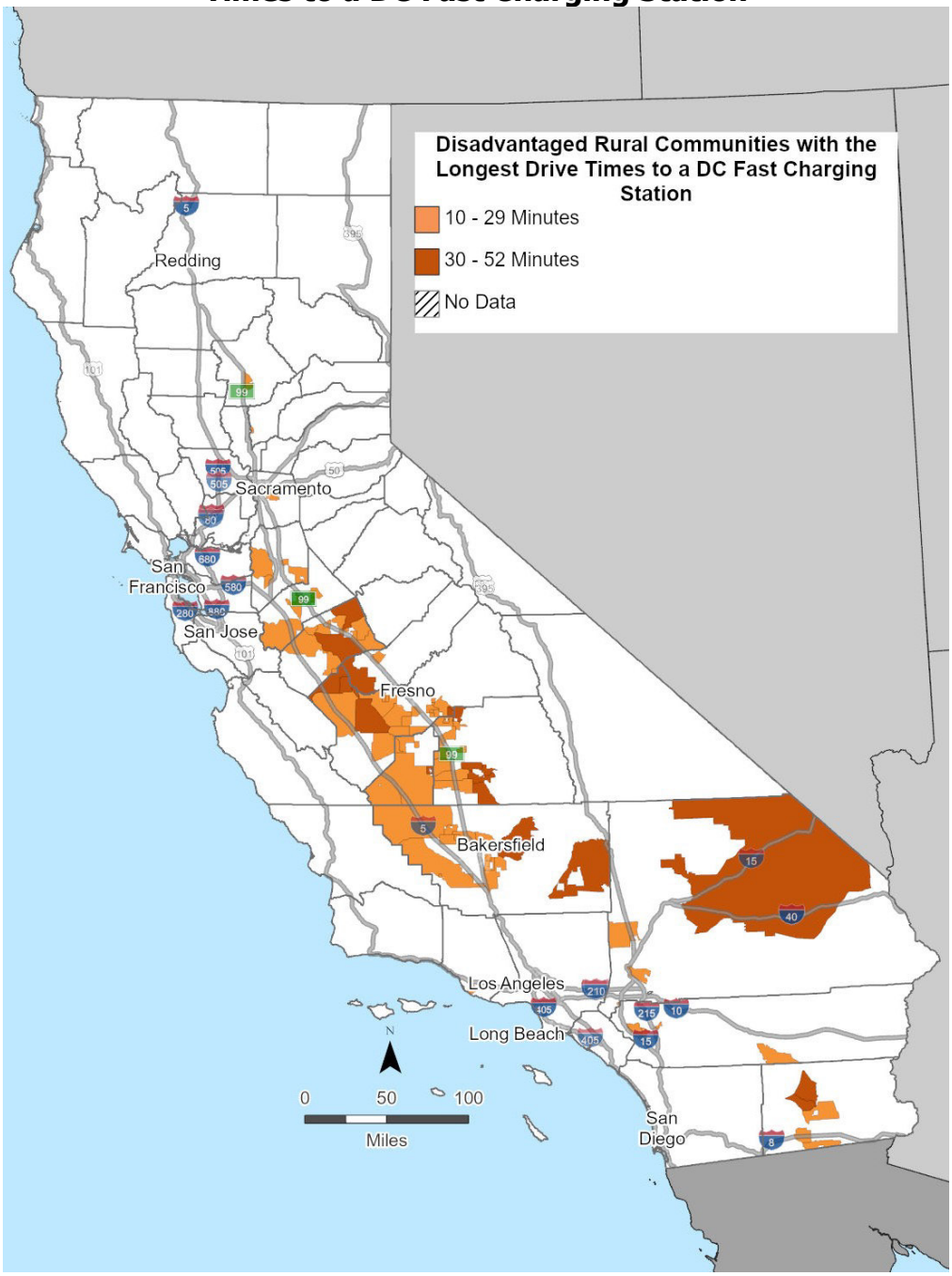
	10 to 29 minutes	**30 to 59 minutes**	**60 plus minutes**	**Total***
Disadvantaged Rural	50%	13%	0%	63%
Disadvantaged Urban	10%	Less than 1%	0%	11%
Non-Disadvantaged Rural	41%	13%	5%	59%
Non-Disadvantaged Urban	12%	1%	Less than 1%	13%

*Column percentages do not add up to 100 since drive times below 10 minutes are not included.

Source: California Energy Commission staff

Figure 2.13 shows disadvantaged rural communities with drive times of more than 10 minutes to a public DC fast charging station, categorized by those with drive times between 10 and 29 minutes, and between 30 and 52 minutes.

Figure 2.13: Map of Disadvantaged Rural Communities with the Longest Drive Times to a DC Fast Charging Station



Of the disadvantaged rural communities with drive times of 10 minutes or more, about half have drive times between 10 to 30 minutes, 13 percent have drive times between 30 and 60 minutes, and none has an average drive time of 60 minutes or more.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2010 Urban and Rural Classifications, California Environmental Protection Agency disadvantaged community designations using the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 mapping tool, U.S. Department of Energy Alternative Fuels Data Center as of February 2, 2021, and California Air Resources Board California Hydrogen Infrastructure Tool roadway data.

Limitations of Analysis

One way to evaluate statewide community public DC fast charging station coverage is to calculate the drive time from census tract population centers to the nearest station during peak traffic. Communities with drive times of 10 minutes or more to a public DC fast charging station have sparse fast charging coverage. Additional DCFC investments may be needed for these communities to improve access for residents. This drive time analysis identifies communities with sparse public DC fast charging station coverage, but will need to be combined with inputs such as traffic patterns, population, land use, and grid capacity, for siting decisions.

This analysis uses census tract population centers as a proxy for the origin of travel. Census tract population centers represent an average of where people live within a census tract. Therefore, the drive times calculated represent the average drive time for residents of a census tract rather than an individual driver's experience. Trips that begin away from home, including trips from work and other origins are not evaluated.

Furthermore, the analysis focuses overall on charging coverage; charging capacity is not evaluated. One public DC fast charging station, regardless of how short the drive is, may not satisfy a community's charging need. Urban communities will need many more chargers to meet demand and mitigate congestion. More examination of EV adoption projections, travel behavior, charging behavior, and charger utilization would be helpful to assess where additional chargers are needed and where targeted public funding would be most beneficial.

This analysis is limited to publicly installed DC fast charging stations but Level 2, Level 1, shared-private[27], and private[28] charging stations are also important parts of the charging network. CEC staff will continue to assess access metrics for unique use cases, such as Level 2 charging. Since charging takes longer with Level 2 chargers, other components of access will be more important than drive time to a Level 2 charger from home. Since electric vehicle service providers (EVSPs) and others are not required to report Level 1, shared-private, or private chargers, the spatial data that is available through voluntary report is very limited. This analysis requires ubiquitous data statewide to evaluate charging deployment.

Charging components including, but not limited to, reliability, cost, vehicle compatibility, and utilization are important for understanding community charging access. CEC staff are addressing some of these components through separate efforts. CEC staff held a public workshop on charging reliability in March of 2022 to gather feedback on how to measure

[27] Shared-private chargers include workplace chargers shared among employees and visitors, multi-unit dwelling chargers shared among tenants and visitors, and fleet chargers shared among vehicles in a fleet.

[28] Private chargers are privately owned and operated and often reserved for a specific person or household.

charger reliability and ensure reliable and accessible chargers for all.[29] As previously mentioned, the SB 1000 deployment assessment requires ubiquitous data statewide, which includes high-resolution spatial data, to conduct analysis at the census tract level and evaluate community charging access. Currently, data at the resolution and completeness needed to evaluate various components of access is limited but CEC staff will continue to analyze charging technologies, attributes, and use cases as more data becomes available. Stakeholder feedback on data and metrics to consider for ongoing SB 1000 analysis is welcomed.[30] The analysis detailed in this report is part of ongoing analysis at the CEC to evaluate existing charging access, which will inform future light-duty EV charging investments.

[29] CEC staff held a public workshop on electric vehicle charging infrastructure reliability on March 11, 2022. More information is available at https://www.energy.ca.gov/event/workshop/2022-03/electric-vehicle-charging-infrastructure-reliability-workshop.

[30] Stakeholder engagement in public workshops on SB 1000 is strongly encouraged. CEC staff have hosted several workshops that provide an overview of SB 1000 analysis, including one on July 8, 2021, to solicit feedback on initial drive time analysis. Upcoming SB 1000 events can be found on the SB 1000 webpage at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure.

CHAPTER 3:
Conclusions and Future Analysis

This analysis finds that about 81 percent of census tracts in California, regardless of whether they are urban or rural, low-, middle-, or high-income, disadvantaged, or non-disadvantaged, or a combination, have population centers within a 10-minute drive of a public DCFC station. This represents about 81 percent of California's total population and 14 percent of the state's geographic area. About 54 percent have drive times within 5 minutes (54 percent of population and 6 percent of the state's geographic area).

Grouped by urban or rural, income level, disadvantaged community designation, and combinations of these, analysis shows:

- **Rural communities have less public fast charging station coverage than urban communities.** About 60 percent of rural communities have drive times of 10 minutes or more to the nearest public DC fast charging station. This group makes up 8 percent of California's population and 84 percent of the state's geographic area. About 12 percent of urban communities have drive times of 10 minutes or more (11 percent of population and 1 percent of the state's geographic area).
- **Low-income rural communities have the least public fast charging station coverage.** About 69 percent of low-income rural communities have drive times of 10 minutes or more to the nearest public DC fast charging station. This group makes up 4 percent of California's population and 64 percent of the state's geographic area. Most low-income communities are urban (89 percent). About 11 percent of low-income urban communities have drive times of 10 minutes or more (6 percent of population and less than 1 percent of the state's geographic area).
- **Public fast charging station coverage among disadvantaged urban communities varies and gaps exist.** About 15 percent of disadvantaged communities have drive times of 10 minutes or more to the nearest public DC fast charging station. Disadvantaged communities make up 25 percent of California's population and 14 percent of the state's geographic area. 92 percent of all disadvantaged communities are urban and about 11 percent of disadvantaged urban communities have drive times of 10 minutes or more (22 percent of population and less than 1 percent of the state's geographic area).

The SB 1000 webpage, available at https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/electric-vehicle-infrastructure, provides high resolution drive time maps and spreadsheets with drive times by census tracts.

CEC staff will continue to refine and update the SB 1000 analysis to help inform new charging infrastructure deployment that improves access for all Californians. This will include analyzing various charging technologies and use cases, improving metrics, and updating designations of low-income, disadvantaged, and rural communities. Possible questions to explore include:

- How to combine charging infrastructure coverage and density metrics to better assess community charging access and identify areas where more public DCFCs may be needed to meet expected demand. For example, of the rural, low-income, and disadvantaged communities with drive times of less than 10 minutes to a public DCFC, which have a low ratio of DCFCs to population? What are drive times to the second nearest public DC fast charging station?
- What is the potential to install at-home charging for residents of urban and rural communities, specifically in those that are low-income and/or disadvantaged?
- What does public charging access look like in and near areas with high density of multifamily, rental, and/or affordable housing? What attributes do these areas have (e.g., built environment characteristics like garage, street parking ratios) and how can these be used to guide investments?
- How does the road network, built environment, and typical daily travel behavior contribute to long drive times observed among communities?

The CEC is committed to increasing charging access for underserved communities to ensure that all Californians benefit from the transition to ZEVs. As of August 2021, the CEC has awarded about 51 percent of CTP funding to projects located in disadvantaged and/or low-income communities and will continue to commit more than 50 percent of program funding to these populations.[31] At the end of 2021, the CEC announced two grant funding opportunities targeting multifamily housing residents and rural residents where at least 50 percent of project funding has to be within disadvantaged or low-income communities.[32] However, project location is not the only metric for CTP community benefits. CEC staff are working on a public process to define, measure, track and increase program community benefits. CEC staff are also developing partnerships to increase community participation and program benefits. An example of this is CEC's partnership with CARB to expand program eligibility and funding for window 2 of the Clean Mobility Options (CMO) Program, serving disadvantaged and low-income communities, and California Native American Tribes.[33] The CEC has also partnered with

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[31] Brecht, Patrick. 2021. *2021-2023 Investment Plan Update for the Clean Transportation Program*. California Energy Commission. Publication Number: CEC-600-2021-038-CMF. Available at https://www.energy.ca.gov/publications/2021/2021-2023-investment-plan-update-clean-transportation-program.

[32] The Reliable, Equitable, and Accessible Charging for multi-family Housing (REACH) Grant Funding Opportunity provided $26,622,490 to improve charging access for MFH residents. More information is available at https://www.energy.ca.gov/solicitations/2021-11/gfo-21-603-reliable-equitable-and-accessible-charging-multi-family-housing.

The Rural Electric Vehicle (REV) Charging Grant Funding Opportunity announced over $20 million in proposed awards to improve charging access for rural residents in June 2022. More information is available at https://www.energy.ca.gov/solicitations/2021-12/gfo-21-604-clean-transportation-program-rural-electric-vehicle-rev-charging.

[33] The CMO Program provides zero-emission carsharing, carpooling, vanpooling, bike sharing, innovative transit services, and ride-on-demand services and supporting refueling infrastructure to disadvantaged communities and

the Foundation for California Community Colleges to expand local community outreach and engagement and technical assistance across the CTP.[34] Ongoing SB 1000 analysis will provide guidance for the CEC's light-duty EV block grant programs, focused on charger deployment, and future grant funding opportunities, focused on innovative charging technologies and business models for targeted populations.

low-income communities and households and California Native American Tribes. The CEC is providing $8 million to fund additional CMO Program vouchers, technical assistance, and outreach to communities.

[34] The IDEAL Communities Partnership was launched in 2020 through an agreement with the Foundation for California Community Colleges (FCCC).

GLOSSARY

AIR POLLUTANT – Amounts of foreign and/or natural substances occurring in the atmosphere that may result in adverse effects to humans, animals, vegetation and/or materials.

CALENVIROSCREEN – A mapping tool that helps identify California communities that are most affected by many sources of pollution, and where people are often especially vulnerable to pollution's effects.

CALENVIROSCREEN SCORE – A percentile rank given to each California Census Tract in relation to the rest of California based on potential exposures to pollutants, adverse environmental conditions, socioeconomic factors, and prevalence of certain health conditions. This data is provided by the Office of Environmental Health Hazard Assessment (OEHHA). For more information on the CalEnviroScreen Score and how it is calculated, please go to www.oehha.ca.gov.

CALIFORNIA AIR RESOURCES BOARD (CARB) – The "clean air agency" in the government of California, whose main goals include attaining and maintaining healthy air quality; protecting the public from exposure to toxic air contaminants; and providing innovative approaches for complying with air pollution rules and regulations.

CALIFORNIA ENERGY COMMISSION (CEC) - The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are forecasting future statewide energy needs; licensing power plants sufficient to meet those needs; promoting energy conservation and efficiency measures; developing renewable and alternative energy resources, including assisting to develop clean transportation fuels and ZEV infrastructure; and planning for and directing state response to energy emergencies.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY (CalEPA) – A state government agency established in 1991 for unifying environmental activities related to public health protection in the State of California. There are six boards, departments, and offices under the organization of CalEPA including the California Air Resources Board (CARB), State Water Resources Control Board (SWRCB) and its nine Regional Water Quality Control Boards (RWQCB), Department of Pesticide Regulation (DPR), Department of Toxic Substances Control (DTSC), Department of Resources Recycling and Recovery (CalRecycle), and Office of Environmental Health Hazard Assessment (OEHHA). The CalEPA boards, departments and offices are directly responsible for implementing California environmental laws or play a cooperative role with other regulatory agencies at regional, local, state, and federal levels.

CALIFORNIA PUBLIC UTILITES COMMISSION (CPUC) – A state agency created by a California constitutional amendment in 1911 to regulate the rates and services of more than 1,500 privately owned utilities and 20,000 transportation companies. The CPUC is an administrative agency that exercises legislative and judicial powers. The major duties of CPUC are to regulate privately owned utilities, securing adequate service to the public at rates that are just and reasonable to customers and shareholders of the utilities, and the oversight of electricity

transmission lines and natural gas pipelines. The CPUC also provides electricity and natural gas forecasting, and analysis and planning of energy supply and resources.

CENSUS TRACTS – Small, relatively permanent statistical subdivisions of a county or equivalent entity that are updated by local participants prior to each decennial census as part of the U.S. Census Bureau's Participant Statistical Areas Program. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. A census tract usually covers a contiguous area; however, the spatial size of census tracts varies widely depending on the density of settlement. Census tract boundaries generally follow visible and identifiable features.

CHARGER – Chargers or Electric Vehicle Supply Equipment (EVSE) are manufactured units that safely deliver electricity to charge the battery of a plug-in electric vehicle.

CHARGING STATION – One or more chargers located at a specified address. There are three categories of charging station access:

- Public charging stations have parking space(s) designated by a property owner or lessee to be available to and accessible by the public. Under Section 44268 of Division 26 of the Health and Safety Code, a publicly available parking space shall not include a parking space that is part of, or associated with, a private residence or a parking space that is reserved for the exclusive use of a driver or drivers.
- Private charging stations have parking space(s) that are privately owned and operated, often dedicated for a specific driver or vehicle.
- Shared-private charging stations have parking space(s) designed by a property owner or lessee to be available to and accessible by employees, tenants, visitors, and/or residents. Parking spaces are not reserved to individual drivers or vehicles, and include workplaces, multifamily dwellings, and fleets.

DISADVANTAGED COMMUNITIES – Census tracts that score within the top 25th percentile of the Office of Environmental Health Hazards Assessment's California Communities Environmental Health Screening Tool (CalEnviroScreen) 3.0 scores, as well as areas of high pollution and low population, such as ports. (At the time of this analysis, disadvantaged community designations under CalEnviroScreen 4.0 had not been finalized.)

ELECTRIC VEHICLE (EV) – A broad category that includes all vehicles that can be fully powered by electricity or an electric motor.

EQUITY – Refers to the fair treatment, meaningful involvement, and strategic investment of resources through clean transportation programs, incentives, and processes for all Californians so that race, color, national origin, or income level are not barriers to increased opportunities and participation.

GREENHOUSE GAS (GHG) – Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide

(NO_x), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

HIGH-INCOME COMMUNITIES – Census tracts with median household incomes at or above 120 percent of the statewide median income or with median household incomes at or above the threshold designated as moderate-income by the Department of Housing and Community Development's list of state income limits adopted under Healthy and Safety Code section 50093.

LIGHT DUTY VEHICLE (LDV) – Any motor vehicle with a gross vehicle weight of 6,000 pounds or less.

LOW-INCOME COMMUNITIES – Census tracts with median household incomes at or below 80 percent of the statewide median income or with median household incomes at or below the threshold designated as low income by the Department of Housing and Community Development's list of state income limits adopted under Healthy and Safety Code section 50093.

MIDDLE-INCOME COMMUNITIES – Census tracts with median household incomes between 80 to 120 percent of the statewide median income, or with median household incomes between the threshold designated as low- and moderate-income by the Department of Housing and Community Development's list of state income limits adopted pursuant to Healthy and Safety Code section 50093.

POPULATION CENTER – The mean center of population for a geographic area (e.g., census tract).

RURAL COMMUNITIES – Census tracts with population and where at least 50 percent of the census tract's land area is rural.

URBAN COMMUNITIES – Census tracts with population that are not rural communities.

ZERO-EMISSION VEHICLE (ZEV) - Vehicles that produce zero emissions from the on-board source of power. There are three types of zero-emission vehicles:

- Battery-electric vehicles (BEVs), also known as an "All-electric" vehicle (AEV), utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source to recharge.
- Plug-in hybrid electric vehicles (PHEVs) are powered by an internal combustion engine and an electric motor that uses energy stored in a battery. The vehicle can be plugged in to an electric power source to charge the battery. Some can travel nearly 100 miles on electricity alone, and all can operate solely on gasoline (similar to a conventional hybrid).
- Fuel cell electric vehicles (FCEVs) run on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

- Plug-in electric vehicles (PEVs) run at least partially on battery power and is recharged from the electricity grid. There are two types of PEVs: pure battery-electric and plug-in hybrid electric vehicles.

APPENDIX A:
Senate Bill 1000 (Lara, Statutes of 2018, Chapter 368) Excerpt

The following is an excerpt from Senate Bill (SB) 1000 (Lara, Statutes of 2018, Chapter 368), with language from sections 1 and 3 relevant to this report.

Section 1.

(a) The Legislature finds and declares that ensuring electric vehicle infrastructure is accessible to all types of electric vehicles is not a municipal affair, as that term is used in Section 5 of Article XI of the California Constitution, but is instead a matter of statewide concern.

(b) It is the intent of the Legislature that local entities do not adopt ordinances that create unreasonable barriers to the use of electric vehicle infrastructure.

(c) It is the policy of the state to promote and encourage the use of electric vehicle infrastructure and to limit obstacles to its use.

(d) It is the intent of the Legislature to increase access to electric vehicle infrastructure in all California communities. Charging speed is a critical component of access and should be considered in public investment strategies related to electric vehicle charging infrastructure.

Section 3.

Section 25231 is added to the Public Resources Code, to read:

25231.

(a) The commission, in consultation with the State Air Resources Board, shall, as part of the development of the plan prepared pursuant to Section 44272.5 of the Health and Safety Code, assess whether charging station infrastructure is disproportionately deployed by population density, geographical area, or population income level, including low-, middle-, and high-income levels. This includes whether direct-current fast charging stations are disproportionately distributed and whether access to these charging stations is disproportionately available. Upon making a finding that charging station infrastructure has been disproportionately deployed, the commission shall use moneys from the Alternative and Renewable Fuel and Vehicle Technology Fund, to the extent authorized by law, as well as other mechanisms, including incentives, to more proportionately deploy new charging station infrastructure, unless the commission makes a finding that the disproportionate deployment is reasonable and furthers state energy or environmental policy as articulated by the commission.

(b) For purposes of this section, "charging station" means the removable equipment that provides alternating or direct current to the battery electric vehicle or plug-in hybrid electric

vehicle, but does not include the supporting charging infrastructure, such as wiring, conduit, and electric panels.

APPENDIX B:
Methodology for Identifying Low-, Middle-, and High-Income Communities

SB 1000 low-, middle-, and high-income communities are defined as:

- **Low-income communities** are census tracts with median household incomes at or below 80 percent of the statewide median income or with median household incomes at or below the threshold designated as low income by the Department of Housing and Community Development's list of state income limits adopted pursuant to Section 50093 of the California Health and Safety Code.[35]
- **Middle-income communities** are census tracts with median household incomes between 80 to 120 percent of the statewide median income, or with median household incomes between the threshold designated as low- and moderate-income by the Department of Housing and Community Development's list of state income limits adopted pursuant to section 50093 of the California Health and Safety Code.
- **High-income communities** are census tracts with median household incomes at or above 120 percent of the statewide median income or with median household incomes at or above the threshold designated as moderate-income by the Department of Housing and Community Development's list of state income limits adopted pursuant to section 50093 of the California Health and Safety Code.

Low-, middle-, and high-income communities are identified using the state median household income and the California Department of Housing and Community Development (HCD) 2020 state income limits table. The HCD publishes annual state income limits for extremely low-, very low-, low-, and moderate-income households.[36] The HCD establishes state income limits for each county by household size as shown by Table B.1 for Los Angeles County as an example. To identify low-, middle-, and high-income communities, CEC staff referred to the low-income and moderate-income limits from the HCD state income limit table. The HCD's low-income limit "reflects 160 percent of the very low-income limit," which is typically 50 percent of the median family income. The HCD's moderate-income limit "reflects 120 percent of the county's area median income," which is determined using a 4-person household.

[35] California Health and Safety Code Section 39713. Available at https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=26.&title=&part=2.&chapter=4.1.&article=.

[36] California Department of Housing and Community Development staff. 2020. State Income Limits for 2020. Available at https://www.hcd.ca.gov/grants-funding/income-limits/state-and-federal-income-limits/docs/income-limits-2020.pdf.

Table B.1: California Department of Housing and Community Development 2020 State Income Limits for Los Angeles County

Number of Persons in Household		1	2	3	4	5	6	7	8
Los Angeles County Area Median Income: $77,300	Extremely Low	23,700	27,050	30,450	33,800	36,550	39,250	41,950	44,650
	Very Low	39,450	45,050	50,700	56,300	60,850	65,350	69,850	74,350
	Low Income	63,100	72,100	81,100	90,100	97,350	104,550	111,750	118,950
	Median Income	54,100	61,850	69,550	77,300	83,500	89,650	95,850	102,050
	Moderate Income	64,900	74,200	83,500	92,750	100,150	107,600	115,000	122,450

Source: California Energy Commission staff from the California Department of Housing and Community Development

Figure B.1 illustrates how low-, middle-, and high-income census tracts were identified for the SB 1000 assessment using the HCD income limits and state median income level for parts of Los Angeles County. The median household income[37], average household size[38], and county of each census tract were identified from the U.S. Census Bureau. These attributes were used to identify the income level of a census tract using HCD's low- and moderate-income limits. Staff rounded average household sizes to the nearest whole number and cross-referenced these with the row in the HCD's income limits table listing the number of persons in the household for the county to identify the appropriate limits to apply from the table. Staff then identified California's median household income (MHI)[39] and calculated 80 and 120 percent of the MHI to apply the full definitions of low-, middle-, and high-income communities; these include county median incomes and state median income as baselines.

Staff assessed whether census tracts fall under, between, or above the HCD's low- and moderate-income limits. Or, whether census tracts fall under, between, or above 80 and 120 percent of the state median income limit. For example, the median household income for census tract 6037106112, which is $90,875, falls above the HCD low-income limit and 80 percent of the state MHI limit, and is therefore not a low-income community. But it falls between the HCD low- and moderate-income limits and above 120 percent of the state MHI

[37] U.S. Census Bureau. 2014- 2018. Census Tracts, California, B19013 Median Household Income (Data). 2018 American Community Survey 5-Year Estimates. Available at https://www.census.gov/data.html.

[38] U.S. Census Bureau. 2014 – 2018. Census Tracts, California, B25010 Average Household Size of Occupied Housing Units by Tenure (Data). 2018 American Community Survey 5-Year Estimates. Available at https://www.census.gov/data.html.

[39] U.S. Census Bureau. 2014- 2018. Census Tracts, California, B19013 Median Household Income (Data). 2018 American Community Survey 5-Year Estimates. Available at https://www.census.gov/data.html.

limit and could therefore be a middle- or high-income community. When a census tract meets two income definitions, it is assigned the lower income level. So, although, census tract 6037106112 meets both the middle-income and high-income definitions, it is considered a middle-income community. This way, any community that meets the low-income definition but also meets the middle-income definition is designated as a low-income community and is considered for program funding that targets low-income communities.

Figure B.1: Identification of Low-, Middle-, and High-income Communities in Los Angeles County

1. Identify the median household income, average household size, and county of each census tract.

Census Tract ID*	Median Household Income	Average Household Size	County
6037101110	$53,007	3	Los Angeles
6037106112	$90,875	4	Los Angeles
6037109800	$96,422	4	Los Angeles

*Sample of census tracts in Los Angeles County

2. Use the average household size of each census tract county combination to identify the income limits that apply from the California Department of Housing and Community Development's state income limits table.

Number of Persons in Household		1	2	3	4
Los Angeles County Area Median Income: $77,300	Low-income	$63,100	$72,100	$81,100	$90,100
	Moderate-income	$64,900	$74,200	$83,500	$92,750

Census Tract ID	Median Household Income	Average Household Size	County	HCD Low Income Limit	HCD Moderate Income Limit
6037101110	$53,007	3	Los Angeles	$81,100	$83,500
6037106112	$90,875	4	Los Angeles	$90,100	$92,750
6037109800	$96,422	4	Los Angeles	$90,100	$92,750

3. Calculate 80 and 120 percent of the state median household income.

State Median Household Income	80% of State Median Household Income	120% of State Median Household Income
$71,228	$56,982	$85,474

4. Apply limits to identify whether a census tract is a low-, middle-, or high-income community.

Census Tract ID	Low-income Community?	Middle-income Community?	High-income Community?
6037101110	HCD Limit: **Yes** ($53,077 ≤ $81,100) OR State MHI Limit: **Yes** ($53,077 ≤ $56,982)	HCD Limit: No ($81,100 < $53,007 < $83,500) OR State MHI Limit: No ($56,982 < $53,007 < $85,474)	HCD Limit: No ($53,007 ≥ $83,500) OR State MHI Limit: No ($53,007 ≥ $85,474)
6037106112	HCD Limit: No ($90,875 ≤ $90,100) OR State MHI Limit: No ($90,875 ≤ $56,982)	HCD Limit: **Yes** ($90,100 < $90,875 < $92,750) OR State MHI Limit: No ($56,982 < $90,875 < $85,474)	HCD Limit: No ($90,875 ≥ 92,750) OR State MHI Limit: **Yes*** ($90,875 ≥ $85,474)
6037109800	HCD Limit: No ($96,422 ≤ $90,100) OR State MHI Limit: No ($96,422 ≤ $56,982)	HCD Limit: No ($90,100 < $96,422 < $92,750) OR State MHI Limit: No ($56,982 < $96,422 < $85,474)	HCD Limit: **Yes** ($96,422 ≥ $92,750) OR State MHI Limit: **Yes** ($96,422 ≥ $92,750)

*When a census tract meets both the HCD and state MHI limits, income is identified in the following order: low-, middle-, then high-income.

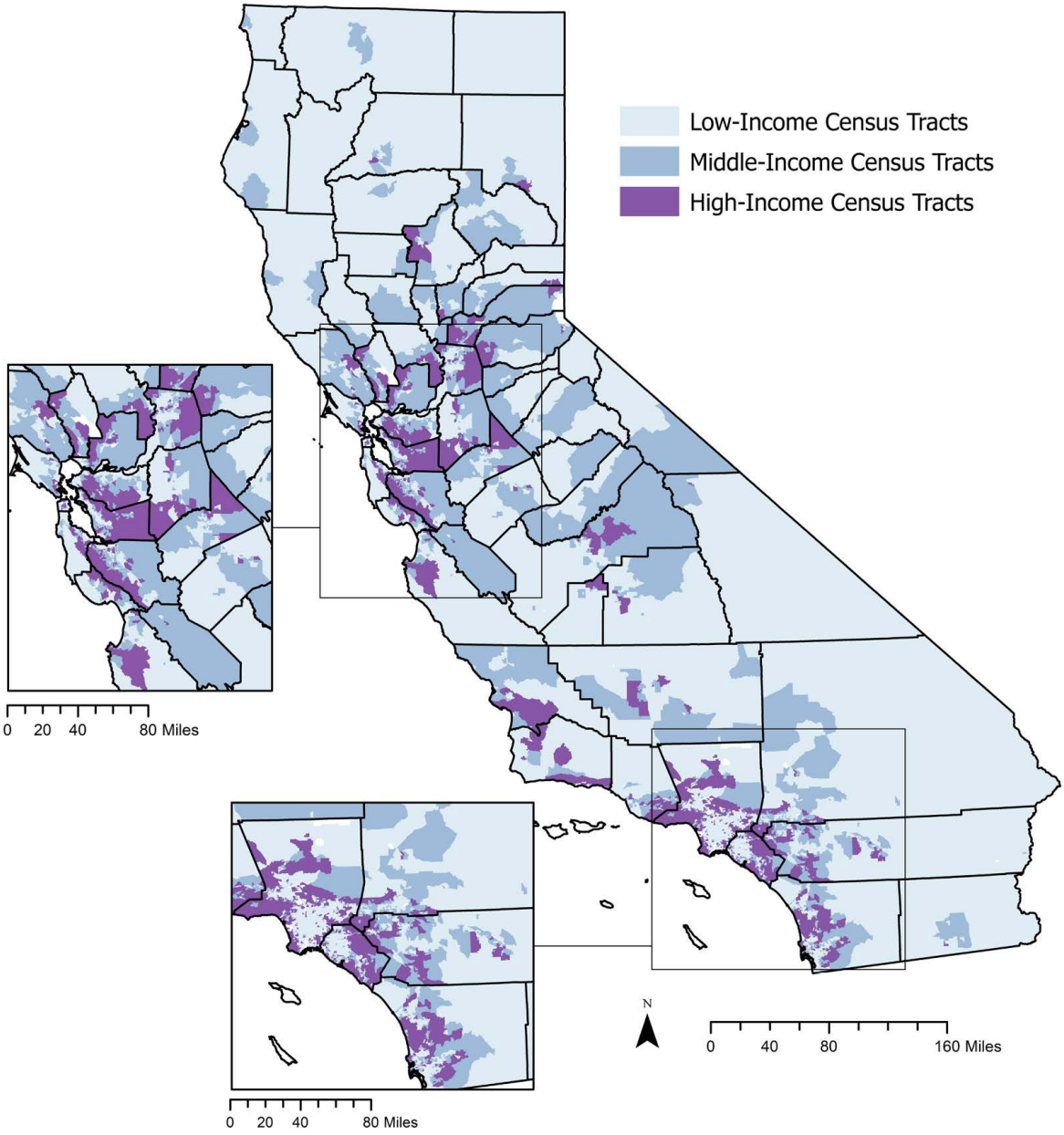
Census tracts are grouped by income level to conduct income-specific analysis required by SB 1000. CEC staff identified low-, middle-, and high-income communities using census tract median

household incomes, average household sizes, and accounted for county median income and state median income.

Source: California Energy Commission Analysis using data from U.S. Census Bureau 2014 – 2018 American Community Survey and California Department of Housing and Community Development 2020 State Income Limits.

Figure B.2 shows the locations of low-, middle-, and high-income communities.

Figure B.2: Map of SB 1000 Low-, Middle-, and High-income Communities



SB 1000 requires analysis of chargers by population income level, including low-, middle-, and high-income levels.

Source: California Energy Commission analysis using data from the U.S. Census Bureau 2014-2018 American Community Survey Median Household Income and Average Household Size 5-Year Estimates and California Department of Housing and Community Development 2020 State Income Limits.