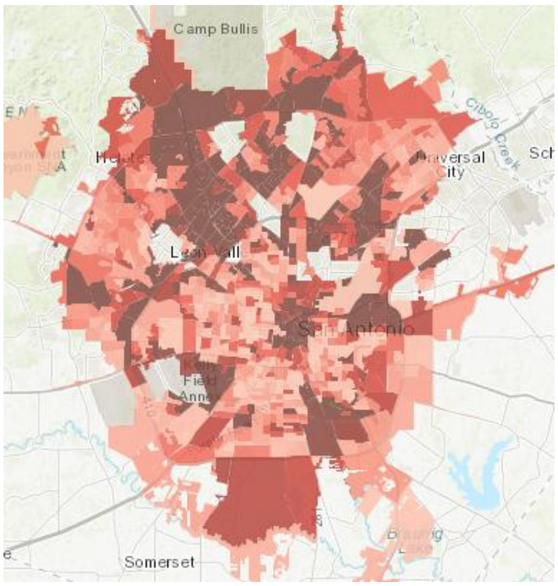
# City of San Antonio

## Electric Vehicle Fleet Conversion and City-Wide Electric Vehicle Infrastructure Study

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# MESSAGE FROM THE MAYOR

San Antonio's transportation sector is quickly changing. Ridesharing and carsharing programs connect our communities, save travelers' time and money, create new employment opportunities, and reduce car ownership. Micro-mobility, like shared electric scooters and bikes, dot our sidewalks and provide "last mile" solutions to mobility challenges. Yet, nowhere are changes in the transportation sector more evident than in the rapidly growing market for electric vehicles (EVs).

We cannot hide the fact the transportation sector has real challenges. Over the past few years, ground-level ozone in Bexar County has risen, creating tangible health impacts for all residents – particularly those in underserved communities. Greenhouse gases emitted from combustion engines contribute to climate change and impact our residents' susceptibility to flooding and inclement weather. San Antonio must do everything we can to improve our air and environment.

I am proud of the progress to date for addressing these issues—San Antonio is one of 25 cities chosen to participate in the American Cities Climate Challenge to accelerate the mitigation of greenhouse gas emissions by the end of 2020. Eight actions have been prioritized in the building energy and transportation sectors, two of which impact EVs. Additionally, the *Climate Action and Adaption Plan* outlines several actions that will result in cleaner and more efficient vehicle technologies.

Largescale transportation electrification is needed now! This study provides a blueprint for a smooth, equitable, and cost-effective transition to greater EV adoption. The path is not easy. We must take the "long view" and ensure our infrastructure and municipal programs are ready for the transition. We must build on successes, one at a time. We must harness the collective spirit of all EV stakeholders. It is hard work, but ultimately, transportation electrification will clean our air, improve our health, reduce traffic noise, and save us money.

Mayor Ron Nirenberg

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# GLOSSARY

**ADA –** American Disabilities Act

**AMD –** Automated Mobility Districts. A campus-sized implementation of connected/automated vehicle technology to realize the full benefits of a fully electric automated mobility service within a confined region or district.

**BEV** – Battery electric vehicle is a vehicle powered exclusively by electricity (such as a Nissan LEAF).

**CAAP** – *San Antonio Climate Ready: A Pathway for Climate Action and Adaptation Plan*, adopted in October 2019, is a community-driven plan to guide San Antonio's efforts to reduce its greenhouse gas contributions to climate change and prepare for current and future impacts.

**CPS Energy** – Municipal-owned utility that provides electricity to Bexar County.

**DCFC** – Direct-current (DC) fast charging equipment, sometimes called DC Level 2 (typically 208/480V AC three-phase input), enables rapid charging of an EV. More details are below.

**DOE** – United States Department of Energy.

**EV** – Electric vehicle is a vehicle powered, at least in part, by electricity. Unless otherwise noted, the term "EV" refers to all plug-in vehicles in this report and includes BEVs and plug-in hybrid electric vehicles (PHEVs) defined below. The term "EV" is synonymous with "plug-in electric vehicle" (PEV).

**GHG** – Greenhouse gas.

**ICE vehicle** – Internal combustion engine vehicle is a vehicle that combusts fuel, such as gasoline or diesel, for power.

**kW** – Kilowatt is a unit of power.

**kWh** – Kilowatt-hour is a unit of energy.

**Level 1 station** – AC Level 1 station (often referred to simply as Level 1) provides charging through a 120-volt (120V) AC port.

**Level 2 station** – AC Level 2 station offers charging through 208V (typical in commercial applications) to 240V (typical in residential applications) electrical service.

**LMI households** – Low- and moderate-income households are defined by the United States Department of Housing and Urban Development as at least 80% (low) and 100% (moderate) of the median income of a region. For example, for a four-person household in the San Antonio–New Braunfels metro area, the low threshold is $56,800 and the moderate threshold is $71,000 in 2019.[1]

**$NO_x$** – Oxides of nitrogen.

[1] US Department of Housing and Urban Development. 2019. *Low and Moderate Income Thresholds*. https://www.huduser.gov/portal/datasets/il/il2019/2019ILCalc3080.odn

**PEV** – Plug-in electric vehicle is a vehicle powered, at least in part, by electricity. The term "PEV" is synonymous with the term "EV." In this document the term EV is used instead of PEV.

**PHEV** – Plug-in hybrid electric vehicle (such as a Prius Prime) is a vehicle that is powered by electricity or an internal combustion engine.

**Plug** – The component of a station that connects with the vehicle and provides electricity. Plug is sometimes used interchangeably with "connector" or "port." This study uses the word "port." See Figure 1.

**$PM_{2.5}$** – Fine particulate matter.

**$PM_{10}$** – Large particulate matter.

**Port –** The component of a station that connects with the vehicle and provides electricity. Port is sometimes used interchangeably with "connector" or "plug." This study uses the word "port." See Figure 1.

**$SO_x$** – Sulfur oxides.

**Station** – A stand-alone piece of equipment capable of charging a vehicle. Station is sometimes used interchangeably with "charger," "pedestal," "machine," "electric vehicle supply equipment (EVSE)," or "dispenser." See Figure 1.

**Station plaza** – A set of one or more stations at a single location operated by the same EV service provider. See Figure 1.

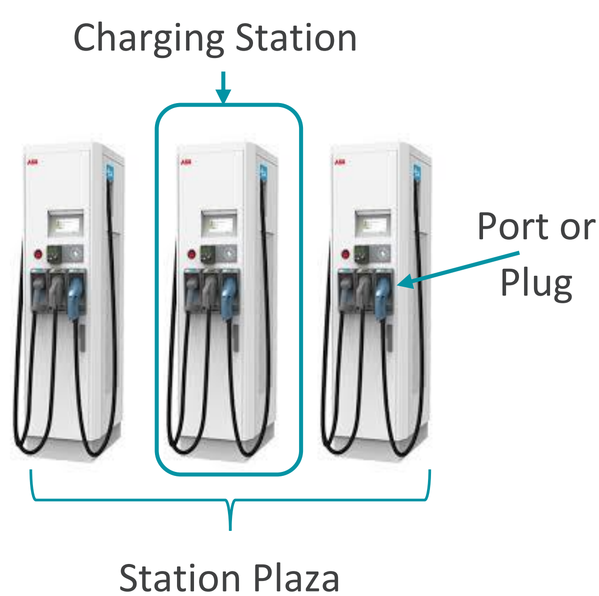


**Figure 1. Explanation of station, port, and station plaza.**

**TCO** – Total cost of ownership, comprising vehicle purchase cost, infrastructure costs, and operations and maintenance costs, less any residual value recovered at the time of sale.

**TNC –** Transportation Network Companies, such as Uber and Lyft.

**TOU rates** – Time of use electricity rates that typically trade higher on-peak rates for lower off-peak rates. They can be designed for residential customers in general, or specifically for EV charging.

**VOC** – Volatile organic compounds.

**Well-to-wheels** – A complete vehicle fuel-cycle analysis that includes the emissions associated with fuel mining, transport, and production (well-to-tank), as well as vehicle operation (tank-to-wheels).

# EXECUTIVE SUMMARY

*The Electric Vehicle Fleet Conversion and City-Wide Electric Vehicle Infrastructure Study* assesses the barriers and opportunities to greater electric vehicle (EV) adoption in San Antonio. EVs include any car or truck powered by electricity, including pure battery electric vehicles (BEVs) such as the Nissan LEAF and plug-in hybrid electric vehicles (PHEVs) such as the Prius Prime.[2] The objectives of this study are to promote a common understanding of EVs in San Antonio, provide near-term strategies for accelerating EV adoption, describe a plan for the electrification of the municipal fleet, and ensure that the benefits and costs of EVs are shared equally across residents of San Antonio. The box below summarizes basic facts about San Antonio's emerging EV market.[3]

## QUICK FACTS: SAN ANTONIO EVs

**2,400 EVs in San Antonio**
~50% BEVs and ~50% PHEVs

**16 light-duty EV models available**
Many more expected in next 3 years, including electric pickup trucks

**1.5 EVs per 1,000 people**
Compared to 1.4 in Texas and 3.9 nationally

**253 public charging ports**
19 DC fast charging ports and 234 public Level 2 ports

**45,000 EVs projected by 2030**
Based on CPS Energy forecasts

**1 charging port per 10 EVs**
Compared to 5 to 10 in leading EV cities

EVs offer San Antonio an array of economic, environmental, public health, and social benefits:

### Health outcomes

Internal combustion engine vehicles produce air pollution through tailpipe emissions, which adversely affects health outcomes. Populations in disadvantaged communities are particularly vulnerable to air pollution stressors and often live closer to roadways than people in other communities.[4] Transportation electrification is the only technological strategy that entirely eliminates tailpipe emissions.

### Greenhouse gas reductions

The transportation sector accounts for 38% of greenhouse gas (GHG) emissions in San Antonio, most of which are from light-duty vehicles. On a lifecycle basis, EVs are superior to internal combustion

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[2] BEVs are powered exclusively by electricity. PHEVs are powered by either electricity or gasoline/diesel.
[3] According to CPS Energy, there were 3,202 EVs in Bexar County in August 2019. San Antonio has approximately 75% of the vehicle population in Bexar County. The San Antonio count reflects 75% of 3,202. Texas and U.S. values for EVs per 1,000 people are based on EV populations available in Auto Alliance. 2019. *Advanced Technology Vehicle Sales Dashboard*. https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/
The 45,000 EVs in 2030 projections are explained below in the *EV Charging Needs Assessment* section.
The estimate of 16 EV models available is described in the *Barriers to Electric Vehicle Ownership* section.
Values for charging ports include networked and non-networked stations: three DCDC station plazas with 19 ports, 73 networked public Level 2 stations with 164 ports, and 70 non-networked public Level 2 stations with 70 ports.
[4] Hajat, Anjum, et al. 2015. *Socioeconomic Disparities and Air Pollution Exposure: Global Review*. https://doi.org/10.1007/s40572-015-0069-5

engine vehicles in San Antonio. For example, according to the Union of Concerned Scientists' online calculator, a Nissan LEAF driven in San Antonio emits an estimated 168 grams of carbon dioxide equivalent[5] ($CO_2e$) per mile, while a similarly sized gasoline vehicle emits 381 grams of $CO_2e$ per mile.[6] As renewable electricity generation increases in coming years, the benefits of EVs will further increase compared to gasoline and diesel vehicles.

## Regulatory compliance

San Antonio lies in Bexar County, a marginal non-attainment area for ground-level ozone. High ozone levels result in negative human health impacts, such as chronic respiratory problems and even premature death. Ozone forms through complex interactions between nitrogen oxides ($NO_x$) and volatile organic compounds (VOCs) in the presence of sunlight. Transportation is a major contributor to $NO_x$ emissions, and therefore ozone formation. With zero tailpipe emissions, the EV is a key enabling technology to solve the ozone problem. Bexar County must demonstrate ozone attainment or will face stricter regulations that could affect industry activity and expansion.

## Benefits to the electricity grid

Widespread transportation electrification increases the utilization rate of the grid, to the extent that charging can be shifted to off-peak periods. By strategically adding new electric load at the right times (such as at night when grid use is lowest), EV adoption in San Antonio can support increased utilization of renewable wind energy.

## Economic development

By transitioning its transportation system toward EVs, San Antonio can increase dependence on locally produced fuels (electricity). San Antonio could benefit from the job growth created through the installation of an estimated 10,000 new charging ports by 2030, as well as related EV and charging station services like education and training of EV mechanics (see the *EV Charging Needs Assessment* section). Figure 2 shows construction of a new charging station.[7]


**Figure 2. Installing and maintaining the estimated 10,000 charging ports needed by 2030 will create new jobs for electricians and construction workers.**

Despite the benefits of EVs, several barriers impede greater EV ownership in San Antonio. These are shown in Figure 3, and include upfront vehicle cost, vehicle availability, consumer awareness, charger availability, housing stock, and equity.

[5] $CO_2e$ is a metric that includes the global warming potential of *all* GHG emissions combined into a single metric: units of $CO_2$.
[6] Values are lifecycle emission estimates, which include upstream emissions from electricity and gasoline production, as well as emissions in the fuel supply chain and at the tailpipe. Source: Union of Concerned Scientists. 2019. *How Clean is Your Electric Vehicle?* https://www.ucsusa.org/resources/how-clean-your-electric-vehicle#z/78201/
[7] Photo by Leo Jarzomb, SGV Tribune/ SCNG.

# Barriers to EV Ownership in San Antonio

### Upfront Vehicle Cost

The average cost of a new EV is $56,000 across all available models within San Antonio. After removing luxury vehicles and accounting for the federal EV tax credit, the average cost of non-luxury EV brands in San Antonio is $27,000.

### Vehicle Availability

As of November 2019, only 16 light-duty EV options were available at San Antonio dealerships: nine PHEV models and seven BEV models (see Appendix A).

### Consumer Awareness

Research strongly suggests that both consumers and dealers lack an understanding and awareness of basic principles of EVs, including incentives, charging operations, and model availability.

### Charger Availability

Although San Antonio has a similar level of public charge ports to EVs (10 EVs per charger) as other major metropolitan areas, large sections of San Antonio have no access to these faster forms of public charging (i.e., DCFCs and Level 2 chargers).

### Housing Stock

Within San Antonio, 44% of residents live in a home without access to overnight charging at a dedicated garage or driveway.

### Equity

The perception that EV programs only favor high-income households creates a lack of support among the general population for these programs.

**Figure 3. Barriers to EV ownership in San Antonio.**

Moving forward, the City of San Antonio can help drive EV adoption by expanding EV readiness programs, deploying EV infrastructure, and electrifying its municipal fleet. This document provides a number of specific strategies to help the City succeed in these tasks. As entities in San Antonio work together with the City to implement strategies, it will be important to conduct pilot tests and evaluate the impact of these policies as they are implemented to ensure the strategies are having the desired impact of increasing EV adoption.

The study begins by exploring common barriers to EV ownership. Then it presents recommendations to electrify the City's municipal fleet and increase available EV charging infrastructure. The study then outlines specific and achievable strategies to increase public EV adoption. Lastly, the study provides San Antonio with plans to increase the equity of the City's transportation system and to accommodate emerging mobility options.

## Municipal Fleet Electrification

Chapter 4 of this study describes a plan for converting the municipal fleet of San Antonio to electric. The analysis identifies 1,202 vehicles in the fleet that are candidates for electrification. Of these, 26% have a lower total cost of ownership than the comparable gasoline or diesel vehicle. Additionally, the average $CO_2e$ and $NO_x$ savings on a lifecycle basis are 74% and 76%, respectively.

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# 1. INTRODUCTION

The transportation sector is rapidly evolving, with new modes of travel and innovative technologies disrupting a decades-old status quo. One quickly evolving trend is increased adoption of electric vehicles (EVs)—in 2018, over 320,000 EVs were sold nationwide, compared to 188,000 in 2017 and 146,000 in 2016. EVs include any vehicle that uses electricity for propulsion, including pure battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). This study refers to these by their common name: EVs. This study does not discuss hydrogen fuel cell EVs.

## *1.1. Context within San Antonio*

As with many American cities, San Antonio is built around the automobile. Over 90% of San Antonio full-time workers commute by car, while over 79% drive alone by car.[8] San Antonio's transportation sector accounts for 38% of San Antonio's greenhouse gas (GHG) emissions, as shown in Figure 4.[9]

Today, San Antonio has approximately 2,400 EVs, composed mostly of small and mid-sized passenger cars. Approximately 1% of new vehicle sales in 2018 were EVs.[10] For comparison, leading markets in the United States, such as San Jose, California, have new EV sales rates of closer to 10%.

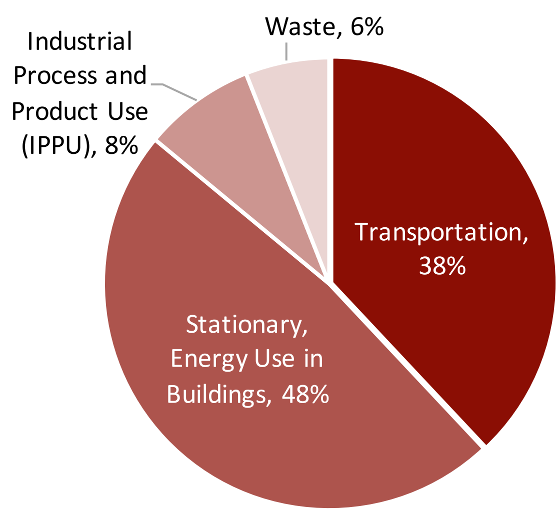


**Figure 4. GHG emissions by sector in San Antonio in the 2016 Community GHG Inventory.**

Near-term EV growth within San Antonio is almost certain as more makes and models become available, upfront costs decrease, public charging infrastructure grows, and the availability of programs and incentives increases. In the longer term, EV growth remains more uncertain. A 2018 report from Frontier Group forecasts 40,000 EVs on the road in San Antonio by 2030.[11] CPS Energy estimates approximately 45,000 EVs in San Antonio in its Medium Scenario by 2030.[12] For reference, in 2018 the State of Texas had a stock of 45,020 EVs.[13]

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[8] U.S. Census Bureau. *2013-2017 American Community Survey 5-Year Estimates, City of San Antonio, Texas.* "Aggregate Number of Vehicles (Car, Truck, Or Van) Used In Commuting By Workers 16 Years And Over By Sex." https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_B08015&prodType=table

[9] City of San Antonio. 2019. *San Antonio Climate Ready: A Pathway for Climate Action and Adaptation*. https://saclimateready.org/wp-content/uploads/2019/08/SACR-DRAFT-082219_SPREAD_WEB.pdf

[10] Values provided in phone conversation with CPS Energy. There were 3,202 EVs in Bexar County in August 2019. San Antonio has approximately 75% of the vehicle population in Bexar County. The San Antonio count reflects 75% of 3,202, or approximately 2,400.

[11] Frontier Group, Environment America, U.S. PIRG, and PennEnvironment Research and Policy Center. 2018. *Plugging In: Readying America's Cities for the Arrival of Electric Vehicles.* https://frontiergroup.org/sites/default/files/reports/US%20Plugging%20In%20Feb18.pdf

[12] Values provided in phone conversation with CPS Energy, based on forecasts performed by EPRI. 45,000 EVs by 2030 is the portion of EVs for the City of San Antonio from CPS Energy's projection of 60,000 EV's in Bexar County by 2030.

[13] Auto Alliance. 2019. *Advanced Technology Vehicle Sales Dashboard*. https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/

## 1.2. Municipal Actions

The City of San Antonio has taken several actions to lower transportation emissions. In 2010, with funding from the State Energy Conservation Office (SECO), the Office of Sustainability converted five of its fleet Toyota Priuses into plug-in electric vehicles. The grant also supported five dedicated electric vehicle charging stations which were assigned to different City departments. In the intervening years, the City has committed to purchasing hybrid electric vehicles for its administrative sedan fleet. As of September 30, 2019, hybrid sedans accounted for 83% of administrative sedans. The *San Antonio Tomorrow Sustainability Plan*, adopted on August 11, 2016, provides a roadmap for enhancing San Antonio's quality of life and overall resilience, while balancing the impacts of its expected 1.1 million-person population growth by 2040 with existing resources.[14] Additionally, amplifying its backing of worldwide partnerships to address climate change, San Antonio's City Council *Resolution No. 2017-06-22-0031R*, passed on June 22, 2017, supports the Paris Climate Agreement with its own goals to reduce GHG emissions.[15]

On October 17, 2019, the City adopted *San Antonio Climate Ready: A Pathway for Climate Action and Adaptation Plan* (CAAP), which outlines its strategy to transition to cleaner and more efficient personal vehicles, trucks, transit, and freight.[16] The implementation actions related to EVs in this strategy are to:

- Invest in new EV charging infrastructure throughout the City,
- Develop EV group purchase programs,
- Accelerate the adoption of carbon-free vehicular transportation in all sectors through education and incentives, and
- Assess the barriers to EV ownership, with a priority focus on equity.[17]

Additionally, San Antonio was one of 25 cities in the United States selected to participate in the *American Cities Climate Challenge*, through which the City committed to pursue infrastructure and policy improvements to advance electric transportation by the end of 2020. At the time of this report, the City was exploring business models and partnership opportunities for publicly accessible EV charging infrastructure on City property. The City's EV-SA program includes outreach, policy, and infrastructure initiatives.

## 1.3. Utility Actions (CPS Energy)

CPS Energy began participating in the EV market in 2011, launching its education program for early EV adopters. By 2012, the community-owned utility had installed a network of Level 2 public charging stations at more than 30 locations across San Antonio. Since then, CPS Energy continues to add charging stations, including in VIA Metropolitan Transit's newest and largest park and ride facility located in far north San Antonio.

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[14] City of San Antonio. 2016. *SA Tomorrow: City of San Antonio Sustainability Plan*. https://www.sanantonio.gov/Portals/0/Files/Sustainability/SATomorrowSustainabilityPlan.pdf
[15] City of San Antonio. 2017. *A Resolution of the City of San Antonio in Support of the Paris Climate Agreement.* https://www.sanantonio.gov/Portals/0/Files/Sustainability/Resolution2017-06-22-0031R.pdf
[16] City of San Antonio. 2019. *San Antonio Climate Ready: A Pathway for Climate Action and Adaptation*. https://saclimateready.org/about-us/climate-action-adaptation-plan/
[17] Ibid.

In January 2019, CPS Energy launched a website to help customers navigate the fast growing EV industry.[18] The website provides savings calculators for fuel and carbon reduction, where entering a current internal combustion vehicle model and an EV model results in a calculation comparing gasoline costs to electricity for the estimated miles driven. The website also includes a directory of EV models using data from the U.S. Department of Energy (DOE) with images available from the automobile manufacturers.

CPS Energy is active in piloting electricity rates that accelerate EV adoption and create a positive customer experience. A pilot Public Charging Flat Rate Program is available that allows access to charging stations in the CPS Energy ChargePoint® network for an annual fee. Powered by CPS Energy and using a pilot time-of-use (TOU) rate with a demand charge, Electrify America installed a station plaza featuring six 150 kilowatt (kW) and two 350 kW DC fast chargers (DCFC) in a Walmart parking lot (Figure 5). CPS Energy plans to evaluate pilot programs to learn about charging behavior and to create the right experiences for customers.

**Figure 5. Electrify America station powered by CPS Energy.**

## 1.4. State Actions

At a statewide level, in 2018 the Texas Commission on Environmental Quality (TECQ) published the *Volkswagen Environmental Mitigation Trust: Beneficiary Mitigation Plan for Texas*. This plan identifies seven priority areas that "bear a disproportionate share of air pollution and particularly ozone within Texas," and allocates specific funding for emission reductions strategies for each of these areas, including an estimated $61.5 million for San Antonio.[19] The plan also establishes specific actions to increase funding for EVs and charging infrastructure across the state. The TECQ also administers a limited-time Light-Duty Motor Vehicle Purchase and Vehicle Lease Incentive Program, where EVs are eligible for a rebate of $2,500 for the first 2,000 applicants.


**Figure 6. Examples of City, CPS Energy, and State planning documents and websites related to EVs.**

[18] CPS Energy. 2019. *Electric Vehicles*. https://www.cpsenergy.com/en/about-us/programs-services/electric-vehicles.html

[19] Texas Commission on Environmental Quality, Air Quality Division. 2018. *Volkswagen Environmental Mitigation Trust: Beneficiary Mitigation Plan for Texas*. https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg-537.pdf

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# 2. COMMUNITY EV STRATEGIES

This section describes barriers to EV ownership, projections of EVs and EV infrastructure to 2030, a geospatial analysis of charging locations, and descriptions of best practices on EV permitting, codes, parking, and signage.

## 2.1. *Barriers to Electric Vehicle Ownership*

Several barriers hinder the growth of EVs in San Antonio, including economic, technical, behavioral, and social. This section draws on academic literature, public data sources, input from the Office of Sustainability, input from CPS Energy (the municipal utility), and survey data from the CAAP.

### *2.1.1. Upfront Vehicle Price*

Despite lower fuel and maintenance costs, EVs are still more expensive to purchase than similar gasoline vehicles. In a recent public engagement survey, conducted as part of San Antonio's CAAP,[20] 914 respondents were asked about barriers that influenced their vehicle purchases. A majority (52%) said that purchase price was "very important" to whether they would purchase an EV. Only 5% of respondents said the purchase price was "not important at all."

$27,000

Average purchase price of an EV in San Antonio after removing luxury brands and accounting for the federal EV tax credit.

The average purchase price of EV models in San Antonio is $61,000, or $56,000 after accounting for federal EV tax credits.[21] This relatively high average price can be misleading, however, because many currently available EVs are luxury brands, aimed at high-income households. When considering non-luxury EV models (such as the Chevy Bolt, Nissan LEAF, and Tesla Model 3), the average, after-federal tax credit price in San Antonio is $27,000—which is much closer to a comparable gasoline vehicle. Additionally, EV purchase prices are quickly decreasing. Bloomberg New Energy Finance recently estimated that EV upfront vehicle costs will reach cost parity with gasoline upfront vehicle costs as early as 2022.[22] Appendix A provides a list of the 16 EV models for sale at dealerships and online in San Antonio as of October 2019.[23]

### *2.1.2. Vehicle Availability*

Another constraint on EV market growth is a lack of diversity in vehicle size. Nationally, consumers prefer large vehicles: more than 65% of passenger vehicles sold in 2018 were pickup trucks, vans, and crossovers or sports utility vehicles (SUVs).[24] Yet, of these larger vehicles, only electric crossovers/SUVs are available in San Antonio, as shown in Table 1.

[20] City of San Antonio. 2019. *San Antonio Climate Ready: A Pathway for Climate Action and Adaptation*. https://saclimateready.org/wp-content/uploads/2019/08/SACR-DRAFT-082219_SPREAD_WEB.pdf
[21] U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. *Federal Tax Credits for All-Electric and Plug-in Hybrid Vehicles*. https://www.fueleconomy.gov/feg/taxevb.shtml
Tesla is the only automaker to no longer receive the federal tax credit.
[22] Bullard, Nathaniel. 2019. *Electric Car Price Tag Shrinks Along with Battery Cost*. https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost
[23] Data were collected by the analysts using the website autotrader.com.
[24] Auto Alliance. *Facts About Auto Sales*. https://autoalliance.org/economy/facts-about-auto-sales/

This trend could be changing. Over the next few years, automakers will introduce several new, larger EV models. For example, Ford, General Motors, and Tesla have all confirmed plans for an electric truck in the next three to five years.

Vehicle availability presents an even larger barrier for medium- and heavy-duty vehicles. Appendix B lists this market segment's vehicle makes and models in the United States at the time of this writing. Many vehicles in this segment are custom-built and only available in certain regions of the United States. Except for electric buses, no mass market models are available in the medium- and heavy-duty vehicle classes.

**Table 1. Availability of EV models in San Antonio by size class.**

| Vehicle Class | PHEV Models | BEV Models |
|---|---|---|
| **Subcompact** | 0 | 1 |
| **Compact** | 1 | 3 |
| **Mid-sized sedan** | 4 | 0 |
| **Full-sized sedan** | 0 | 1 |
| **Sports car** | 1 | 0 |
| **Crossover/SUVs** | 3 | 2 |
| **Total** | **9** | **7** |

### *2.1.3. Consumer Awareness*

Studies clearly demonstrate that awareness of EVs is low among the car-buying public. One study revealed the results of a survey conducted with 5,654 new car buying households across the country and estimated that the fraction of a given state's respondents who reported seeing EVs on the road ranged from 25% in Delaware to 72% in Oregon.[25] Other research shows that, even after driving an EV for several weeks, drivers may be confused about how the vehicle operates and when it must be plugged into a power source.[26] Awareness barriers can compound one another. For example, staff at auto dealers often lack training to speak knowledgeably about EVs, thereby reducing the propagation of knowledge among consumers.

### *2.1.4. Housing Stock*

Another barrier to greater EV ownership in San Antonio is the housing stock. One estimate suggests that overnight charging at home accounts for an estimated 80% of all charging among the general public.[27] Yet, a large fraction of San Antonio homes are ill-equipped for installing a charger. Of the 893,000 housing units in San Antonio (per the American Housing Survey), only 56% are single-family detached homes that have a driveway or garage.[28] The implication is that 44% of potential EV owners in San Antonio would need to rely on public or workplace charging.

### *2.1.5. Equity*

Government investment to advance EV ownership often confronts opposition because of the perception that EVs are "only for the rich." This creates an indirect barrier. Rather than impacting a consumer EV purchase decision, this barrier tends to stall programming and policies. Without question, early EV adopters are largely high-income households, and often own more than one vehicle. Additionally, EV

[25] Kurani, Ken, Nicolette Caperello, and Jennifer TyreeHageman. 2016. *New Car Buyers' Valuation of Zero-Emission Vehicles: California*. https://ww3.arb.ca.gov/research/apr/past/12-332.pdf
[26] Kurani, Ken, and Gil Tal. 2014. *Growing PEV markets?* University of California, Davis Sustainable Transportation Energy Pathways (STEPS).
[27] Idaho National Laboratory. *Plugged In: How Americans Charge Their Electric Vehicles*. https://avt.inl.gov/sites/default/files/pdf/arra/PluggedInSummaryReport.pdf
[28] U.S. Census Bureau. *American Housing Survey*. https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=41700&s_year=2017&s_tablename=TABLE0&s_bygroup1=3&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1

adopters need a sufficiently high tax liability to take advantage of the federal income tax credit. Overcoming this perception requires stressing the shared benefits of EVs and that purchase prices of EVs are rapidly falling.

### *2.1.6. Charger Availability and Access*

Compared to gasoline vehicles, EVs have fewer public charging stations and require greater refueling times than gasoline vehicles. Results from an early CAPP survey clearly demonstrated that the range per charge and the lack of public charging stations pose barriers for most people. As described in the EV Charging Needs Assessment section below, San Antonio has approximately 2,400 EVs, 234 public charge ports, and an estimated population of 1.99 million people.[29] This means the City has approximately 8,000 people or 12.5 EVs per charge port, which aligns with leading cities throughout the United States (see Figure 7).[30]

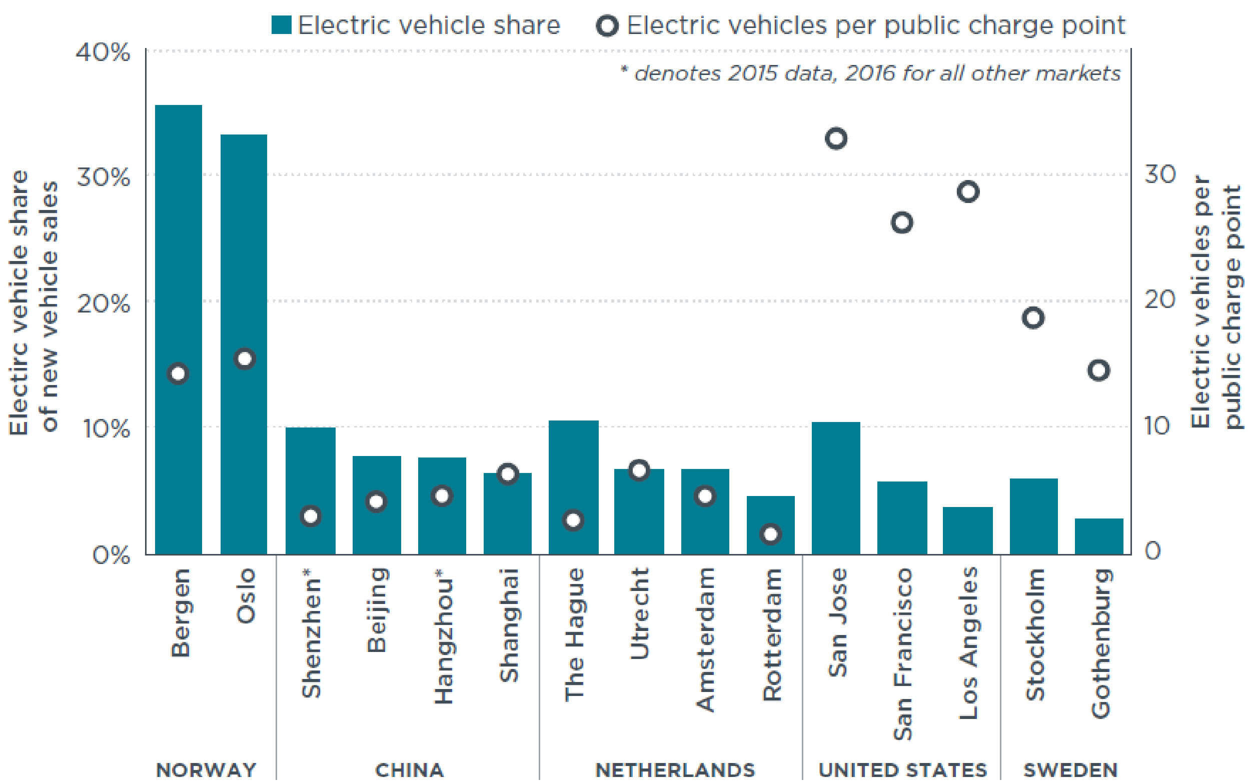


**Figure 7. Figure from International Council on Clean Transportation white paper showing EV sales shares and EVs per public charge port for cities throughout the world.**

[29] U.S Census Bureau. *Community Facts*. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk
[30] The International Council on Clean Transportation. 2018. *Emerging Best Practices for Electric Vehicle Charging Infrastructure*. https://theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf

## 2.2. EV Charging Needs Assessment

This section describes EV infrastructure in San Antonio, identifies high-priority locations for new charging stations, and provides insights into building, permitting, and zoning to future-proof EV infrastructure in San Antonio.

### 2.2.1. Types of Electric Vehicle Chargers

There are three primary types of EV chargers currently available in the United States: Level 1, Level 2, and DC Fast Charging (DCFC) stations:

- **Level 1 chargers** are a standard 120V outlet. Though the slowest option, Level 1 chargers offer the least expensive make-ready costs, since no permits or supplemental equipment are typically needed beyond an electrical outlet. Due to the slow charge rate, Level 1 chargers are good for vehicles with long dwell times and relatively low daily mileage. For example, Level 1 chargers are good for a vehicle that is driven 30 miles or less per day and that is parked at work most of the work day and at home at night. Level 1 chargers provide 3-5 miles per hour of charge.
- **Level 2 chargers** require a 208V to 240V electrical circuit (as do dryers) and have a faster charge speed than Level 1 charger.[31] Level 2 chargers require a residential permit and a certified electrician and comprise the vast majority of public chargers in San Antonio (approximately 98%). Tesla Level 2 chargers have a unique connector that can only be used by Tesla vehicles. The J1772 connector on all other Level 2 chargers can be used by all PHEVs and BEVs (with an adaptor for Tesla vehicles). Level 2 chargers provide 10-25 miles per hour of charge.
- **DCFCs** provide between 50 kW and 350 kW of power and are the most expensive, fastest chargers available today. However, only BEVs and one PHEV (the Mitsubishi Outlander) are capable of using DCFCs.[32] Additionally, because of limitations in the battery management systems on the vehicles, 50 kW is the highest charging power that most vehicles can accept today (except Tesla vehicles, which can charge up to 250 kW). The next generation of EVs coming to U.S. markets will charge at power levels up to 350 kW. Electrify America, a major provider of DCFC in the United States, now exclusively builds DCFC stations equipped to charge up to 350 kW. The newest chargers are backward compatible with the older, slower charging vehicles. DCFCs come with three different charger connectors. The Combined Charging System Combo connector is used by American- and European-made EVs. The CHAdeMO connector is used by Japanese- and Korean-made EVs. Tesla superchargers are only capable of charging Tesla vehicles. However, Tesla vehicles are capable of charging at CHAdeMO connectors if using a $450 adapter. DCFCs provide 200 miles per hour of charge.


**Figure 8. Dual-port DCFC station.**

[31] City of Palo Alto. 2019. *Submittal Guidelines: Residential Electric Vehicle Supply Equipment – Expedited*. https://www.cityofpaloalto.org/civicax/filebank/documents/37623

[32] All other PHEVs are only capable of charging at Level 2 chargers at a maximum of 9 kW.

Table 2 describes the three types of EV chargers in more detail.

**Table 2. Descriptive information about EV charger types.**

| | Level 1 | Level 2 | DCFC |
|---|---|---|---|
| **Primary Use** | Home charging, but can be used for workplace and public charging | Home charging, public, and workplace charging | Public, on-the-go charging; sometimes for multifamily residents and fleets with high daily mileage* |
| **Equipment Cost** | No additional cost unless new plug is needed | $1,500 to $7,000 for single or dual port station | $50,000 for a 150 kW station with two ports |
| **Make-Ready Cost** | No additional cost unless new plug is needed | $2,000 to 8,000 for single or dual port station | $37,500 for station plaza with four 150 kW stations, or $9,000 per station |

*Note: Table cost values are based on detailed modeling and discussions with EV service providers.*
** Source: The International Council on Clean Transportation. 2018. Lessons Learned on Early Electric Vehicle Fast-Charging Deployments.* https://www.theicct.org/sites/default/files/publications/ZEV_fast_charging_white_paper_final.pdf

Charger technology is rapidly evolving. DCFCs are becoming faster each year as automakers shift toward producing EVs that can accept higher charging levels. Level 1 and Level 2 charger prices continue to decrease and there is considerable innovation around solutions such as smart circuit breakers (Eaton, and Atom Power) that could revolutionize the charging landscape. For these reasons, cost projections are highly uncertain and were not attempted in this study.

To maximize station usage, publicly available chargers can be placed in centrally located attractions—such as near shopping centers, parks, schools, and workplaces—to increase use and charging accessibility. DCFC stations are useful in locations with relatively short dwell times, such as at groceries stores and big-box stores, or along corridors at convenience stations. Level 1 and Level 2 charging stations are useful where vehicles may be parked for longer time periods, such as workplaces, government offices, airports, and hotels.[33]

### *2.2.2. Meeting Future Electric Vehicle Charging Demand*

It is key for the City to anticipate the EV population in the coming decade: the answer shapes the quantity of public and workplace EV chargers needed. Frontier Group projects 40,000 EVs in San Antonio by 2030,[34] while CPS Energy projects 60,000 EVs in Bexar County by 2030 in its medium adoption scenario.[35] In collaboration with the City and CPS Energy, a projection of 45,000 EVs is used in this report as a medium adoption scenario for San Antonio for 2030.[36]

Table 3 shows vehicle sales and vehicle stock numbers needed to reach 45,000 EVs by 2030. The table values were estimated using a simple stock turnover model that assumes all vehicles are retired after 10 years and that the vehicle population in San Antonio is a constant 1.66 million.[37]

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[33] U.S. Department of Energy Alternative Fuels Data Center. *Charging Plug-In Electric Vehicles in Public*. https://afdc.energy.gov/fuels/electricity_charging_public.html
[34] Frontier Group, Environment America, U.S. PIRG, and PennEnvironment Research and Policy Center. 2018. *Plugging In: Readying America's Cities for the Arrival of Electric Vehicles.* https://frontiergroup.org/sites/default/files/reports/US%20Plugging%20In%20Feb18.pdf
[35] Value provided by CPS Energy via a telephone conversation with the analysts of this report.
[36] This value is based on an estimate of 60,000 EVs in Bexar County by 2030 and the fact San Antonio has approximately 75% of the vehicles in Bexar County.
[37] Estimate analyzing San Antonio Metro Area using U.S. Department of Energy Alternative Fuels Data Center. 2019. *Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite*. https://afdc.energy.gov/evi-pro-lite

**Table 3. Projections of EV sales in San Antonio to reach 45,000 EVs on the on road in 2030.**

| Year | New EV Sales | | Total Stock of EVs | |
|---|---|---|---|---|
| | EV Sales Share of New Vehicles | Annual EV Sales | EV Share of Vehicle Population | Cumulative EV Population |
| **2019** | 0.8% | 1,300 | 0.25% | 2,400 |
| **2025** | 2% | 3,500 | 0.8% | 16,500 |
| **2030** | 6% | 10,000 | 2% | 45,000 |

The projections in Table 3 are only a starting point and should be updated and refined. To estimate the number of chargers needed over the next decade, the analysts used the *EVI-Pro Lite Tool,* developed by National Renewable Energy Laboratory. This tool uses manual location-specific inputs on home charging, vehicle mix, and electrified miles in PHEVs and estimates the number of DCFC, public Level 2, and workplace Level 2 plugs needed to support a given vehicle population.[38]

When using this tool, the analysts used the following input assumptions:

- Home charging. Over half (56%) the population has access to home charging. This value was discussed in more detail in the *Barriers to Electric Vehicle Ownership* section above.
- Vehicle mix. PHEVs with a 20-mile range account for approximately 45% of EVs in San Antonio, while PHEVs with a 50-mile range account for 7% of EVs, BEVs with a 100-mile range or less account for 14% of EVs, and longer-range BEVs account for 34% of EVs.[39]
- Electric miles in PHEVs. Analysts selected the "partial support" option, which assumes that PHEV are driven using a mix of gasoline and electricity.

Table 4 gives the number and type of stations that currently exist. Note the *EVI-Pro Lite Tool* assumes one port per station. Many Level 2 and DCFC stations have multiple ports per station, but typically only one can operate at a time at the rated power level.

**Table 4. Estimated number of stations needed to support 16,500 EVs by 2025 and 45,000 EVs by 2030.**

| | Number of Ports in 2019 | New Ports Needed by 2025* | New Ports Needed by 2030* |
|---|---|---|---|
| **Public Level 2 ports** | 234 | 1,069 | 2,687 |
| **DCFC ports** | 19 | 1,284 | 2,902 |
| **Workplace Level 2 ports** | Unknown | 1,672 | 4,422 |
| **Total** | **Unknown** | **4,025** | **10,011** |

** New ports are the incremental number needed in addition to 2019 numbers.*

One insight from Table 4 is that workplace Level 2 ports are the largest share of new ports needed. Municipal programs that mobilize individual workplaces to install EV charging have been effective in other jurisdictions and are especially critical for small workplaces with limited resources. Workplace charging is also attractive for San Antonio because the time of charging (during the workday) matches peak solar generation.

Another insight from Table 4 is that San Antonio needs to vastly expand its DCFC network. The DOE recommends prioritizing DCFC networks before Level 2 networks because of DCFCs important role in alleviating range anxiety among the car-buying public.

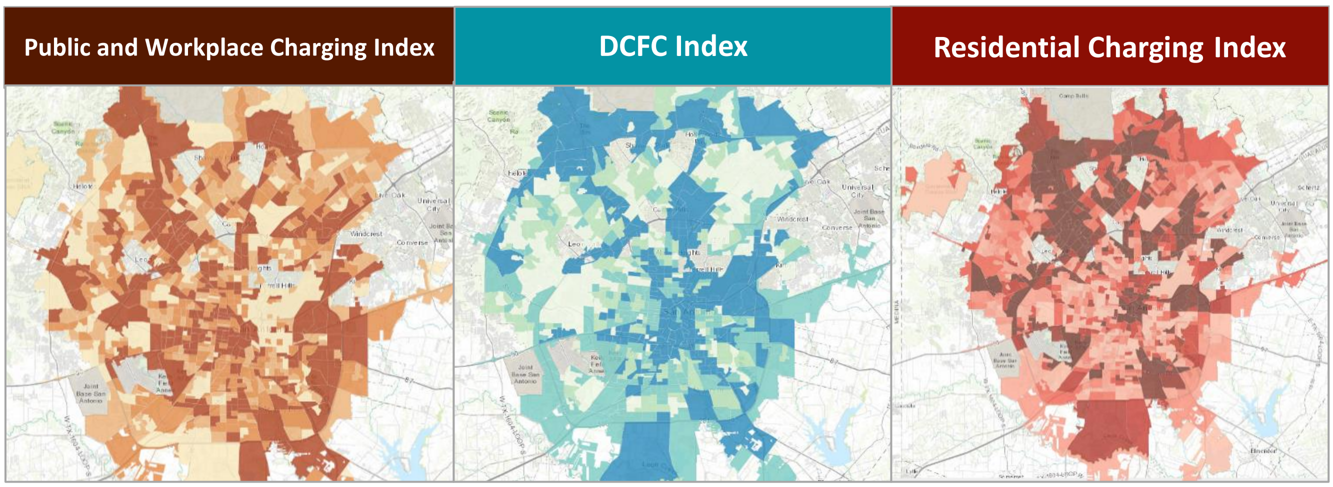
[38] U.S. Department of Energy Alternative Fuels Data Center. 2019. *Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite*. https://afdc.energy.gov/evi-pro-lite
[39] Values based on data provided by CPS Energy.

## 2.2.3. Geospatial EV Charger Analysis for San Antonio

A geospatial EV charging analysis is a quantitative method for identifying and prioritizing locations for future EV charging infrastructure based on a set of pre-defined attributes. A well-planned charging network in San Antonio ensures cost-effective and equitable use of public money and strengthens buy-in from various stakeholder groups. The geospatial analysis focused on three EV charging use cases:

1. Public and Workplace: Level 2 chargers shared between drivers in public locations or employee parking lots.
2. DCFCs: Public DCFCs shared by drivers in public locations near major intersections or major retail centers.
3. Residential: Level 2 chargers in multi-unit dwellings for drivers without a garage or driveway for overnight charging.

**Figure 9. Geospatial analysis of charging prioritization for San Antonio, comparing three use cases. Darker regions are more attractive locations for new charging infrastructure.**




The three indices shown Figure 9 are composite scores based on multiple indicators that were normalized on a scale of 0 to 1 then summed based on weights. The set of indicators and weights were determined in coordination with the City of San Antonio. Each indicator, the rationale for including it, and its weight are given in Table 5. In the maps above, the scores are portrayed in four shade gradients (used to allow for easier viewing): lighter shades are lower scoring block groups and darker shades are higher scoring block groups. Larger versions of each map and a list of the 25 highest scoring block groups are given in Appendix C and Appendix D.

Based on geospatial analysis conducted in ArcGIS, certain block groups emerged as highest priorities for each index for installing an EV charge port.

- The Public and Workplace Index shows that the top three block groups of highest priority are (in order, starting with the highest) 480291101001 (zip code 78205), 480291814021 (zip code 78229), and 480291918171 (zip code 78258), as symbolized by the darker brown locations in the left-most map in Figure 9.
- The DCFC Index shows that the top three block groups of highest priority are (in order, starting with the highest) 480291101001 (zip code 78205), 480291101003 (zip code 78207), and

480291909011 (zip code 78216), as symbolized by the darker blue locations in the middle map in Figure 9.

- The Residential Index shows that the top three block groups of highest priority are (in order, starting with the highest) 480291810033 (zip code 78229), 480291814031 (zip code 78229), and 480291810042 (zip code 78229), as symbolized by the darker red locations in Figure 9.

**Table 5. Indices and justifications to determine San Antonio charging infrastructure needs.**

| Factor | Weight | Rationale for Inclusion of Factor |
|---|---|---|
| **Public and Workplace Index** | | |
| Number of jobs | 30% | Assuming that areas with larger numbers of jobs attract more people and that people will charge while at work or near their work when running errands or engaged in activities near their workplaces |
| Number of longer dwell time sites | 40% | Assuming that people will charge their cars when engaged in activities at these longer dwell time sites |
| Number of existing charge ports | 30% | New charging infrastructure is needed in areas where it is currently lacking, assuming that the City is trying to address a coverage issue with charging infrastructure rather than a capacity issue |
| **DCFC Index** | | |
| Number of short- and medium- dwell time sites | 40% | Assuming that DCFC users will likely charge at places with shorter average dwell times, such as grocery stores and gas stations |
| Number of existing DCFC ports | 20% | New DCFC infrastructure is needed in places where it currently does not exist |
| Traffic counts (max) at highway exits | 40% | Assuming that high average annual daily traffic values provide a good indicator of where people are driving and that it would be convenient for drivers to exit the highway to charge |
| **Residential Index** | | |
| Share of multifamily buildings | 50% | Assuming that those living in multifamily buildings will have less access to at-home charging (garage orphans) and that there is a higher likelihood of having any (or more) EV owners in larger apartment buildings than in a three-family multifamily building |
| Share of renters | 12.5% | Assuming that those who rent are less likely to have at-home charging access and will need to use public charging infrastructure |
| Share of car commuters | 12.5% | Assuming that areas with a higher number of drivers will be more likely to use charging infrastructure |
| Median income | 25% | Using the finding from the Center for Sustainable Energy CA EV owner survey that 47% of EV owners have a household income over $150,000 and 20% of EV owners have an income between $100,000 and $149,999 |

## 2.3. *Permitting, Codes, Parking Requirements, and Signage*

### 2.3.1. *Streamline Permitting Process*

Streamlined permitting for residential charger installation is a revenue-neutral approach to encouraging EV adoption. The City of San Antonio is already effective at streamlining its permitting process and follows best practices regarding residential permits, including rapid processing and relatively low fees. For an existing residence in San Antonio, a licensed electrician can obtain an electrical permit online or in person the same day as the application.[40] The cost of obtaining the permit is based on the scope of

[40] City of San Antonio. 2018. *Electrical Permit Application*. https://docsonline.sanantonio.gov/FileUploads/DSD/DSD_Electrical_Application.pdf

work performed. If a port is being installed, the permit cost is $51.50. If a new panel must be installed along with the port, the permit cost is $59.60. These costs compare favorably with jurisdictions (Table 6 shows a sample of cities and state residential Level 2 permitting fees).

**Table 6. Example of residential Level 2 charger permit fees.**

| Jurisdiction | Average Residential Permit Fee | Available Online? |
|---|---|---|
| **Palo Alto*** | $172.00 to $270.00 | Y |
| **Arizona**** | $96.11 | Y |
| **Oregon**** | $40.98 | Y |
| **Tennessee**** | $41.15 | Y |
| **Washington**** | $78.27 | Y |
| **San Antonio***** | $51.50 to 59.60 | Y |

** Source: City of Palo Alto. 2019. Adopted Municipal Fee Schedule.* https://www.cityofpaloalto.org/civicax/filebank/documents/66147
*** Source: New York State Energy Research and Development Authority. 2013. Residential EVSE Permit Process Best Practices.* https://www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Permit-Process-Streamlining.pdf
**** Source: City of San Antonio. 2018. Electrical Permit Application.* https://docsonline.sanantonio.gov/FileUploads/DSD/DSD_Electrical_Application.pdf

For commercial permits, a port could be installed with a trade permit in the exact same manner as in residential construction, and the permit would be issued immediately. If the work includes an upgraded service, engineering drawings are required. These permits are typically processed the same day as the application but not longer than three days after the application. CPS Energy review is required for any projects that increase connected load by 25 kW or more.

### 2.3.2. Pre-Wiring Parking

The City of San Antonio can encourage EV ownership by ensuring that new construction is ready for Level 2 chargers. The most common EV-readiness building codes include pre-wiring electricity outlets near parking spots with Level 2 charger voltage (208V or 240V). Even if EV chargers are not installed during initial construction of parking facilities, pre-wiring decreases future costs when EV chargers are installed. Other jurisdictions in the United States with charge-ready building codes tend to require that between 5% and 25% of parking spots are wired for Level 2 charging.

### 2.3.3. EV-Ready Codes

Through the American Cities Climate Challenge, the City is considering developing “EV Ready” construction requirements for new residential and commercial buildings, as well as for certain retrofits or rehabilitations. As it creates these new requirements, the City will balance the goal of expanding access to EV charging with the need to maintain equity and housing affordability.

The City of San Antonio has adopted the 2018 International Energy Conservation Code (IECC). The State of Texas follows the 2015 IECC. The IECC is a set of model building code regulations, enacted by the International Code Council, to establish minimum design and construction requirements to achieve energy efficiency. Many states and municipal governments adopt the IECC, which is updated every three years. The IECC contains separate guidelines for commercial buildings and for low-rise residential buildings (those with no more than three stories).[41] The next version of the IECC will be issued in 2021.

[41] International Code Council. 2019. *Overview of the International Energy Conservation Code*. https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/iecc/

## 2.3.4. Signage

Not only does EV signage provide useful information for drivers, it promotes general awareness about EVs, thereby accelerating EV adoption. The Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* defines standards for signage on U.S. roads and includes 15 different EV-related signs. Transportation agencies are authorized by the FHWA to develop their own signs or to use pavement markings to reinforce signage.

Figure 10 provides examples of EV signage. The sign on the left indicates a parking spot that is reserved for EVs only. The charging station's host may choose to post this sign to reserve spaces for EVs, in which case non-EVs parked in these spots could face fines (see the *Parking Enforcement* section). The center sign indicates temporary EV parking with enforced time limits in municipal lots and streets: this sign may be used to increase usage at a charging station. The sign on the right indicates that an interstate corridor has been designated by the FHWA as an "alternative fuel corridor." To receive this designation, a corridor must have at least one DCFC station every 50 miles or less.[42]

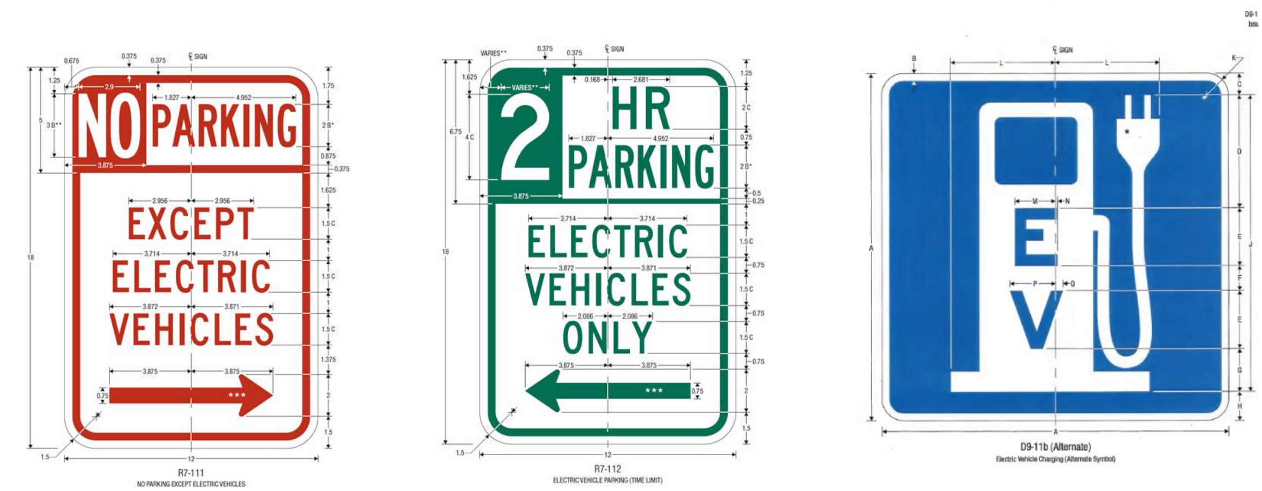



**Figure 10. Examples of EV signage.**

## 2.3.5. Parking Enforcement

A common government strategy to incentivize EV ownership is to impose fines on internal combustion engine (ICE) vehicles that are parked in charging parking spots. Currently, 12 states and many municipal governments have these "anti-ICEing" laws.[43] For example, Colorado recently passed a law that fines ICE vehicles $150 for parking in a spot with an EV charger.[44]

Some governments and private charging providers impose a fee on EVs if they are hooked to a charger but not charging. For example, Electrify America charges an idle fee of $0.40 per minute after a 10-minute grace period to encourage turnover.[45] However, such fees do not prevent EVs from parking in EV charging spots if they are not plugged in. Also, some vehicles can remotely terminate the charging session to avoid dwell time charges while connected.

[42] U.S. Department of Transportation Federal Highway Administration. *Alternative Fuel Corridors: Frequently Asked Questions*. https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/resources/faq/

[43] Plug In Sites. 2019. *Legislation Reference – Reserved Parking for Plug-In Vehicle Charging.* https://pluginsites.org/plug-in-vehicle-parking-legislation-reference/

[44] Colorado General Assembly. 2019. *HB19-1298: Electric Motor Vehicle Charging Station Parking.* https://leg.colorado.gov/bills/hb19-1298

[45] Electrify America. 2019. *Pricing and Membership*. https://www.electrifyamerica.com/pricing

Municipal governments often use existing local ordinances to regulate and enforce parking at EV-only spots, rather than passing specific anti-ICEing laws. For example, lawmakers in Ocean City, Maryland combine a local town ordinance, which restricts parking when explicitly prohibited by an official sign, and EV-only signage to enforce EV-only parking.[46]

### 2.3.6. Accessibility Requirements

The Americans with Disabilities Act (ADA) of 1990 prohibits the discrimination of Americans based on disability for state and local governments and for private businesses, and the Rehabilitation Act of 1973 prohibits discrimination in programs receiving federal funding. To meet the requirements of these federal laws, the City needs to ensure that EV charging stations have physical, program, and communication access for persons with disabilities. This means EV station developers must ensure physically accessible parking spaces and charging infrastructure.

The DOE has provided developers with ADA guidance for charging stations.[47] Additionally, several states have produced stand-alone guidance with diagrams showing how station developers can install ADA-compliant EV charging. The State of Texas has issued guidance for the installation of accessible electric charging stations in new or existing parking lots. In parking garages or other locations containing parking spaces, 20% (but not less than one of each type of charging station in each cluster on a site) shall meet the criteria listed in the *Technical Memoranda*.[48]

## 2.4. Strategies to Increase EV Adoption

This section describes a set of strategies that the City of San Antonio and its stakeholders could use to advance EV adoption (Table 7). The strategies presented have been grouped into several overarching categories: (1) Goals and Targets, (2) Direct Financial and Other Incentives, (3) Special Electricity Rates, (4) Marketing and Communications, (5) Partnerships and Emerging Business Models, (6) Public Investment, and (7) Codes and Standards.

The priority level (low, medium, or high) of each strategy in Table 7 was established in close coordination with the City and aligns with the guidance in the *PEV Policy Evaluation Rubric*, a guide on best practices of EV policies and incentives published in 2018 by the National Association of State Energy Officials.[49] The strategies in Table 7 are suggestions only; they have not been vetted through the various City stakeholders who are needed to ensure buy-in and to support each strategy. Further study of each strategy may be necessary to ensure that all specific impacts are considered.

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[46] Plug In Sites. 2016. *Signs in Ocean City Warn of $30 Penalty for Not Plugging In.* https://pluginsites.org/signs-in-ocean-city-warn-of-30-penalty-for-not-plugging-in/

[47] U.S. Department of Energy, Energy Efficiency & Renewable Energy. 2014. *Guidance in Complying with Americans with Disabilities Act Requirements.* https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf

[48] Texas Department of Licensing and Regulation. 2012. *Technical Memorandum: Electric Vehicle Charging Stations.* https://www.tdlr.texas.gov/ab/info/TM2012-01.pdf

[49] National Association of State Energy Officials and Cadmus. 2018. *PEV Policy Evaluation Rubric: A Methodology for Evaluating the Impact of State and Local Policies on Plug-in Electric Vehicle Adoption*. https://naseo.org/Data/Sites/1/pevpolicyrubricmethodology_naseo.pdf

**Table 7. Strategies to Advance Public EV Adoption in San Antonio**

| Strategy | Priority | Benefits | Current Status | Lead Entities* |
|---|---|---|---|---|
| **Goals and Targets:** *Goals and binding targets help achieve certain levels of EV deployment and send an important, long-term signal to the market.* | | | | |
| Using EV sales projections as a metric, quantify and compare annual sales to evaluate impact of City and partner-led programs. | High | High visibility and resulting potential to influence constituents; compels City departments to act. | Strategy 9 of San Antonio's CAAP is to have cleaner and more efficient vehicle technologies.** | CoSA OS, CPSE, AACOG |
| **Direct Financial and Other Incentives:** *Incentives reduce EV adoption and charging station development economic barriers.* | | | | |
| Offer incentive to trade-in high-polluting vehicles and replace them with new EVs. | High | Increase vehicle turnover to help remove high-polluting vehicles. | Not currently planned in San Antonio. Texas has a Cash for Clunkers program.*** | TCEQ |
| Create incentive programs for residential charging. | High | Potentially reduces EV ownership costs; supports grid resilience and optimizes electric infrastructure investment. | CPS Energy is evaluating new incentive programs. | CPSE |
| Create incentive programs to install workplace chargers. | Medium | Potentially reduces EV ownership costs | TCEQ, through the Texas Emission Reduction Plan, provides grants for commercial chargers. | TCEQ |
| Offer free or preferred parking for EVs in public lots and curbside areas. | Medium | High visibility and resulting potential to influence constituents. | Vehicles displaying an Authorized Vehicle placard can park for free at City-managed downtown street parking meters or pay stations up to the meter's or pay station's limit. | CoSA CCDO |
| Offer unlimited, unrestricted high-occupancy vehicle lane access for EVs. | High | Reduces travel time for EV drivers. | Nothing currently planned. | TxDOT |
| Exempt EVs from any vehicle registration taxes. | Low | Reduces cost of ownership of EVs. | There are no State or City registration taxes. Bexar County collects county road bridge and mobility fees. | State of Texas |
| **Special Electricity Rates:** *Electricity rates affect operational costs for EV drivers.* | | | | |
| Leverage smart chargers and smart metering to support programs for EV charging. | Medium | Enables managed charging programs and supports the possible launch of optional TOU rates; supports grid resilience and more balanced electricity usage level. | CPS Energy completed deployment of smart meters to service territory. | CPSE |

| Strategy | Priority | Benefits | Current Status | Lead Entities* |
| --- | --- | --- | --- | --- |
| Evaluate variable rates and/or other tariffs designed for residential, public, or fleet EV charging. | Medium | Potentially reduces EV ownership costs; supports grid resilience and optimizes electric infrastructure investment. | A pilot TOU tariff was approved by CoSA for large DCFC customers and is currently in use. CPS Energy is evaluating additional TOU offerings and offers an annual membership to discounted charging fees at 40 locations. | CPSE |
| **Marketing and Communications:** *These initiatives can help improve EV knowledge and ultimately the public's confidence in the technology.* | | | | |
| Amplify outreach and education initiatives to constituents and potential private-site hosts for EV awareness. | Medium | Increases awareness about EVs; incites others to act, removing the onus from the City and CPSE. | Underway with CAAP and this study. | CoSA OS, CPSE |
| Develop dealership strategies with area dealers to support education and outreach initiatives. | Medium | Increases awareness about EVs; increases the number of EV adopters as dealers interact with drivers selecting their next vehicles. | Discuss manufacturer-funded incentives with CPS Energy. | CoSA OS, CPSE, AACOG |
| Educate the public and businesses on funding opportunities, how to find certified mechanics, how to obtain permits, and other aspects through website pages and a technical assistance phone line. | Medium | Increases EV awareness. | Coordinate CoSA and other EV website information. | CoSA OS, CPSE |
| Develop informational resources and technical assistance targeted to specific entities (such as owners of detached single-family homes, residents in multi-unit dwellings, landlords/homeowner associations of multiunit dwellings, businesses, and private fleets). | Medium | Increases EV awareness. | Underway with this study. | CoSA OS, CPSE, AACOG |
| **Partnerships and Emerging Business Models:** *New business models may be able to offer significant market penetration.* | | | | |
| Use geospatial analysis to identify public and private site hosts for EV charging infrastructure. | High | Optimizes EV charging infrastructure. | Initial geospatial analysis at block level is complete. Next step is to identify individual sites. | CoSA OS |
| Partner with auto dealerships to encourage greater vehicle availability. Survey dealerships to understand their specific barriers. | Medium | Increased vehicle availability; increased EV knowledge levels. | Nissan will provide CPS Energy customers with a dealer incentive of up to $3,500 for a new LEAF. CPS Energy is developing other dealer programs. | CoSA OS, CPSE |

| Strategy | Priority | Benefits | Current Status | Lead Entities* |
|---|---|---|---|---|
| Partner with shared-use mobility companies or transportation network companies (TNCs) to build electrified hubs/plazas that enable the use of EVs for ride sharing. | Medium | Can electrify greater number of vehicle miles traveled compared to a single constituent's EV; high visibility and resulting potential to influence others. | CPS Energy's Large Commercial Fast Charging TOU pilot rate is available for electrified hubs/plazas. | CoSA OS, CPSE |
| Partner with freight and e-commerce organizations to encourage trial electrification projects in the region. | Low | Can electrify greater number of vehicle miles traveled compared to a single constituent's EV; high visibility and resulting potential to influence others. | Evaluating programs to support local companies pursuing trial electrification projects. | CoSA OS, CCDO, CoSA Aviation, VIA, CPSE |
| Partner with associations and businesses to offer training to mechanics and electricians. To ensure demand, require attendance at these trainings for any City-funded EV charger installations. | Medium | Increases EV awareness; allows local workers to support electrification process and vehicle needs and reap economic benefits. | In coordination with COSA EV infrastructure plans. | AACOG, Bexar County, AAMPO |
| Encourage neighborhood institutions (such as hospitals, schools, community centers, and places of worship) to install charging infrastructure and allow after-hours access. | Medium | Increases EV awareness; incites others to act, removing the onus from the City; high visibility and resulting potential to influence others. | CPS Energy has deployed charging infrastructure at hospitals and schools with after-hours access and is evaluating additional programs to promote EV charging. | CoSA OS, CCDO, CoSA Aviation, VIA, CPSE |
| Require taxi or TNC fleets to be hybrids or electrics to access local airports. | Medium | Can electrify greater number of vehicle miles traveled compared to a household EVs; High visibility. | Nothing currently planned. | CoSA OS, CPSE |
| Develop EV group purchase programs. | High | Reduces upfront cost of EVs for City and other fleets. | Noted in the adopted CAAP. | CoSA BESD, Finance |
| **Public Investment:** *San Antonio's use of EVs for its public fleets sets an important example for constituents, and publicly owned and accessible EV chargers can support other drivers.* | | | | |
| Install charging infrastructure in public lots and expand availability and awareness of charging by the curbside and in the right of way. | High | Increases access to chargers; allows City to influence the charging market, ensuring that equity and other City values are considered. | Under consideration. | CoSA OS |

| Strategy | Priority | Benefits | Current Status | Lead Entities* |
|---|---|---|---|---|
| **Codes and Standards:** *Streamlined codes, ordinances, and permits can dramatically reduce installation costs for associated infrastructure supporting EV charging.* | | | | |
| Enact "right to charge" regulations that prohibit landlords or condo associations from unreasonably restricting an owner from installing charging infrastructure in areas where they have exclusive use or in a common area (if the station is reasonably close to the resident's parking spot). | High | Ensures residents of multiunit buildings can install chargers. | Nothing currently planned. | CoSA Planning, DSD |
| Liaise with electrician/contractor associations and individuals to assess hurdles, define training needs, and build an improved process for permits and inspections. | Low | Better understand the local context for building EV electrical infrastructure. | Nothing currently planned. | CoSA DSD |
| Enact EV-ready building codes, zoning ordinances, and streamlined permitting. | High | Ensures buildings and the underlying electrical infrastructure are prepared for future EV chargers. | San Antonio complies with the 2015 IECC. | CoSA DSD |
| Reduce the minimum parking standard if EV chargers are installed at a property or parking lot. | Medium | Support the region's transition away from personal vehicle use while prioritizing EVs when personal vehicles are needed. | Nothing currently planned. | CoSA DSD, CoSA Planning |

** Abbreviations: AACOG: Alamo Area Council of Governments; AAMPO: Alamo Area Metropolitan Planning Organization; BESD: CoSA Building and Equipment Services Department; CAAP: Climate Action and Adaptation Plan; CCDO: City of San Antonio, Center City Development & Operations Department; CoSA Sustain: City of San Antonio, Office of Sustainability; CPSE: CPS Energy; DCFC: direct current fast charger; DSD: CoSA Development Services Department; IECC: International Energy Conservation Code; Planning: CoSA Planning Department; TCEQ: Texas Commission on Environmental Quality; TNC: transportation network company; TOU: time-of-use; VIA: VIA Metropolitan Transit*
*** Source: City of San Antonio. 2019. San Antonio Climate Ready: A Pathway for Climate Action and Adaptation. https://saclimateready.org/wp-content/uploads/2019/08/SACR-DRAFT-082219_SPREAD_WEB.pdf*
**** Source: Cash for Clunkers. 2019. Texas Cash for Clunkers. https://www.cashforclunkers.org/texas-cash-for-clunkers/*

## 2.5. Resiliency and Electric Vehicles

EV adoption and investment in the associated charging infrastructure can contribute to resilience in several ways:

- EV adoption diversifies the fuel needs of passenger, municipal, and commercial transportation, potentially reducing bottlenecks at petroleum fueling stations during evacuations.
- Fuel diversification allows for investment decisions that may reduce the impacts of fuel shortages on transportation during a major disruption or disaster. For example, EV charging infrastructure can be powered through distributed renewable energy and managed with battery storage technologies, which can be used as backup power during a disaster.
- In coming years, it may be possible to use vehicle-to-grid technology to provide power to the grid or to key facilities and individual residences from EVs, essentially using them as battery storage.

There are also resilience limitations with EV infrastructure. Compared to petroleum refueling stations, EV chargers can only store a relatively small amount of fuel on the site. Additionally, EVs take longer to recharge during emergencies. Intentional, long-term planning for EV adoption and charging infrastructure helps ensure that transportation and electric power systems contribute to a resilient community.

The City and CPS Energy are partnering with Sandia National Laboratories and other stakeholders on a project for the DOE: *Designing Resilient Communities: a Consequence-Based Approach for Grid Investment*. The project goal is to improve integration between community-focused resilience planning by local governments and asset investment planning by electric utilities. One planned focus area is the resilience impact of proposed locations for DCFCs and other electrical transportation infrastructure, including investigating the potential for collocating EV charging infrastructure with other key community assets and providing joint backup power and storage options.

# 3. EVS AND EMERGING MOBILITY

As the City develops programs to increase EV adoption, it should integrate EV planning with planning for other mobility options. This section explores EV charging considerations in the broader context of multi-modal transportation and emerging transportation trends.

## *3.1. Park and Rides and Transit Centers*

Park and rides and transit centers serve as central hubs for mobility services, offering commuters opportunities to pair single-occupant vehicle trips with carpool, vanpool, or public transit trips. Park and rides and transit centers tend to have long dwell times and typically have access to the electrical infrastructure needed for EV charging.

CPS Energy data show that EVs that charge at park and rides are full after two hours with Level 2 chargers and block access to the charger for the rest of the day. This suggests that using mostly Level 1 chargers and a few Level 2 chargers would be an ideal configuration at these settings. CPS Energy already has installed several Level 2 chargers at the Crossroads and Stone Oak park and rides. The City could work with third-parties to identify opportunities to install EV charging at other park and ride stations, such as those listed in Table 8, which have a larger number of parking spaces, relatively high levels of boardings and alightings, and that intersect with a relatively large number of transit routes.[50]

**Table 8. Park and Ride and Transit Center locations meriting further research.**

| Type | Location | Parking Spaces | Routes Served |
|---|---|---|---|
| **Park and Ride** | Randolph | 287 | 8, 17, 21, 502, 505, 509, 550/551, 629, 630, 631, 632 |
| **Park and Ride** | University | 200 | 93, 94, 97, 101, 603, 660 |
| **Transit Center** | Ingram | 81 | 82, 89, 90, 534, 550/551, 607, 609, 610, 618, 620 |
| **Transit Center** | South Texas Medical Center | 123 | 100, 501, 522, 534, 602, 603, 604, 606, 607 |

*Sources: VIA Metropolitan Transit. "Park & Ride | Commuters."* https://www.viainfo.net/park-ride-commuting/
*VIA Metropolitan Transit. "Transit Centers."* https://www.viainfo.net/transit-centers/

## *3.2. Airports*

Airports present another opportunity for charging station deployment. At airports, dwell times vary depending on the driver. Vehicles of airport passengers have dwell times of days to weeks and therefore could use Level 1 chargers. Vehicles of airport staff and tenant staff have dwell times similar to any workplace, meaning a combination of Level 1 and Level 2 chargers is needed. Ground transportation vehicles, such as taxis and TNC vehicles (such as Uber and Lyft) tend to have the shortest dwell times since they conduct passenger pickup and would therefore benefit from DCFCs. The San Antonio International Airport offers EV charging with paid parking in its short- and long-term parking garages.

## *3.3. Transportation Network Companies*

TNCs, such as Lyft and Uber, are among the fastest growing trends of the transportation sector and provide an opportunity for advancing electrification. TNCs operate on duty cycles similar to taxis; during

[50] City of San Antonio. 2016. *Multimodal Transportation Plan*. https://www.satransportationplan.com/files/managed/Document/260/6_VIA_2035_TransitPlan_Map_7_2_15%20%281%29.pdf

an eight- to 12-hour shift they could drive as much as 300 miles. This suggests a greater need for DCFC than among the average household vehicle. Potential ideas to advance electrification among TNCs include having a dedicated TNC DCFC plaza that ensures TNC drivers have access when they need charging or provides discounted DCFC fees. In return, TNCs would be required to have a certain fraction of total miles electrified (such as 20% of miles).

## *3.4. Emerging Mobility Options*

The City issued an RFI to implement an automated vehicle (AV) pilot in July 2018,[51] announcing the launch of the pilot in July 2019.[52] The City has developed Innovation Zones in key areas of the City—specifically in Brooks (a 1,300-acre mixed use campus), the South Texas Medical Center (a 900-acre campus), and Downtown.[53] The Alamo Area Metropolitan Planning Organization notes that in Brooks, "…consideration should be given to integrate the VIA Metropolitan Transit…Brooks Transit Center and VIA's new Primo operation on SW Military Drive."[54] For the Medical Center, the Alamo Area Metropolitan Planning Organization states that the focus should be on providing first mile/last mile transportation options for the medical facility's 27,000 employees and for the more than 29,000 employees in associated businesses.[55]

An opportunity exists for the City to consider developing Automated Mobility Districts (AMDs) within each of its Innovation Zones, increasing mobility and leveraging micro-mobility opportunities. The National Renewable Energy Laboratory defines AMD as "a campus-sized implementation of connected/automated vehicle technology to realize the full benefits of a fully electric automated mobility service within a confined region or district."[56]

AMDs are distinct from the rest of the City, in that they are in constrained, dense areas that discourage non-automated vehicles and should allow for easy navigation through a mix of on-demand automated vehicles, walking, and fixed route services.[57] AMDs use bike-sharing and micro-mobility to provide additional access within AMDs as well as at their edges.[58] Examples of suitable locations for AMDs include university campuses, urban centers, business campuses, and military bases. In the longer-term, the City could work with the University of Texas, San Antonio and Joint Base San Antonio to develop additional AMD pilots. The City of San Antonio Office of Innovation is currently exploring an AV pilot project that connects the Brooks City Base Transit Center with residences and businesses within the campus.

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[51] City of San Antonio. 2018. *Request for Information for Autonomous Vehicles Pilot Program.* https://webapp1.sanantonio.gov/RFPFiles/RFI_3598_201807200359261.pdf
[52] City San Antonio. 2019. *District 1 to be Testing Grounds for the First H-E-B Self-Driving Delivery Service.* https://www.sanantonio.gov/gpa/News/ArtMID/24373/ArticleID/16255/District-1-to-be-testing-grounds-for-first-H-E-B-self-driving-delivery-service
[53] Alamo Area Metropolitan Planning Organization. 2019. *Mobility 2045: Moving People. Connecting Places.* http://www.alamoareampo.org/Plans/MTP/docs/Mobility2045/Mobility2045_document.pdf
[54] Ibid.
[55] Ibid.
[56] Garikapati, Venu. 2018. *Smart Mobility: Systems and Modeling for Accelerated Research in Transportation.* https://www.nrel.gov/docs/fy18osti/71347.pdf
[57] Garikapati, Venu, and Stanley Young. 2017. *Next Generation Integrated Mobility: Driving Smart Cities* http://www.princeton.edu/~alaink/Orf467F17/Young_NREL_TSWC17_AMD_Final.pdf
[58] Young, Stanley E., Yi Hou, Venu Garikapati, Yuche Chen, and Lei Zhu. 2017. *Initial Assessment and Modeling Framework Development for Automated Mobility Districts.* https://www.nrel.gov/docs/fy18osti/68290.pdf

# 4. MUNICIPAL FLEET ELECTRIFICATION

In 2019, the analysts of this study began working with the City of San Antonio fleet administrator to identify, prioritize, and sequence vehicles for conversion to EVs. This chapter describes the current fleet composition, the methodology behind the fleet electrification analysis, and the results and recommendations from the analysis.

## *4.1. Current Municipal Fleet Composition in San Antonio*

The City of San Antonio has a fleet of 5,393 vehicles and equipment, spread between 27 municipal departments as shown in Figure 11.

The Building and Equipment Services Department manages the majority of light-duty vehicles and oversees vehicle acquisition, maintenance, repair, and disposition. The City's fleet uses a diversity of fuels, including diesel, unleaded gasoline, compressed natural gas, and propane. Most of the vehicles (97%) use gasoline and diesel. The majority (over 90%) of vehicles are funded through an internal service fund, called the Equipment Renewal and Replacement Fund, under which City departments are charged a monthly "lease" fee. The Fund recovers the vehicle's lifetime cost, thereby paying for the subsequent acquisition costs of future vehicles. With an average age of five years, San Antonio's fleet is composed primarily of Class 1 and Class 2 vehicles, as shown in Figure 11.

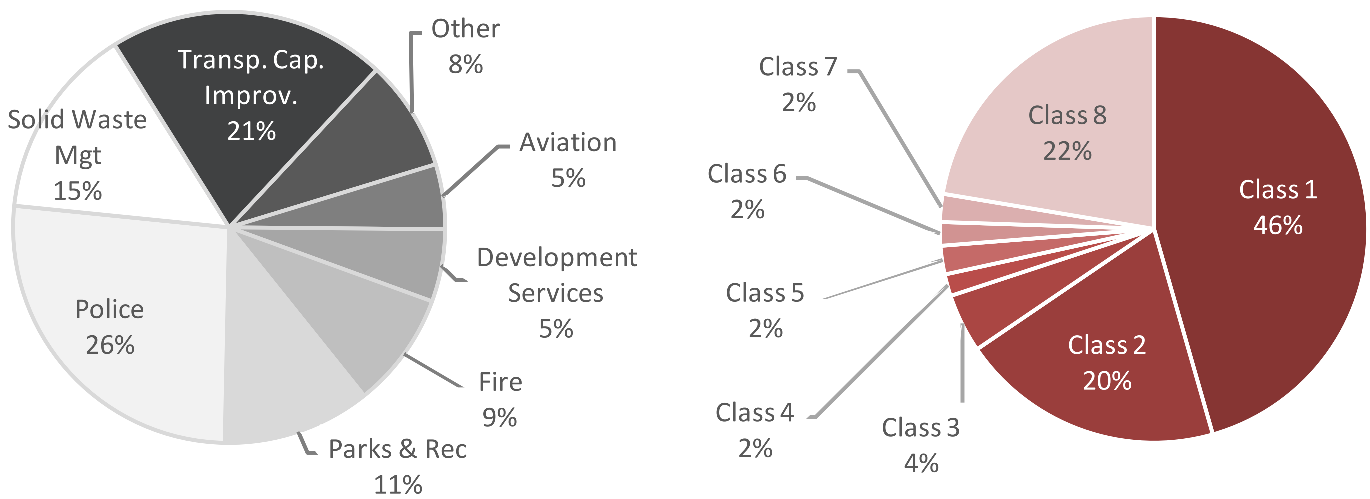


**Figure 11. Vehicles by Department (Left) and Vehicle Class (Right).**

As part of its San Antonio 2020 Goals, the City seeks to reduce diesel and unleaded gasoline consumption by 14% within its light-duty fleet by the end of Fiscal Year 2020, relative to Fiscal Year 2013. The City uses several strategies to meet this goal:

- Control fleet size (conduct usage assessment, identify under-used vehicles, limit fleet creep)
- Reduce miles traveled (reduce take-home vehicles, offer alternative options)

- Implement telematics (GPS, route optimization)
- Optimize vehicle and equipment lifecycles
- Introduce/expand alternative fuel vehicles and equipment
- Improve vehicle and equipment acquisition justification/approval process

A second City program guiding the City's decision making in fleet procurement is the *Vehicle Fleet Environmental Acquisition Policy*.[59] Published in 2010, this document lays the City's foundation to reduce GHG emissions, air pollution, and oil dependence from its vehicle fleet, while considering total costs of ownership (TCO) and strategic partnerships. City staff are updating the policy to be consistent with current GHG reduction and ozone attainment goals.

## 4.2. *Methodology of Fleet Electrification Analysis*

To conduct the fleet conversion analysis, the analysts and City Fleet Administrator coordinated on a multi-step process, summarized in Figure 12, that filtered the City's vehicles then scored them on their suitability for replacement with EVs. Each step is described below the figure.

| | Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|---|
| 5,393 Vehicles and Equipment in CoSA Fleet | Initial screening by City | Selection of EV replacement model | Removal of vehicles with high daily mileage | Scoring system:<br>• *TCO*<br>• *EV infrastructure cost*<br>• *Emissions* |
| | *2,348 vehicles* | *1,322 vehicles* | *1,202 vehicles* | *1,202 vehicles* |

**Figure 12. Summary of fleet electrification analysis.**

*Step 1. Initial screening by City.* Beginning with the full municipal fleet (5,393), the City Fleet Administrator removed over 3,000 vehicles and equipment that were not under consideration for electrification, including police pursuit vehicles, first responder emergency vehicles, off-road units, and non-rolling stock equipment. This left 2,348 vehicles.

*Step 2. Selection of EV replacement model*. The analysts compared the remaining 2,348 vehicles with EV models available on the market today (shown in Appendix A and Appendix B) or available through the *Climate Mayors EV Purchasing Collaborative.* The analysts selected the best EV replacement model for each City fleet vehicle based on vehicle size and vocation (per direction from the City, we only considered BEVs). This step removed 1,026 vehicles, mostly large light-duty and medium- and heavy-duty vehicles. For example, large SUVs and pickup trucks do not currently have an EV replacement on the market. This step shrank the selection to 1,322 potential vehicles.

*Step 3. Removal of vehicles with high daily mileage.* The analysts removed vehicles with an average daily mileage that exceeded the range of the EV selected as a replacement in Step 2: the implicit assumption is that a fleet EV would only charge once per 24-hour period (typically at night) and would therefore be limited in its daily range. Daily mileage was estimated using the odometer readings and age

[59] City of San Antonio. 2010. *An Ordinance: Establishing and Adopting a Vehicle Fleet Environmental Acquisition Policy, Consistent with the City of San Antonio's Mission Verde Sustainability Plan that will Guide Future Vehicle and Fuel Acquisitions for the City's Fleet.* https://www.sanantonio.gov/Portals/0/Files/Purchasing/pdf/fleet-acquisition-policy.pdf

of the vehicle, accounting for fleet vehicles typically only being used five days per week. While this is a very rough method to estimate daily mileage, it was the only available option. As the City continues its fleet electrification program, it should consider a closer examination of daily mileage across all vehicles. This step shrank the selection to 1,202 potential vehicles, as shown in Figure 12.

*Step 4. Scoring system.* In the final step, the analysts applied a rigorous scoring system to prioritize vehicles for replacement. This system accounted for TCO of the vehicle, lifecycle emissions of major pollutants, and EV infrastructure costs. For both the current vehicle and its selected EV replacement, the analysts estimated, weighed, and summed each factor to create a composite EV Suitability Score to compare to other vehicles. The higher the score, the more attractive the vehicle for replacement with an EV. Weights are shown in Table 9 and were chosen in coordination with the City.

**EV Suitability Score**

A value between 0 and 1 that captures the appeal of converting each fleet vehicle to an EV. Score includes the TCO, EV charger cost, and emissions.

The analysts estimated vehicle costs by summing the time-discounted depreciation, fuel, maintenance, and repair costs over the vehicle's lifetime, assumed to be 10 years and 100,000 miles. Costs for the current vehicle were available from the City. Costs of the EV replacement were collected from public sources. Upfront vehicle costs are shown in Appendix A and Appendix B. Maintenance costs for EVs were taken from Argonne National Laboratory's AFLEET tool. The electricity cost for EVs was assumed to be $0.0826 per kilowatt-hour.[60] All costs were placed into a cost per mile metric. EV infrastructure costs were added into the TCO (dollars per mile) for all EVs. The analysts assumed each vehicle required a Level 2 charger, requiring a one-time upfront cost $4,000.

**Table 9. Weights applied to the scoring system for each factor.**

| | |
|---|---|
| Cost per mile | 40% |
| $CO_2e$ | 30% |
| $NO_x$ | 10% |
| $PM_{2.5}$ | 5% |
| $PM_{10}$ | 5% |
| VOC | 10% |

The analysts estimated the lifecycle emissions using standard emission coefficients in Argonne National Laboratory's AFLEET tool and scaling by each vehicle's fuel economy (provided by the City). This methodology was not intended to be exact, but rather to provide an order of magnitude estimate of on-road emissions. Several pollutants were estimated on a grams per mile basis: $CO_2e$, $NO_X$, fine and large particulate matter (PM), and VOCs. $CO_2e$ emissions reflect the EPA's eGrid region for San Antonio.[61] All data sources are annotated in the fleet electrification spreadsheet provided to the City. Modeling inputs described in this section can be easily modified in the spreadsheet.

## 4.3. Results and Recommendations

### 4.3.1. Cost Comparison

If comparing only costs, a substantial number of the fleet vehicles are cheaper as an EV than as a gasoline/diesel vehicle. As shown in the bottom row of Table 10, 315 of the 1,202 vehicles in the final analysis step have a cost per mile lower for the EV replacement vehicle on a TCO basis. TCO includes vehicle depreciation, fuel, maintenance, repair, and upfront costs of Level 2 chargers. Table 10 summarizes the number of vehicles in each size class that have lower TCO for EVs compared to the

[60] Reflects commercial electricity rates for Texas per the Energy Information Administration. https://www.eia.gov/electricity/data.php
[61] ERCOT eGrid region has a $CO_2e$ intensity of 1014 lbs/MWh. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

current vehicle. For example, the top row shows that 220 of 674 vehicles in the Class 1 category could be replaced by an EV today and save the City money on a TCO basis. As battery costs continue to decline over the next decade, this fraction of vehicles will increase.

**Table 10. Number of vehicles in final electrification analysis with cheaper total cost of ownership, by size class.**

| Class | Total Vehicles in Analysis | Current Vehicles are Cheaper | EV Replacement is Cheaper |
|---|---|---|---|
| 1 | 674 | 454 | 220 |
| 2 | 32 | 24 | 8 |
| 3 | 51 | 36 | 15 |
| 4 | 3 | 0 | 3 |
| 5 | 51 | 47 | 4 |
| 6 | 41 | 40 | 1 |
| 7 | 48 | 44 | 4 |
| 8 | 302 | 242 | 60 |
| **Total** | **1,202** | **887** | **315** |

### *4.3.2. Emission Comparison*

If comparing only emissions, the EV replacement vehicle almost always has lowers emissions than the current gasoline/diesel vehicle; for example, the average EV replacement vehicle has 45% lower lifecycle $CO_2$e emissions. This accounts for both the tailpipe emissions as well as upstream emission sources from fuel or electricity production and delivery. The only cases in which the EV has higher lifecycle $CO_2$e emissions are for a few hybrid electric sedans with very high miles-per-gallon fuel economy. For the vast majority of hybrid EVs in the municipal fleet, the EV replacement vehicle has lower $CO_2$e emissions.

$NO_x$ is another important pollutant for the City, given its non-attainment status for ground-level ozone. Most EV replacements (95%) have lower lifecycle $NO_x$ than the current fleet vehicle and all EV replacements (100%) have lower $NO_x$ when comparing just tailpipe emissions. Overall, EV replacements have an average $NO_x$ lifecycle savings of 51% over current gasoline/diesel vehicles in the fleet.

### *4.3.3. EV Suitability Scores*

As noted, costs and emissions were combined and weighted into a composite EV Suitability Score between 0 and 1 for each fleet vehicle. While the absolute value of the score is meaningless, the relative scores between vehicles allows for prioritization in the fleet conversion process (where higher-scoring vehicles should be prioritized for EV replacement). Scores for every one of the 1,202 fleet vehicles are available in the scoring spreadsheet provided to the City.

In general, the highest scoring vehicles are large Class 1 vehicles. Electrified versions of these vehicles reduce TCO and emissions the most of any vehicles. To help visualize the EV Suitability Scores, the analysts aggregated vehicles by vehicle make and model. The top 10 overall highest scoring vehicle models are shown in Table 11. A full list of aggregated scores by make and model is given in Appendix E.

As shown in Table 11, the EV replacement vehicle is not always an exact replacement for the current vehicle. For example, the analysts recommend replacing the Chevy C1500 Suburban with a 2019 Hyundai Kona Electric (top row). The means replacing an eight-seat vehicle with a five-seat vehicle and reducing interior space from 121 cubic feet to 117 cubic feet.[62] However, the EVs often outperform the current vehicle in other attributes (such as TCO, emissions, acceleration, and refueling convenience).

**Table 11. Top 10 Scoring Vehicle Makes and Models in San Antonio Fleet to Replace with EVs.**

| Municipal Fleet Vehicle Type | Recommended EV Replacement | EV Suitability Score | Avg Cost of Current Vehicle ($/mile) | Avg Cost of EV ($/mile) | Avg $CO_2$e Emissions of Current Vehicle (lb/mile) | Avg $CO_2$e Emissions of EV (lb/mile)[63] |
|---|---|---|---|---|---|---|
| **Chevrolet C1500 Suburban** | 2019 Hyundai Kona Electric | 97% | $0.90 | $0.55 | 2.44 | 0.30 |
| **Dodge Durango SSV** | 2019 Hyundai Kona Electric | 96% | $0.89 | $0.55 | 2.37 | 0.30 |
| **Ford Crown Victoria** | 2019 Nissan LEAF | 96% | $0.68 | $0.49 | 2.55 | 0.32 |
| **Jeep Wrangler** | 2019 Hyundai Kona Electric | 96% | $0.77 | $0.55 | 2.52 | 0.30 |
| **Ford Explorer XLT** | 2019 Hyundai Kona Electric | 96% | $0.62 | $0.55 | 2.23 | 0.30 |
| **Chevrolet Caprice** | 2019 Nissan LEAF | 96% | $0.84 | $0.49 | 2.21 | 0.32 |
| **Chevrolet C3500HD Sierra** | 2018 Lightning Systems Ford Transit 350HD | 88% | $1.63 | $1.26 | 3.67 | 1.44 |
| **Dodge Durango** | 2019 Hyundai Kona Electric | 75% | $0.89 | $0.55 | 2.37 | 0.30 |
| **Ford Explorer** | 2019 Hyundai Kona Electric | 70% | $0.66 | $0.55 | 1.60 | 0.30 |
| **Chevrolet C3500HD Silverado** | 2018 Lightning Systems Ford Transit 350HD | 70% | $1.40 | $1.26 | 3.40 | 1.44 |

## Top 100 Scoring Vehicles

Another way to consider the benefits of fleet electrification is to summarize key metrics for the top 100 scoring vehicles. Figure 13 provides calculations of the average reduction in $CO_2$, $NO_x$, VOC, and TCO when shifting the top 100 scoring vehicles to electric.

74% $CO_2$e Reduction
On lifecycle basis

26% Cost Reduction
Per mile on total cost of ownership basis

78% $NO_x$ Reduction
On lifecycle basis

98% VOC Reduction
On lifecycle basis

**Figure 13. Summary of metrics across top 100 scoring vehicles.**

[62] Hyundai USA. 2019. *2019 Kona Electric: Features & Specifications*. https://www.hyundaiusa.com/kona-electric/specifications.aspx
Car and Driver. 2019. *Chevrolet Suburban*. https://www.caranddriver.com/chevrolet/suburban/specs
[63] Emissions calculated using ERCOT eGrid sub-region coefficient of 1014 lb/mWh.

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# 5. COMMUNICATIONS AND STAKEHOLDER ENGAGEMENT PLAN

In the coming decade, San Antonio's EV market will mature from a small group of early adopters to a much larger set of mass market EV drivers. As EV adoption scales, so too must the communications and stakeholder engagement from the City.

EVs exist within a broader ecosystem of stakeholders in San Antonio, as illustrated in Figure 14. Stakeholder groups include internal government entities (dark red nodes) and external entities (dark grey nodes). Effective engagement by the City dispels myths, sets expectations, and guides San Antonio residents toward common goals and understanding. This section describes how the City can effectively engage and communicate with various stakeholder groups on issues around EVs, today and in the future.


**Figure 14. Ecosystem of EV stakeholders in San Antonio.**

## *5.1. Levels of Engagement*

Engagement between the City and EV stakeholders exists on a spectrum of involvement (Figure 15). At one end is "Inform," which entails one-way communication from the City to stakeholders to ensure

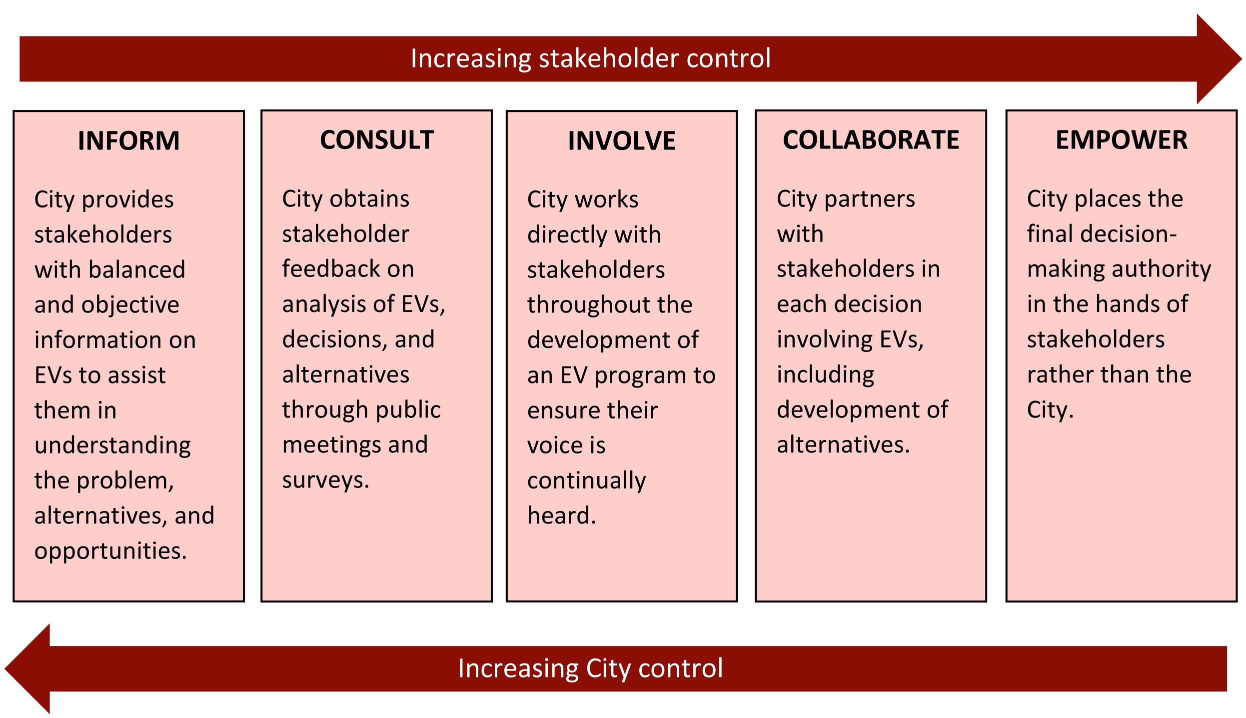


**Figure 15. Spectrum of engagement between City and EV stakeholder groups (adapted from IAPP 2018).**

awareness of government actions on EVs. At the other end is "Empower," in which stakeholders are given full decision-making authority. Moving from left to right in the table, public participation increases, while the City's control decreases. Most stakeholder engagement processes take place at the "Consult," "Involve," and "Collaborate" levels.

For effective engagement, the International Association for Public Participation[64] recommends engaging stakeholders at multiple levels shown in Figure 15. For example, the City's EV-Ready Working Group is comprised of internal and external stakeholders who develop alternative options for the City's EV strategy ("Collaborate" level). The Working Group could hold public meetings to solicit feedback from other citizens ("Consult" level) and City staff could send information to households about final decisions regarding EV infrastructure ("Inform" level).

## 5.2. Stakeholder Concerns and Resources

Effective communication and engagement on EVs are only possible when stakeholders concerns and the real and perceived market barriers of EVs are understood. Table 12 should be used as a starting point for tailored discussions, outreach, and information dissemination with each stakeholder group.

**Table 12. Key questions and concerns about EVs by stakeholder group.**

| Stakeholder Group | Key Questions and Concerns |
|---|---|
| Alamo Area Metropolitan Planning Organization | What are the emissions benefits of EVs today and in the future? |
| | How does EV planning fit with the Alamo Area Metropolitan Planning Organization's master planning process? |
| | Given the reduced noise levels of EVs, are there public safety concerns with greater EV deployment? |
| CPS Energy | Will deployment of charging infrastructure create local grid reliability concerns? |
| | How can CPS Energy best prepare for large-scale electrification of transportation while simultaneously increasing renewable penetration? |
| | What incentives and rate designs will increase EV adoption in CPS Energy's service area in a cost-effective manner? |
| | What can DCFC Stations do to reduce the demand charges? |
| Car Dealerships | Will selling EVs reduce revenue at dealerships? |
| | Where can my customers get information about EV technology, incentives, and makes and models? |
| | How can my staff improve their level of knowledge on EV-related topics? |
| City Departments | Why should the City be interested in increasing EV deployment? |
| | What level of EV ownership should the City expect in five, 10, and 20 years? |
| | How can my department support greater EV adoption within San Antonio? |
| | What are examples of effective municipal-run EV programs outside of San Antonio? |
| Advocacy Groups | How can the City advance EV ownership in an equitable fashion that benefits all citizens of San Antonio? |
| | Which strategies maximize environmental benefits and cost-effectiveness for San Antonio? |
| | How can the City incentivize EVs without disincentivizing public transit? |
| Fleet Managers | Can today's EVs provide City drivers with sufficient range to meet operational needs? |
| | How can the City ensure that drivers plug vehicles in at the end of the day? |
| | Are EVs suitable for emergency situations? |

[64] International Association for Public Participation. 2018. *IAP2 Spectrum of Public Participation.* https://cdn.ymaws.com/www.iap2.org/resource/resmgr/pillars/Spectrum_8.5x11_Print.pdf

| Stakeholder Group | Key Questions and Concerns |
|---|---|
| | Is the workforce trained to support operations and maintenance of an EV fleet? |
| | Which electric makes and models are available and how do costs compare to conventionally powered vehicles? |
| Housing Developers | Which types of EV charging systems are suitable for at-home charging? |
| | Does the provision of EV chargers in a home increase the sales price of the home? |
| | What is the difference between "EV capable" and "EV ready" in terms of technology requirements and costs? |
| | Which charging solutions exist for home renters or for homeowners without garages? |
| Major Employers and Retailers | How can companies install public EV charging in their parking lots? |
| | What signage and design principles should be followed to integrate EV charging into a parking lot or garage? |
| | Can retailers make additional revenue by offering public charging at their sites? |
| | How can companies ensure turnover of EVs parked at chargers? |
| | What access issues must be addressed for disabled EV owners? |
| Private Citizens | How do EVs compare with gasoline and hybrid vehicles on TCO? |
| | Do EVs really reduce emissions? What about the electricity grid emissions? |
| | What types of incentives exist for buying an EV? |
| | Does the range of EVs go down in San Antonio's hot summer months? |

The list is not meant to be comprehensive and is based on the analysts' understanding of the literature that examines stakeholder-specific barriers, such as the report *Overcoming Barriers to Deployment of Plug-in Electric Vehicles* from the National Academies of Sciences, Engineering, and Medicine,[65] the DOE's Alternative Fuel Data Center,[66] and FHWA's Alternative Fuel Toolkit.[67]

## 5.3. *Communication and Engagement Strategies*

The role of municipal governments in transportation electrification has become clearer in recent years, and more examples of effective programs exist now than ever before. Several specific communication and stakeholder engagement ideas are discussed in detail below. Concurrent with the development of this analysis, the City of San Antonio is developing the EV-SA public information campaign to unify communications and outreach strategies. Two surveys have been developed in English and Spanish to gauge general community perceptions about EVs (see Appendix G and Appendix H) and to receive input on new public charging infrastructure.

### 5.3.1. *Developing Stakeholder Teams*

Establishing a set of internal and external teams of stakeholders will help guide EV-related planning and implementation. As depicted in Figure 16, three stakeholder teams with overlapping functions are the Core Decision-Making Team, Implementation Team, and Technical Advisory Team.

- **Core Decision-Making Team.** This core group is internal City staff who are involved in every aspect of EV municipal planning, from start to finish. This team should include the City's sustainability coordinators as well as a mix of senior and junior staff who are responsible for developing analyses, procuring vendors, building the business case for new EV programs,

[65] National Academies of Sciences, Engineering, and Medicine Press. 2015. *Overcoming Barriers to Deployment of Plug-in Electric Vehicles.* https://www.nap.edu/catalog/21725/overcoming-barriers-to-deployment-of-plug-in-electric-vehicles
[66] U.S. Department of Energy. 2019. *Alternative Fuel Data Center*. https://afdc.energy.gov/
[67] Federal Highway Administration. 2019. *Altfuel Toolkit.* http://altfueltoolkit.org/

prioritizing and selecting initiatives for future implementation, organizing stakeholder activities, and communicating with internal and external stakeholders.

- **Implementation Team.** This team is composed of internal and external stakeholders responsible for implementing the EV planning activities. These stakeholders also assist during with developing plans and strategies by guiding the vision, goals, and initiatives so they are implementable and integrated into all aspects of the City's mission. Implementation Team members are important agents for change and will be actively involved in enhancing communication, education, and collaboration to achieve the City's mission by participating in the planning process, generating ideas for EV programs, assisting to develop key performance indicators for tracking progress, and acting as a bridge between San Antonio residents and the City.

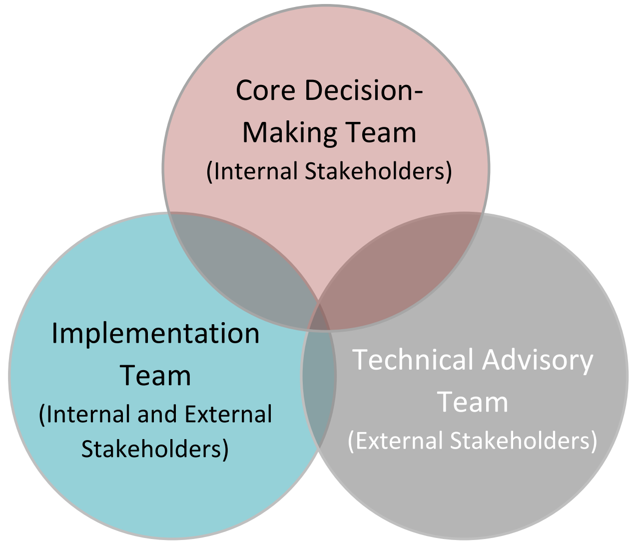


**Figure 16. Overlapping nature of three types of stakeholder teams.**

- **Technical Advisory Team.** This team is comprised of technically savvy external stakeholders who support both the Core Decision-Making and Implementation teams by reviewing important plans and strategies related to EVs. Ideal candidates for the Technical Advisory Team include academics, engineers, and financial experts who have a deep understanding of EV technology and can help the City avoid blind spots as it rolls out EV programs.

### *5.3.2. Hosting Ride-and-Drives Events*

Ride-and-drives and EV showcases are effective ways to draw media attention and allow consumers to experience EVs. Research demonstrates that first-hand experience shared by EV experts is one of the most influential sources of information in an EV purchase decision.[68] A natural fit is for the City to work with partners, such as AACOG's Clean Cities Coordinator, to host ride and drives and continue helping coordinate National Drive EV Day. The City should also consider working with the Office of Innovation to highlight Innovation Zones, such as within the downtown core business district, the South Texas Medical Center, and Brooks Citybase.

**Which Messages Resonate with Potential EV Adopters?**

In a survey of over 18,000 EV owners in California, respondents cited which factor was the most important message prior to their EV purchase decision (from most to least important):

- EVs save me money
- EVs reduce the environmental impact of travel
- EVs provide me high-occupancy vehicle lane access
- EVs improve energy independence
- EVs have better performance than convention vehicles

[68] Williams, Brett, and Clair Johnson. 2016. *EV Consumer Characteristics, Awareness, Information Channels & Motivations*. https://energycenter.org/sites/default/files/docs/ext/transportation/2016-07-20%20EVR9-CSE-PEVmarkets%20handout.pdf

### 5.3.3. *Conducting Awareness Campaigns*

On average, consumers are largely unfamiliar with EV technology, unaware of available incentives, and uninformed about the range of benefits that EVs provide. Public awareness campaigns can be enormously helpful in increasing public acceptance of EVs. Public awareness campaigns should be dedicated, limited duration events or programs that aim to raise consumer awareness and understanding of EVs through innovative channels of communication. Consumer awareness campaigns can involve radio and television announcements, celebrity ambassadors, social network posts and messaging, competitions and challenges, and more. As shown in the call-out box, potential EV adopters respond differently to different messages.[69]

### 5.3.4. *Educating Professionals*

Identifying and preparing to meet workforce needs is integral to establishing EV readiness within San Antonio. Increased EV adoption provides an opportunity to upskill existing workers and to entice students to pursue fields where a worker shortage is anticipated, such as electricians who work charging stations and auto mechanics skilled in EV repair. To this end, San Antonio could convene a stakeholder group, dedicated to identifying training needs for electricians and auto mechanics and designing training programs that meet those needs. Programs could offer a degree or certificate or could target training of recent graduates or professionals. The Contra Costa Transportation Authority developed a workforce training program framework and strategic plan for mechanics and electricians as part of its *Contra Costa County EV Readiness Blueprint*. Its plan for mechanics included a training program outline to fill knowledge gaps for emerging auto technicians, while its plan for electricians relied on the curriculum already developed by the Electric Vehicle Infrastructure Training Program. Municipalities such as the City of Long Beach and the City of Pico Rivera in California have incorporated an Electric Vehicle Infrastructure Training Program requirement for EV charging station installations. Potential partners identified to support Contra Costa County's workforce development efforts included community colleges, auto dealers, the local workforce development board, the Electrical Training Alliance, the International Brotherhood of Electrical Workers, and nonprofits such as GRID Alternatives.

### 5.3.5. *Coordinating Partnerships*

Building strong partnerships with commitments to long-term engagement is easier at a relatively nascent stage of EV adoption than in a mature EV market. Successful partnerships are those in which both parties have more to gain by teaming than by not teaming. There are three common types of partnerships in EV-related planning:

- **Partnerships to reduce EV costs.** The City should focus on partnering to reduce both the up-front and operational costs of EV use. For example, the City can partner with other cities in a joint procurement to reduce the up-front costs of fleet vehicles, such as the Climate Mayors EV Purchasing Collaborative. Moreover, the City can support the ongoing efforts of advocacy groups, CPS Energy, and other entities to help establish state-level policies that may have a more direct impact on costs. Finally, the City can collaborate with CPS Energy to evaluate charging and rate models that improve the economic benefits of EV charging.
- **Partnering to disseminate EV information.** Often, the two entities can both gain by partnering to

[69] Williams, Brett, and Clair Johnson. 2016. *EV Consumer Characteristics, Awareness, Information Channels & Motivations*. https://energycenter.org/sites/default/files/docs/ext/transportation/2016-07-20%20EVR9-CSE-PEVmarkets%20handout.pdf

disseminate information on EVs. For example, the City can help advertise a discount at an automobile dealership. Conversely, if the City or CPS Energy has an established financial incentive, they can partner with dealerships to ensure that such incentives are advertised by partners and captured by consumers.

- **Partnering to build EV infrastructure.** As seen in other jurisdictions, ample opportunities exist for partnerships on EV infrastructure. For example, the City could provide access to the right-of-way to public charging developers in exchange for developing a station plaza with reduced pricing. Seattle runs an Electric Vehicle Charging in the Public Right-of-Way Pilot Program that allows public and private infrastructure providers to install EV charging stations in the public right-of-way if they meet program requirements.

### *5.3.6. Leveraging Existing Resources*

The City should take advantage of existing EV resources that can be easily integrated into the City's information dissemination apparatus. For example, the Greenlining Institute offers the "Electric Vehicles for All: An Equity ToolKit," a specifically designed toolkit that provides tools, tips, and resources to make EVs accessible to underserved communities.[70] The toolkit's chapters are highlight information and lessons learned from other jurisdictions. Other potential resources include fact sheets,[71] videos,[72] online tools,[73] and celebrity promotions.[74]

The City could consider developing a series of informational materials and factsheets to help educate the public about EVs and the work the City is doing to expand infrastructure. The factsheets could be used at community events and could be included in online outreach. The City could also consider developing infographics and other visual communications elements to convey information. Infographics could be used in tandem with factsheets or used in online mechanisms, such as Twitter, to communicate information more easily. The City should develop factsheets in both English and Spanish to ensure that all residents are able to become educated.

### *5.3.7. Conducting Email Outreach*

The City could develop a series of email campaigns to human resources and facilities managers that inform and drive web traffic to the City's and CPS Energy's EV webpage. The City could consider several types of email campaigns:

- General awareness/informational
- Segmented – employer specific by size (small, medium, large businesses) or by type (hospitals)
- Seasonal – (such as January/New Year)
- Deadline-driven – based on countdowns or special events (such as Earth Day or funding deadlines)
- Follow-up – reconnecting with those who have shown interest

The City could utilize the SA SpeakUp platform to gather community input through surveys and work with

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[70] The Greenlining Institute. 2019. E*lectric Vehicles for All: An Equity ToolKit*. http://greenlining.org/publications/online-resources/2016/electric-vehicles-equity-toolkit/
[71] There are many examples for informative fact sheets, such as this "Electric School Bus" fact sheet from the Vermont Energy Investment Corporation: https://www.veic.org/Media/success-stories/types-of-electric-school-buses.pdf
[72] ChargePoint (n.d.) Events and Webinars. https://www.chargepoint.com/about/events/?desktop=true&page=3
[73] Union of Concerned Scientists. (n.d.) "How Clean is your Electric Car?" https://www.ucsusa.org/resources/how-clean-your-electric-vehicle
[74] Wired. 2019. "Arnold Schwarzenegger Stars in New Ad Plugging Electric Cars." https://www.wired.com/story/arnold-schwarzenegger-stars-new-ad-plugging-electric-cars/

other City departments and community groups to leverage exposure at major citywide events such as Siclovia, Earth Day, and the Pollinator Festival.

### *5.3.8. Writing Press Releases, Articles, and Op-Eds*

The City can use press releases to pursue earned media through local channels. Specific local and regional print and radio media outlets can help promote the message. In the future, the City can use ads and articles, and could recruit citizens to write op-eds to express their experience with EVs.

### *5.3.9. Developing Social Media Awareness*

The City’s social media platforms can drive awareness and grow and engage audiences on EV topics. To get the most out of this channel of communication, the City should tailor content to reach various audiences and should consistently use campaign-related hashtags. It is also easy to tag related programs to widen the audience for the message. For example, tagging CPS Energy’s EV incentives can result in mutual cross-promotion and increase web traffic.

### *5.3.10. Conducting Targeted, Paid Media Campaign*

If budgets allow, the City could consider using paid search and social campaigns to create top-of-mind awareness among the target audience. Ads can drive traffic to the websites and to other informational resources. The City could consider paid targeted ads on Facebook, Google, or other websites to amplify a specific message.

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# 6. INCREASING EV ADOPTION IN UNDERSERVED COMMUNITIES

This section highlights the socioeconomic challenges impeding EV adoption in San Antonio and identifies best practices and recommendations for increasing EV adoption and usage in underserved communities. Transportation electrification can greatly benefit low- and moderate-income (LMI) communities and communities of color. Past research shows that low-income and minority families are disproportionately located closer to freeways and are more exposed to air pollution hot spots.[75] Other research demonstrates that improved air quality can benefit homeowner values, particularly for low-income homeowners.[76]

## *6.1. Socioeconomic Challenges Impeding EV Adoption*

High upfront cost will continue to be a barrier to EV adoption in the near term. Data from another large EV market suggests that approximately 80% of new EV buyers have a household income above $100,000.[77] In San Antonio, less than 20% of households make this level of income (Figure 17). The 2018 median household income in the San Antonio metro area was $57,379, which lags median incomes in the United States and other municipalities within Texas.[78] However, reflecting national trends, median income in San Antonio has increased in the past decade.[79]

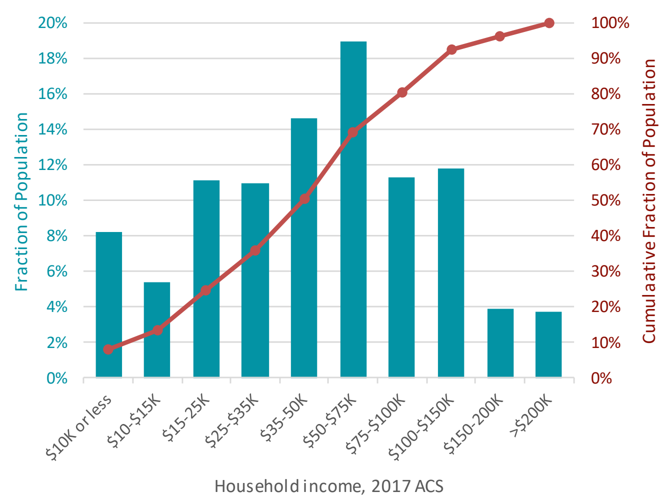


**Figure 17. Household income by income group (turquoise) and cumulatively (red).**

In addition to high upfront costs, there are other factors that can limit EV adoption in underserved communities:

- **Availability of charging infrastructure**: There are a limited number of EV charging stations, including in multifamily dwelling complexes, at workplaces, and in public locations. Since LMI community members are less likely to be homeowners, many must rely on charging stations outside of their households and may lack the decision-making power to get a station installed at a rental property.

[75] Bae, C, G. Sandlin, A. Bassok (2007), *The exposure of disadvantaged populations in freeway air-pollution sheds: a case study of the Seattle and Portland regions*, Environment and Planning B: Planning and Design, 34, 154-170.
[76] Bento, A., M. Freedman, and C. Lang (2015), *Who Benefits from Environmental Regulation? Evidence from the Clean Air Act Amendments*, The Review of Economics and Statistics, 97(3), 610-622.
[77] Tal, Gil, Michael A. Nicholas, Justin Woodjack, and Daniel Scrivano. 2013. *Who is Buying Electric Cars in California? Exploring Household and Vehicle Fleet Characteristics of New Plug-In Vehicle Owners.* https://merritt.cdlib.org/d/ark:%252F13030%252Fm56692z3/1/producer%252F2013-UCD-ITS-RR-13-02.pdf
[78] Census Reporter. *San Antonio-New Braunfels, TX Metro Area.* https://censusreporter.org/profiles/31000US41700-san-antonio-new-braunfels-tx-metro-area/
[79] Royall, Emily. 2018. *San Antonio's Median Income Still Lags Behind Other Texas Cities*. https://therivardreport.com/sa-median-incomes-rises-to-new-heights-but-lags-state-nation/

- **Access to tax credit**: LMI households may not pay high enough taxes to benefit from the federal EV tax credit of up to $7,500.
- **Limited secondary market for EVs:** EV sales in Texas started in 2011 and did not reach 5,000 vehicles per year until 2017, so there are not many local EVs on the road today. However, the San Antonio area is a net importer of used EVs (imported from other parts of the country) and the secondary market will expand as EV penetration grows.
- **Credit access and rating:** Lack of a bank account, lack of access to credit, and poor credit impede the ability to purchase any kind of vehicle, including EVs.
- **Language barriers:** Educational, permitting, and other EV materials that are only available in English may not effectively reach all community members.

## 6.2. Example Municipal EV Programs for Underserved Communities

Several municipalities have piloted and implemented programs to advance EV adoption among underserved communities. Seattle, for example, has worked closely with the Environmental Justice Committee for guidance on how to implement electrification projects in marginalized communities. The Environmental Justice Committee has provided a comprehensive list of recommendations to inform future initiatives in the transportation electrification space. Seattle initiated a community car share pilot and will deploy at least one pilot project for community EV car share that is designed in partnership with community members. Level 2 charging stations and supporting vehicles will likely be provided in locations identified by the community to increase access to electrified mobility, particularly around affordable daycare sites or near home health care and other industry staff who work non-standard shifts or rely on vehicles to travel longer distances.[80]

In 2018, the City of Atlanta Mayor's Office of Resilience and Department of Corrections partnered with a nonprofit to provide transportation using zero emission vehicles for recently released inmates. The rideshare pilot sought to help recently released inmates complete court-mandated requirements, attend treatment for addiction, and seek employment opportunities.[81] The BlueLA Electric Car Sharing Program, managed in partnership with the City of Los Angeles Department of Transportation, is the nation's largest EV car-sharing program for underserved communities. The program focuses on reducing GHG emissions and providing low-income communities with clean, affordable transportation options. Low-income users receive a reduced rate of $0.15 per minute. The program has resulted in the deployment of 100 EVs and 200 charging stations in lower-income neighborhoods surrounding downtown.[82]

## 6.3. Example Utility EV Programs for Underserved Communities

Several utilities also offer EV programs that address barriers for underserved communities. For example, Austin Energy provides cost-effective, citywide charging and incentives to encourage new and existing multifamily developers to install EV charging infrastructure. Austin Energy has recognized that affordable and reliable access to EV charging is essential for EV ownership in lower-income communities. The utility provides rebates up to $4,000, or 50% of the cost to install approved Level 2

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[80] Puget Sound Clean Air Agency. 2018. *Facilitating Low Income Utilization of Electric Vehicles: A Feasibility Study*. http://pscleanair.org/DocumentCenter/View/3578/Final-Report-Website-Version-_Facilitating-Low-Income-Utilization-of-Electric-Vehicles2?bidId=
[81] Kelley, Collin. 2018. *City Launches Pilot Electric Vehicle Rideshare Program*. https://atlantaintownpaper.com/2018/07/city-launches-pilot-electric-vehicle-rideshare-program/
[82] Puget Sound Clean Air Agency. 2018. *Facilitating Low Income Utilization of Electric Vehicles: A Feasibility Study*. http://pscleanair.org/DocumentCenter/View/3578/Final-Report-Website-Version-_Facilitating-Low-Income-Utilization-of-Electric-Vehicles2?bidId=

(240V) charging stations and/or EV Level 1 (120V) outlets. Austin Energy also provides rebates up to $10,000 for entities to install a DCFC. As part of the rebate participation rules, the rebate recipients must join the Austin Energy Plug-In EVerywhere network. Under this program, Austin Energy sets charging services pricing policy and collects revenues. Austin Energy's Plug-in EVerywhere network allows unlimited charging at public stations for just $4.17 per month, including fast charging, making it one of the most affordable charging networks available. EV adoption rates in Austin have grown nearly 200% over the last few years.[83]

In Maryland, Baltimore Gas & Electric, Potomac Electric, Delmarva Power, and Potomac Edison jointly proposed an EV portfolio to accelerate EV charging infrastructure across the state. The proposal was approved by the Maryland Public Service Commission in 2019 and includes incentives for multifamily dwellings, with a carve-out for buildings in which 50% or more of the residents are confirmed as low-income customers.[84] In California, Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison each committed to installing 10% or more of charging stations in disadvantaged communities.[85]

## *6.4. Strategy Options for Addressing Equity in CoSA's EV Program*

The City of San Antonio could take several approaches to increase EV adoption in underserved communities. Noteworthy resources that focus on this topic include The Greenlining Institute's "Electric Vehicles for All: An Equity ToolKit"[86] and "Electric Carsharing in Underserved Communities: Considerations for Program Success"[87] and the International Council on Clean Transportation's "Expanding Access to Electric Mobility in the United States."[88] There are several strategy options, drawn from these resources and incorporating best practices and recommendations for removing barriers to EV adoption for underserved communities, for addressing equity in San Antonio's EV programs:

- **Develop community partnerships**: Developing partnerships with community-based organizations can add nuance to the specific barriers experienced by underserved communities and lead to EV pilot programs. Community partners can also help translate EV educational materials to suit the needs of their audiences.
- **Promote the secondary market for EVs:** Disseminating information about the used EV market can help assuage concerns about risks associated with purchasing a used EV. Information could include that EVs have fewer moving parts than combustion engine vehicles so there is less risk of component break down and less regular maintenance and that the cost for battery pack replacement has dropped significantly since EVs were first introduced.
- **Provide purchase incentives:** Offering purchase incentive tools such as vouchers, rebates, tax credits, and sales tax exemptions lowers the cost of purchasing an EV. Reducing the price of an EV at the time of purchase is the most effective tool for low-income drivers.

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[83] Puget Sound Clean Air Agency. 2018. *Facilitating Low Income Utilization Of Electric Vehicles: A Feasibility Study*. http://pscleanair.org/DocumentCenter/View/3578/Final-Report-Website-Version-_Facilitating-Low-Income-Utilization-of-Electric-Vehicles2?bidId=

[84] Public Service Commission of Maryland. 2019. *Order No. 88997: In the Matter of the Petition of the Electric Vehicle Work Group for Implementation of a Statewide Electric Vehicle Portfolio*. https://www.psc.state.md.us/wp-content/uploads/Order-No.-88997-Case-No.-9478-EV-Portfolio-Order.pdf

[85] The International Council on Clean Transportation. 2017. *Expanding Access to Electric Mobility in the United States*. https://theicct.org/sites/default/files/publications/Expanding-access-electric-mobility_ICCT-Briefing_06122017_vF.pdf

[86] The Greenlining Institute. 2019. *Electric Vehicles for All: An Equity ToolKit*. http://greenlining.org/publications/online-resources/2016/electric-vehicles-equity-toolkit/

[87] The Greenlining Institute. 2015. *Electric Carsharing in Underserved Communities: Considerations for Program Success*. http://greenlining.org/issues/2015/electric-carsharing-underserved-communities-considerations-program-success/

[88] The International Council on Clean Transportation. 2017. *Expanding Access to Electric Mobility in the United States*. https://theicct.org/sites/default/files/publications/Expanding-access-electric-mobility_ICCT-Briefing_06122017_vF.pdf

- **Provide non-purchase incentives:** Reserving or prioritizing a portion of non-purchase incentives for low-income community members, such as free or reduced parking, reduced vehicle registration fees, and high-occupancy vehicle lane access, is helpful to low-income drivers.
- **Provide financing assistance:** Establishing and promoting financing assistance programs like loan loss guarantees allows community members with no or low credit to access loans and financing options for purchasing EVs that may not otherwise be available.
- **Establish EV carsharing opportunities:** Establishing an EV carsharing program, particularly one focused on underserved areas of the City, provides EV access to community members who cannot afford to buy an EV. For these programs to gain traction among underserved communities, they must offer affordable rates, diverse payment options, education and training, and tailored customer service, including multilingual support.
- **Integrate underserved communities in stakeholder engagement:** Engaging members of underserved communities as part of the stakeholder identification process will ensure equal access and inclusion in the decision-making process.
- **Adjust building codes:** Requiring EV charging infrastructure in multifamily and affordable housing will address the current lack of access to charging for residents of these communities.

## Transportation Network Company Involvement in EV Equity

Guided by local government coordination, private TNCs are increasingly involved in EV equity programs, and those programs often increase exposure and access to EVs:

- **Lyft** partnered with General Motors to provide rental cars via the Express Drive Program, with weekly rates between $135 and $250. Drivers are eligible for $0 weekly rates when they reach 75 rides per week.
- **Hertz** partnered with Lyft and Uber to provide rideshare rentals. For Lyft, rates starts at $165 for weekly rentals of compact sedans. After a certain number of rides per week, which varies regionally, drivers can earn a Power Driver Bonus to cover the rental cost. For Uber, similar to Lyft but offered in different cities, rates start at $180 per week and drop to $0 after 75 rides a week.
- **Uber Xchange** offers short-term car leases from partnering car dealerships. Drivers pay a $250 deposit to start and make weekly payments over three years. Xchange leases to people with poor credit, but monthly totals and interest rates are much higher than with conventional financing. For example, a 2013 Toyota Camry L Base leased through Uber Xchange may cost 156 weekly payments of $130, or $520 monthly. Comparatively, leasing a 2017 Camry through a Toyota dealer is only $199 a month—though you need a good credit score. Xchange saves drivers money by including maintenance and insurance, but this means that full-time drivers are dependent on Uber servicing their cars quickly.

# APPENDIX A. LIGHT-DUTY ELECTRIC VEHICLES

Table 13 provides a snapshot of all new publicly available light-duty EV model options in San Antonio as of November 2019. Data was collected using the website autotrader.com. Additional EV models are available in other regional markets then re-located to the San Antonio region, meaning the used EV models may differ slightly. Additionally, public fleet can procure more EV models through the bulk procurement service, *Climate Mayors EV Purchasing Collaborative*.[89] Note that some models in the *Climate Mayors EV Purchasing Collaborative* have lower upfront costs from those listed under the manufacturer's suggested retail price (MSRP) in Table 13.

**Table 13. Publicly available EV models in San Antonio as of November 2019**

| Make | Model | MSRP | Federal Tax Credit ($) | After Tax Credit Price | Battery Size (kWh) | EPA EV Range (mi) | Price per kWh | Luxury? | BEV or PHEV? | Size Class |
|---|---|---|---|---|---|---|---|---|---|---|
| **Audi** | A3 Sport Back E-Tron Premium Plus | $74,800 | $7,500 | $67,300 | 95 | 204 | $787 | Y | PHEV | Compact |
| **BMW** | i8 Roadster | $147,500 | $5,669 | $141,831 | 11.6 | 18 | $12,715 | Y | PHEV | Sports car |
| **BMW** | 745e xDrive | $95,550 | $5,836 | $89,714 | 12 | 16 | $7,962 | Y | PHEV | Mid-sized sedan |
| **Chevrolet** | Bolt EV | $36,620 | $1,875 | $29,120 | 60 | 238 | $610 | N | BEV | Subcompact |
| **Ford** | Fusion Energi | $34,595 | $4,609 | $29,986 | 7.6 | 19 | $4,551 | N | PHEV | Mid-sized sedan |
| **Hyundai** | Ioniq Hybrid SEL | $23,200 | $7,500 | $15,700 | 32 | 75 | $725 | N | BEV | Compact |
| **Kia** | Niro EX | $38,500 | $7,500 | $31,000 | 64 | 239 | $601 | N | BEV | Crossover |
| **Mitsubishi** | Outlander PHEV | $34,595 | $5,836 | $28,759 | 12 | 22 | $2,883 | N | PHEV | Crossover |
| **Nissan** | LEAF | $30,999 | $7,500 | $22,490 | 40 | 151 | $774 | N | BEV | Compact |
| **Porsche** | Cayenne S Hybrid | $81,100 | $6,712 | $74,388 | 14.1 | 20 | $5,751 | Y | PHEV | Crossover |
| **Porsche** | Panamera E-Hybrid | $103,800 | $6,712 | $97,088 | 14.1 | 16 | $7,361 | Y | PHEV | Mid-sized sedan |
| **Tesla*** | Model 3 Standard | $35,000 | $7,500 | $35,000 | 50 | M0 | $700 | N | BEV | Compact |
| **Tesla*** | Model S 75D | $77,000 | $7,500 | $77,000 | 75 | 259 | $1,027 | Y | BEV | Full-sized sedan |
| **Tesla*** | Model X 75D | $83,000 | $7,500 | $83,000 | 75 | 238 | $1,107 | Y | BEV | Crossover |
| **Toyota** | Prius Prime | $27,300 | $4,502 | $22,798 | 8.8 | 25 | $3,102 | N | PHEV | Mid-sized sedan |
| **Volvo** | XC60 AWD T8 R-Design | $58,690 | $5,002 | $53,688 | 10.4 | 17 | $5,643 | Y | PHEV | Crossover |

*Source: Climate Mayors. 2018. Climate Mayors EV Purchasing Collaborative. https://driveevfleets.org/*

** Make/model no longer receives federal tax credit because more than 200,000 vehicles have been sold.*

[89] Climate Mayors. 2018. *Climate Mayors EV Purchasing Collaborative*. https://driveevfleets.org/

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# APPENDIX B. MEDIUM- AND HEAVY-DUTY ELECTRIC VEHICLES

Table 14 provides a list of currently available medium- and heavy-duty vehicles, cost, and range of vehicles on the U.S. market. Note that these vehicles are typically only available via special order from the vendor.

**Table 14. Medium- and heavy-duty vehicles in the U.S. market**

| EV Make and Model | Gross Vehicle Weight Rating Classification | Description | Estimated MSRP Cost ($) | Estimated EV Range (miles) |
|---|---|---|---|---|
| BYD Motors Inc. T3 | 3 | Electric Delivery Van | $18,001 | 155 |
| Lightning Systems Ford Transit 350HD | 3 | Multi-Use Chassis | $99,825 | 50 |
| Zenith Motors Zenith Motors Shuttle Van | 3 | Shuttle Van | $49,309 | 80 |
| Motiv Power Systems All-Electric Ford E-450 Chassis | 4 | Shuttle Buses, School Buses, Work Trucks, and Box Trucks | $188,570 | 85 |
| BYD Motors Inc. T5 | 5 | Delivery Truck | $165,000 | 155 |
| BYD Motors Inc. 5D | 5 | Step Van | $90,000 | 120 |
| BYD Motors Inc. Package Truck | 6 | Package Truck | $175,000 | 155 |
| BYD Motors Inc. 6D | 6 | Step Van | $96,801 | 120 |
| Motiv Power Systems All-Electric Ford F-53 Chassis | 6 | Trollies, Bloodmobiles, and other Special Applications | $208,095 | 80 |
| Lightning Systems 6500XD | 6 | Cab Truck | $96,801 | 110 |
| Motiv Power Systems All-Electric Ford F-59 Chassis | 6 | Shuttle Bus | $228,095 | 120 |
| BYD Motors Inc. T7 | 7 | Straight Truck | $195,000 | 124 |
| BYD Motors Inc. 8TT | 8 | Tandem-Axle Tractor | $146,568 | 62 |
| Motiv Power Systems Class 8 Refuse Truck | 8 | Refuse Truck on Crane Chassis | $150,000 | 80 |
| BYD All-Electric Quantum Rear Loader | 8 | Refuse Truck | $300,000 | 100 |

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# APPENDIX C. EV CHARGING - BLOCKGROUP RANKINGS AND CORRESPONDING ZIP CODES

Table 15 shows the highest-ranked top 25 block groups in San Antonio based on final scores. These block groups are matched with the zip codes that most closely overlap spatially (where centroids were created in ArcGIS for each block group, then the overlapping zip code for each centroid was identified).

**Table 15. Highest-ranking block groups in San Antonio by nearest zip code.**

| | Public Workplace Index | | DCFC Index | | Residential Index | |
|---|---|---|---|---|---|---|
| | Census Block Group | | | | | |
| Ranking | Block Group | Zip Code | Block Group | Zip Code | Block Group | Zip Code |
| 1 | 480291101001 | 78205 | 480291101001 | 78205 | 480291810033 | 78229 |
| 2 | 480291814021 | 78229 | 480291101003 | 78207 | 480291814031 | 78229 |
| 3 | 480291918171 | 78258 | 480291909011 | 78216 | 480291810042 | 78229 |
| 4 | 480291813032 | 78240 | 480291923001 | 78216 | 480291909012 | 78216 |
| 5 | 480291813031 | 78240 | 480291912022 | 78216 | 480291101003 | 78207 |
| 6 | 480291719121 | 78251 | 480291909012 | 78216 | 480291813021 | 78230 |
| 7 | 480291807012 | 78229 | 480291107001 | 78212 | 480291913042 | 78216 |
| 8 | 480291212041 | 78217 | 480291810011 | 78230 | 480291914081 | 78213 |
| 9 | 480291815063 | 78238 | 480291601004 | 78207 | 480291212045 | 78217 |
| 10 | 480291210001 | 78217 | 480291501004 | 78204 | 480291808001 | 78201 |
| 11 | 480291212042 | 78217 | 480291207011 | 78216 | 480291719182 | 78251 |
| 12 | 480291818081 | 78240 | 480291106001 | 78207 | 480291814041 | 78240 |
| 13 | 480291807026 | 78229 | 480291905012 | 78201 | 480291101002 | 78205 |
| 14 | 480291810042 | 78229 | 480291503003 | 78204 | 480291810032 | 78229 |
| 15 | 480291818152 | 78249 | 480291503004 | 78204 | 480291914101 | 78216 |
| 16 | 480291923001 | 78216 | 480291901004 | 78201 | 480291719021 | 78245 |
| 17 | 480291814022 | 78229 | 480291918171 | 78258 | 480291810051 | 78229 |
| 18 | 480291214043 | 78218 | 480291809023 | 78213 | 480291206007 | 78209 |
| 19 | 480291810031 | 78229 | 480291913041 | 78216 | 480291205012 | 78218 |
| 20 | 480291815054 | 78240 | 480291810012 | 78230 | 480291815032 | 78240 |
| 21 | 480291512002 | 78224 | 480291110002 | 78208 | 480291206004 | 78209 |
| 22 | 480291809022 | 78201 | 480291210001 | 78217 | 480291810052 | 78229 |
| 23 | 480291715012 | 78237 | 480291921001 | 78204 | 480291211182 | 78232 |
| 24 | 480291316151 | 78244 | 480291810052 | 78229 | 480291209021 | 78218 |
| 25 | 480291310001 | 78220 | 480291207012 | 78209 | 480291814022 | 78229 |

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# APPENDIX D. GIS MAPS

## *Public Workplace Index*

This map shows high-priority locations in San Antonio for public Level 2 chargers at workplaces, in on-street parking, and at public destination parking facilities. Shaded regions are grouped by quartiles, with the highest scoring 25% of block groups shown as the darkest shade.

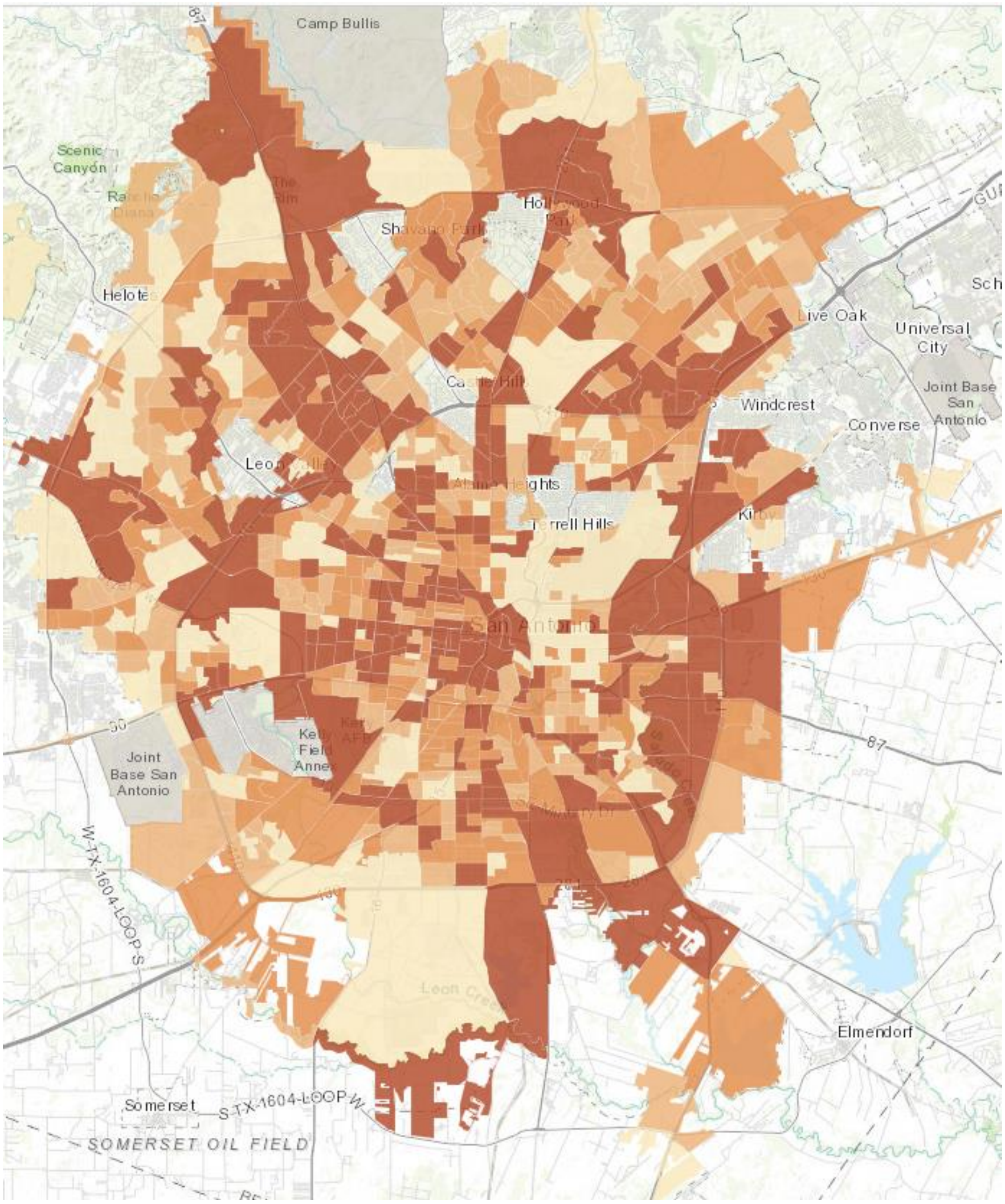


**Figure 18. Workplace charging index.**

## *DC Fast Charging Index*

This map shows high-priority locations in San Antonio for public DCFC. Shaded regions are grouped by quartiles, with the highest scoring 25% of block groups shown as the darkest shade.

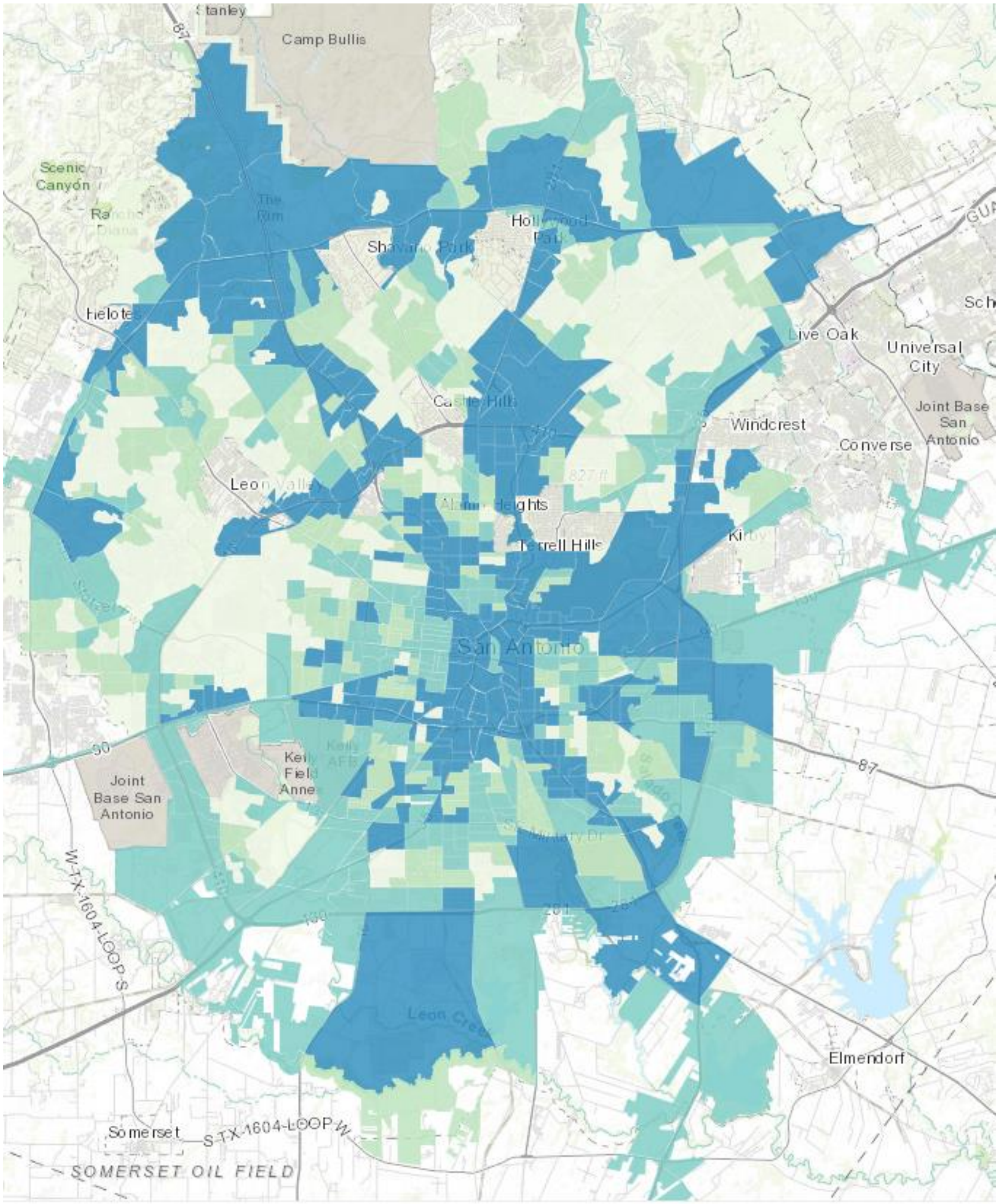


**Figure 19. DC fast charging index.**

## *Residential Index*

This map shows high-priority locations for Level 2 chargers in public locations. Shaded regions are grouped by quartiles, with the highest scoring 25% of block groups shown as the darkest shade.

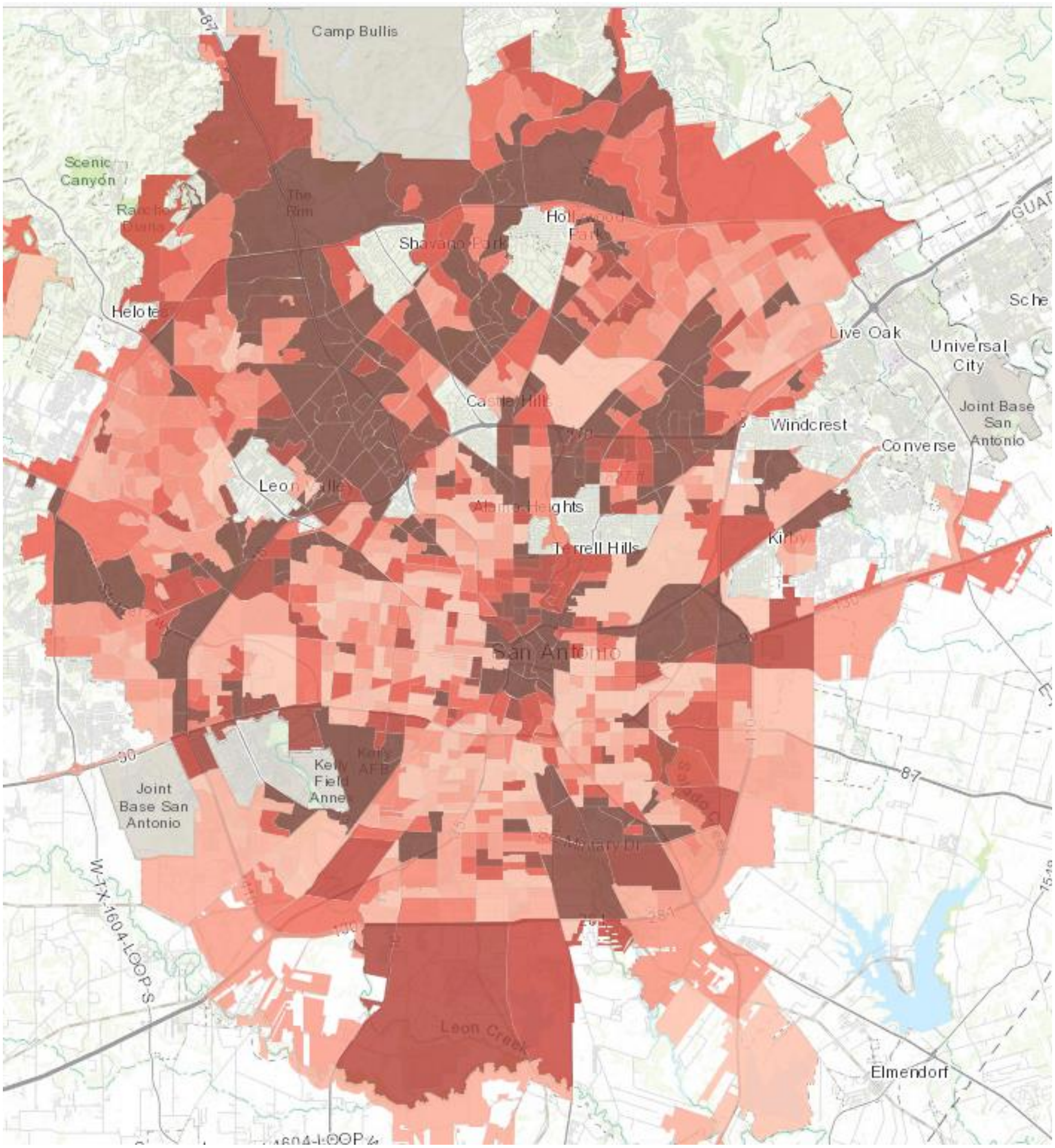


**Figure 20. Residential index.**

## *San Antonio Zip Codes*

This map shows zip codes in San Antonio, to be used in conjunction with Table 16.

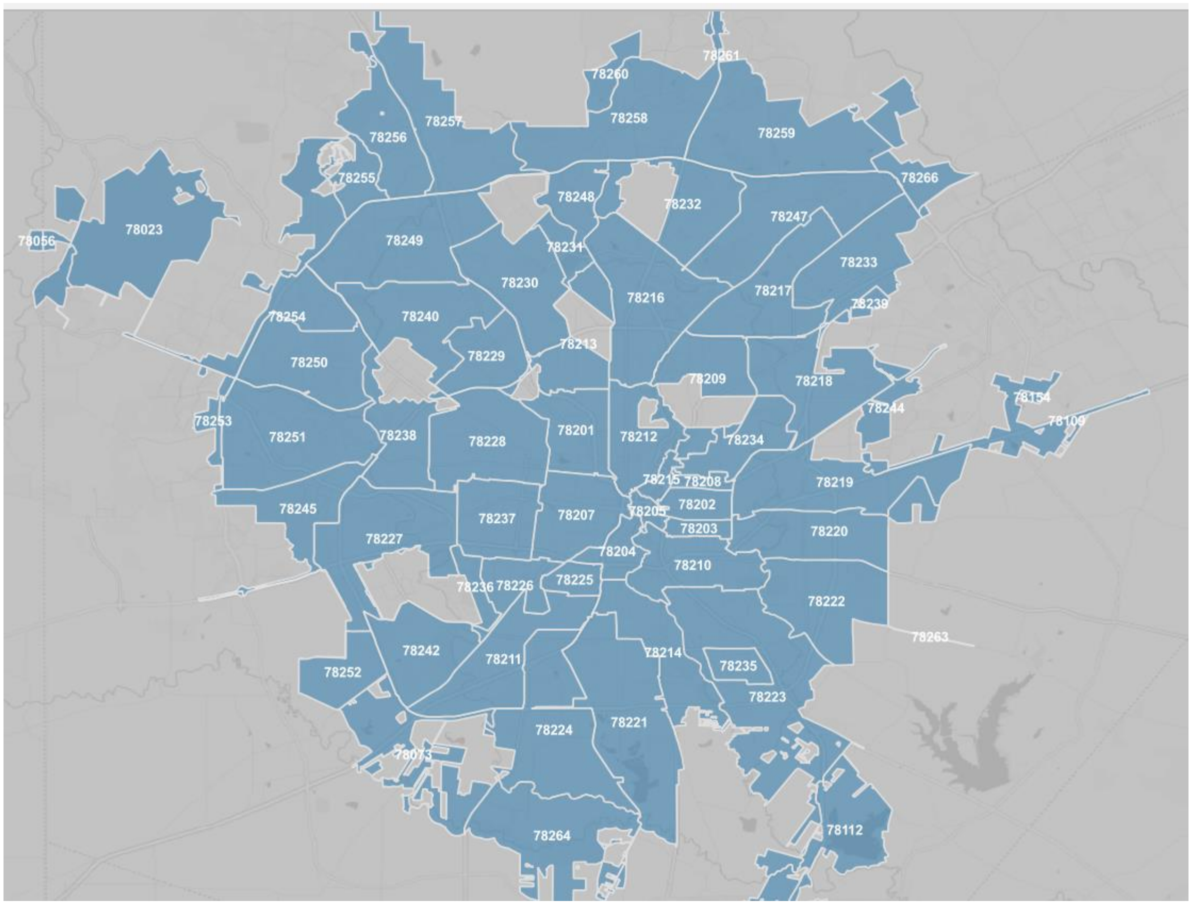


**Figure 21. Zip code map of San Antonio to match with Table 16.**

## *Top Zip Codes in San Antonio for Charging Stations*

Table 16 lists the number of block groups within each zip code that score among the top 25 of all block groups in the respective index.

**Table 16. Top 25 zip codes for building charging stations.**

| Zip Codes of Top 25 Block Groups | Public Workplace Index | DCFC Index | Residential Index |
|---|---|---|---|
| 78229 | 6 | 1 | 7 |
| 78216 | 1 | 6 | 3 |
| 78240 | 4 | | 2 |
| 78217 | 3 | 1 | 1 |
| 78204 | | 4 | |
| 78207 | | 3 | 1 |
| 78201 | 1 | 2 | 1 |
| 78209 | | 1 | 2 |
| 78218 | 1 | | 2 |
| 78205 | 1 | 1 | 1 |
| 78230 | | 2 | 1 |
| 78213 | | 1 | 1 |
| 78251 | 1 | | 1 |
| 78258 | 1 | 1 | |
| 78249 | 1 | | |
| 78244 | 1 | | |
| 78212 | | 1 | |
| 78232 | | | 1 |
| 78245 | | | 1 |
| 78208 | | 1 | |
| 78224 | 1 | | |
| 78238 | 1 | | |
| 78237 | 1 | | |
| 78220 | 1 | | |
| **Grand Total** | **25** | **25** | **25** |

## *Notes on Creation of Indices*

The three indices shown in Figure 18, Figure 19, and Figure 20 above are composite scores based on multiple indicators that are normalized on a scale of 0 to 1 then summed based on weights. The set of indicators and weights were determined in coordination with the City of San Antonio. Each indicator, its weight, and the rationale for its inclusion is given in the tables below. In the maps above, the scores are portrayed as one of four shades, where lighter shades are lowering scoring block groups and darker shades are higher scoring block groups. Only four shades were used for ease of viewing.

## *Public Workplace Index: Methodology*

The Public Workplace Index is comprised of three indicators, each weighted according to the table below.

| Indicator | Weight | Rationale for Including Layer | Scoring Methodology | Source |
|---|---|---|---|---|
| Number of jobs | 30% | Assuming that areas with larger numbers of jobs are attracting more people and that people will charge either while at work or near their work when running errands or engaged in activities near their workplace | Score areas with larger number of jobs higher | American Community Survey, 2018 https://www.census.gov/programs-surveys/acs |
| Number of longer dwell time sites | 40% | Assuming that people will charge their cars when engaged in activities at these longer dwell time sites | Score areas with higher density of longer dwell time sites (grocery stores, shopping centers, parks, fields, schools, movie theaters, libraries) higher | Bexar County parcel data https://gis-bexar.opendata.arcgis.com/ |
| Number of existing charging stations | 30% | New charging infrastructure is needed in areas where it is currently lacking-- assuming that the City is trying to address a coverage issue with charging infrastructure rather than a capacity issue | Score areas that lack existing charging infrastructure higher, meaning block groups with a higher number of charging stations will score lower on the index | U.S. Department of Energy, Alternative Fuel Data Center https://afdc.energy.gov/ |

## *DC Fast Charger Index: Methodology*

The DC Fast Charger Index is comprised of three indicators, each weighted according to the table below.

| Indicator | Weight | Rationale for Including Layer | Scoring Methodology | Source |
|---|---|---|---|---|
| Number of short and medium dwell time sites | 40% | Assuming that DCFC users are likely to charge at places with shorter average dwell times, such as grocery stores or gas stations | Score areas with high number of short and medium dwell time sites higher | Bexar County parcel data https://gis-bexar.opendata.arcgis.com/ |
| Number of existing DCFC stations | 20% | New DCFC infrastructure is needed in places where it currently does not exist | Score areas that lack existing DCFC infrastructure higher, meaning block groups with a higher number of charging stations will score lower on the index | www.PlugShare.com |
| Traffic counts (max) at highway exits | 40% | Assuming that high average annual daily traffic values are a good indicator of where people are driving and that it would be convenient for drivers to hop off of the highway to charge | Score block groups with the highest average annual daily traffic values within one mile (driving) of all highway exits higher | Average annual daily traffic values from FHWA and highway exits from Open Street Map |

## *Residential Index: Methodology*

The Residential Index is comprised of four indicators, each weighted according to the table below.

| Indicator | Weight | Rationale for Including Layer | Scoring Methodology | Source |
|---|---|---|---|---|
| Share of multifamily buildings | 50% | Assuming that those living in multifamily buildings will have less access to at-home charging and that there is a higher likelihood of having any (or more) EV owners in larger apartment buildings than in a 3-family multifamily building | Score areas with large apartment buildings higher | American Community Survey, 2018 https://www.census.gov/programs-surveys/acs |
| Share of renters | 12.5% | Assuming those who rent are less likely to have at-home charging access and will need to use public charging infrastructure | Score areas with greater number of renters higher | California Environmental Protection Agency, 2013 https://energycenter.org/sites/default/files/docs/nav/policy/research-and-reports/California%20Plug-in%20Electric%20Vehicle%20Owner%20Survey%20Report-May%202013.pdf |
| Share of car commuters | 12.5% | Assuming that areas with higher numbers of drivers will be more likely to use charging infrastructure | Score areas with a higher share of drivers to work/car commuters higher | American Community Survey, 2018 https://www.census.gov/programs-surveys/acs |
| Median income | 25% | Using data from the Center for Sustainable Energy California EV owner survey that 47% of EV owners have a household income of over $150,000 and 20% of PEV owners have an income between $100,000 and $149,999 | Score areas with higher median income higher | California Environmental Protection Agency, 2013 https://energycenter.org/sites/default/files/docs/nav/policy/research-and-reports/California%20Plug-in%20Electric%20Vehicle%20Owner%20Survey%20Report-May%202013.pdf |

# APPENDIX E. MUNICIPAL FLEET ELECTRIFICATION PLAN

Table 17 summarizes the municipal fleet electrification analysis by make and model of current vehicle. The City should prioritize the highest scoring vehicles when looking for EV replacements. The full set of costs, emissions, and EV model replacements is the in the spreadsheet provided to the City.

**Table 17. Summary of Fleet Conversion scoring and cost per mile.**

| Row Labels | Number of Vehicles | Average EV Suitability Score | Current Vehicle ($/mile) | Electric Vehicle ($/mil) |
|---|---|---|---|---|
| **Automobile Compact (< 8500 GVW)** | **326** | **42%** | **$0.91** | **$0.49** |
| FORD C-MAX HYBRID | 124 | 49% | $0.92 | $0.49 |
| HONDA CIVIC HYBRID | 18 | 39% | $0.41 | $0.49 |
| HONDA INSIGHT | 12 | 43% | $0.45 | $0.49 |
| TOYOTA PRIUS | 172 | 37% | $0.98 | $0.49 |
| **Automobile Full Size (< 8500 GVW)** | **20** | **55%** | **$0.50** | **$0.49** |
| CHEV CAPRICE PPV | 2 | 91% | $0.84 | $0.49 |
| CHEV IMPALA | 12 | 43% | $0.41 | $0.49 |
| CHEV VOLT | 1 | 49% | $0.56 | $0.49 |
| FORD C VICTORIA INTR | 3 | 91% | $0.65 | $0.49 |
| FORD FUSION S HYBRID | 1 | 34% | $0.44 | $0.49 |
| FORD TAURUS INTR | 1 | 55% | $0.50 | $0.49 |
| **Automobile Intermediate (< 8500 GVW)** | **154** | **39%** | **$0.49** | **$0.49** |
| CHEV CRUZ | 1 | 34% | $0.36 | $0.49 |
| CHEV Malibu | 3 | 43% | $0.42 | $0.49 |
| CHEV MALIBU LS | 8 | 50% | $0.47 | $0.49 |
| DODGE AVENGER | 1 | 30% | $0.44 | $0.49 |
| FORD FUSION S HYBRID | 64 | 43% | $0.61 | $0.49 |
| HYUNDAI SONATA HYBRID | 4 | 39% | $0.44 | $0.49 |
| TOYOTA CAMRY HYBRID | 67 | 36% | $0.40 | $0.49 |
| VOLKSWAGEN JETTA HYBRID | 6 | 32% | $0.43 | $0.49 |
| **Pickups (14,001- 16,000 GVW)** | **1** | **27%** | **$1.10** | **$4.12** |
| FORD F450 SUPERDUTY | 1 | 27% | $1.10 | $4.12 |
| **Pickups One Ton (10,001- 14,000 GVW)** | **52** | **41%** | **$2.00** | **$1.26** |
| CHEV 3500 | 1 | 36% | $0.88 | $1.26 |
| CHEV C3500 | 1 | 50% | $1.32 | $1.26 |
| CHEV C3500 SILVERADO | 3 | 48% | $1.02 | $1.26 |
| CHEV C3500HD SILVERA | 5 | 58% | $1.40 | $1.26 |
| FORD F350 | 3 | 30% | $0.87 | $1.26 |
| FORD F350 SUPER DUTY | 29 | 37% | $2.39 | $1.26 |
| RAM 3500 | 10 | 45% | $1.96 | $1.26 |
| CHEV 3500 | 1 | 36% | $0.88 | $1.26 |
| **Sport Utility Compact (< 8500 GVW)** | **51** | **51%** | **$0.48** | **$0.55** |

| Row Labels | Number of Vehicles | Average EV Suitability Score | Current Vehicle ($/mile) | Electric Vehicle ($/mil) |
|---|---|---|---|---|
| CHEV BLAZER LS | 1 | 46% | $0.41 | $0.55 |
| FORD ESCAPE | 21 | 49% | $0.43 | $0.55 |
| FORD ESCAPE HYBRID | 7 | 53% | $0.53 | $0.55 |
| GMC TERRAIN | 1 | 39% | $0.38 | $0.55 |
| JEEP PATRIOT | 9 | 46% | $0.42 | $0.55 |
| TOYOTA RAV4 HYBRID | 12 | 57% | $0.60 | $0.55 |
| **Sport Utility Half Ton (< 8500 GVW)** | **108** | **66%** | **$0.61** | **$0.55** |
| CHEV C1500 SUBURBAN | 1 | 92% | $0.90 | $0.55 |
| CHEV TRAILBLAZER LS | 1 | 47% | $0.42 | $0.55 |
| CHEV TRAVERSE | 28 | 54% | $0.50 | $0.55 |
| DODGE DURANGO | 2 | 69% | $0.57 | $0.55 |
| DODGE DURANGO SE | 6 | 50% | $0.49 | $0.55 |
| DODGE DURANGO SSV | 2 | 92% | $0.89 | $0.55 |
| DODGE DURANGO SXT | 3 | 60% | $0.53 | $0.55 |
| DODGE JOURNEY | 7 | 61% | $0.52 | $0.55 |
| FORD EXPLORER | 27 | 64% | $0.66 | $0.55 |
| FORD EXPLORER INTR | 5 | 48% | $0.49 | $0.55 |
| FORD EXPLORER XLT | 2 | 69% | $0.54 | $0.55 |
| JEEP WRANGLER | 23 | 92% | $0.77 | $0.55 |
| LINCOLN NAVIGATOR | 1 | N/A | $0.59 | $0.55 |
| **Straight Trucks (10,001- 14,000 GVW)** | **9** | **42%** | **$1.13** | **$1.26** |
| CHEV C3500HD SIERRA | 1 | 78% | $1.63 | $1.26 |
| CHEV C3500HD SILVERA | 1 | 34% | $0.83 | $1.26 |
| FORD F350 SUPER DUTY | 7 | 38% | $1.10 | $1.26 |
| **Straight Trucks (14,001- 16,000 GVW)** | **1** | **29%** | **$0.89** | **$4.12** |
| FORD F450 SUPERDUTY | 1 | 29% | $0.89 | $4.12 |
| **Straight Trucks (16,001- 19,500 GVW)** | **38** | **28%** | **$2.61** | **$3.87** |
| FORD F450 SUPERDUTY | 14 | 23% | $1.41 | $3.87 |
| FORD F550 SUPER DUTY | 19 | 29% | $3.17 | $3.87 |
| FREIGHTLINER MT45 | 1 | 23% | $2.14 | $3.87 |
| RAM 4500 | 3 | 48% | $5.24 | $3.87 |
| RAM 5500 | 1 | 25% | $1.31 | $3.87 |
| **Straight Trucks (19,501- 26,000 GVW)** | **36** | **27%** | **$2.13** | **$5.17** |
| FORD F550 SUPER DUTY | 2 | 26% | $1.46 | $5.17 |
| FORD F650 SUPER DUTY | 5 | 18% | $2.45 | $5.17 |
| FORD F750 SUPER DUTY | 16 | 28% | $2.09 | $5.17 |
| FREIGHTLINER M2 106 | 8 | 22% | $2.09 | $5.17 |
| GMC C7500 | 4 | 43% | $2.42 | $5.17 |
| INTERNATIONAL 4700 | 1 | 22% | $1.65 | $5.17 |
| **Straight Trucks (26,001- 33,000 GVW)** | **39** | **33%** | **$3.18** | **$4.32** |
| FREIGHTLINER M2 106 | 19 | 31% | $3.22 | $4.32 |
| INTERNATIONAL 4300 | 18 | 35% | $3.17 | $4.32 |
| INTERNATIONAL 4300V | 1 | 44% | $4.35 | $4.32 |

| Row Labels | Number of Vehicles | Average EV Suitability Score | Current Vehicle ($/mile) | Electric Vehicle ($/mil) |
|---|---|---|---|---|
| INTERNATIONAL 4700 | 1 | 24% | $1.40 | $4.32 |
| **Sanitation (>33,000 GVW)** | **243** | **23%** | **$5.31** | **$5.90** |
| AUTOCAR ACX64 XPEDITOR | 89 | 31% | $5.85 | $5.90 |
| FREIGHTLINER 108SD | 8 | 11% | $4.22 | $5.90 |
| FREIGHTLINER 114SD | 16 | 13% | $4.48 | $5.90 |
| FREIGHTLINER M2 106 | 50 | 17% | $4.69 | $5.90 |
| INTERNATIONAL 4400 | 1 | 9% | $3.04 | $5.90 |
| MACK LEU613 | 18 | 26% | $5.60 | $5.90 |
| MACK LR613 | 31 | 23% | $5.48 | $5.90 |
| PETERBILT 320 | 6 | 20% | $4.95 | $5.90 |
| PETERBILT 520 | 9 | 15% | $4.98 | $5.90 |
| STERLING ACTERRA | 4 | 13% | $4.81 | $5.90 |
| WESTERN STAR 4700 | 11 | 23% | $5.73 | $5.90 |
| **Sanitation (16,001- 19,500 GVW)** | **13** | **18%** | **$2.16** | **$3.87** |
| HINO 195 | 5 | 27% | $1.92 | $3.87 |
| HINO 195H | 8 | 13% | $2.31 | $3.87 |
| **Strght Trks Sani (19,501- 26,000 GVW)** | **5** | **25%** | **$2.36** | **$5.17** |
| CHEV C5500 | 1 | 8% | $2.23 | $5.17 |
| GMC W5500HD | 2 | 24% | $2.01 | $5.17 |
| INTERNATIONAL 7400 | 1 | 38% | $2.35 | $5.17 |
| UD 2300DH | 1 | 33% | $3.22 | $5.17 |
| **Sanitation (26,001- 33,000 GVW)** | **9** | **9%** | **$2.60** | **$5.90** |
| HINO 338 | 2 | 9% | $2.17 | $5.90 |
| PETERBILT 220 | 7 | 9% | $2.73 | $5.90 |
| **Truck Tractors (>33,000 GVW)** | **59** | **26%** | **$2.43** | **$4.71** |
| FREIGHTLINER CORONADO SD | 2 | 31% | $3.27 | $4.71 |
| FREIGHTLINER M2 106 | 46 | 27% | $2.39 | $4.71 |
| FREIGHTLINER M2 112 | 5 | 24% | $2.64 | $4.71 |
| INTERNATIONAL 7400 | 5 | 25% | $2.22 | $4.71 |
| VOLVO VNL | 1 | 26% | $2.53 | $4.71 |
| **Van Cargo (< 8500 GVW)** | **14** | **42%** | **$1.14** | **$0.45** |
| CHEV CITY EXPRESS | 3 | 11% | $0.38 | $0.45 |
| DODGE B2500 RAM WAGON | 1 | 71% | $0.62 | $0.45 |
| FORD TRANSIT CONNECT | 5 | 53% | $1.64 | $0.45 |
| FORD WINDSTAR CARGO | 2 | 44% | $0.48 | $0.45 |
| RAM PROMASTER CITY | 2 | 31% | $0.70 | $0.45 |
| **Van Cargo (8501- 10,000 GVW)** | **23** | **29%** | **$0.63** | **$0.78** |
| CHEV EXPRESS 2500 | 4 | 17% | $0.59 | $0.78 |
| CHEV G2500 EXPRESS | 1 | 19% | $0.62 | $0.78 |
| FORD E250 | 2 | 27% | $0.54 | $0.78 |
| FORD E250 ECONOLINE | 14 | 33% | $0.63 | $0.78 |
| FORD TRANSIT | 2 | 36% | $0.75 | $0.78 |
| **Grand Total** | **1202** | **38%** | **$2.01** | **$2.32** |

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# APPENDIX F. UTILITY RATES AND ELECTRIC VEHICLES

In a recently published study by the Electric Power Research Institute in the Salt River Project electric service territory,[90] 70 EVs were tracked for an entire year to characterize charging behavior and utility system impacts. The study clearly demonstrated that 80% of residents' charging takes place at home. Residents on non-TOU rates typically charged on-peak and TOU rates were effective in shifting charging behavior off-peak. While the study did not discuss impacts to the distribution grid, based on the capacity of Level 2 chargers (7.2 kW to 18 kW), significant distribution system investments would be needed in the absence of strategies to shift charging from on-peak to off-peak.

CPS Energy intends to evaluate EV pricing programs that will optimize the community's investment in electric infrastructure by encouraging off-peak charging. These solutions will meet a diverse set of customer needs:

- Residential home charging
- Public DCFC
- Other public charging (Level 1 and Level 2)
- Commercial fleet charging
- Workplace charging

Currently, no standard rate or rebate solution has emerged amongst utilities in the country. Utilities are testing various rate and rebate approaches including time-based rates and demand charges. The intent is to offer pricing programs that still recover infrastructure cost, but also incentivizes efficient use of electric infrastructure, while also encouraging adoption of EVs in order to drive electrification.
CPS Energy continually monitors market trends to stay informed of best practices amongst peer utilities.

[90] Electric Power Research Institute. July 2018. *Electric Vehicle Driving, Charging, and Load Shape Analysis, A Deep Dive Into Where, When, and How Much Salt River Project Electric Vehicle Customers Charge*. EPRI Report 3002013754. http://mydocs.epri.com/docs/PublicMeetingMaterials/ee/000000003002013754.pdf

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# APPENDIX G. PUBLIC ENGAGEMENT SURVEY (ENGLISH)

## San Antonio Electric Vehicle Transportation Survey

This survey is sponsored by the City of San Antonio. Your participation in this survey will contribute to a better understanding of regional transportation trends. Thank you for your participation!

In the following section, we will be asking a variety of questions that pertain to specific types of electric vehicles and conventional gasoline vehicles. **Battery Electric Vehicles [BEVs]** are 100% electric and must be plugged in to an outlet to charge the battery (for example, the *Nissan LEAF* or the *Chevrolet Bolt*) while **Internal Combustion Engine [ICE] Vehicles** use an internal combustion engine and must be refueled using either gasoline or diesel (the most common type of vehicle).

Please mark or write the most appropriate response for each of the following questions. Select only one response unless otherwise indicated. Remember that there are no "right" or "wrong" responses for any questions. We value your thoughtful and honest response to each question.

---

1. **On average, how many miles do you travel in your vehicle as part of your daily round trip commute to and from work with occasional errands?**

☐ None

☐ Fewer than 5 miles

☐ 5-10 miles

☐ 11-30 miles

☐ 31-50 miles

☐ 51-75 miles

☐ Over 75 miles

---

2. **If purchasing, how much are you planning to spend on your next vehicle purchase? If leasing, what is the approximate purchase value of the next vehicle you plan to lease?**

☐ $20,000 or less

☐ $20,001 - $30,000

☐ $30,001 - $40,000

☐ $40,001 - $50,000

☐ $50,001 - $60,000

☐ $60,001 - $70,000

☐ $70,001 or more

☐ I have no plans to purchase or lease a new vehicle in the foreseeable future.

☐ I don't know

---

The following two questions pertain only to **Battery Electric Vehicles** (100% electric that must be plugged into an outlet to charge). Please answer each question to the best of your ability. Even if you are not very familiar with this technology, your answers will help us get a better sense of current perceptions on these topics.

---

**3. When compared with traditional gas or diesel vehicles, the maintenance requirements (changing engine oil, replacing air filters or spark plugs, tire condition, etc.) for Battery Electric Vehicles are typically:**

☐ Lower

☐ Higher

☐ About the same

---

**4. Which of the following statements provides the most accurate comparison of the fuel cost per mile traveled for an electric vehicle compared to a conventional Internal Combustion Engine (ICE) vehicle? Fuel costs for an electric vehicle are…**

☐ Roughly the same

☐ 15-40% less expensive

☐ 40-65% less expensive

☐ 5-10% more expensive

☐ 10-25% more expensive

---

5. **How much do you agree or disagree with the following statements about electric vehicles?**

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| I am familiar with electric vehicles. | ☐ | ☐ | ☐ | ☐ | ☐ |
| I could use an electric vehicle to drive to most places I regularly drive. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Electric vehicles save money on fuel. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Electric vehicles are safe. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Electric vehicles are an affordable option for me. | ☐ | ☐ | ☐ | ☐ | ☐ |
| In the next three years, I expect to own or lease an electric vehicle. | ☐ | ☐ | ☐ | ☐ | ☐ |

6. **On a scale of 1 to 5 (1= not at all concerned and 5=very concerned), how concerned are you with the following aspects of Battery Electric Vehicles (100% electric that must be plugged into an outlet to charge)?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| The ***reliability*** of electric vehicle batteries | ☐ | ☐ | ☐ | ☐ | ☐ |
| The ***availability and convenience*** of electric vehicle charging | ☐ | ☐ | ☐ | ☐ | ☐ |
| The ***length of time*** it takes to charge a Battery Electric Vehicle | ☐ | ☐ | ☐ | ☐ | ☐ |
| The ***distance that can be traveled*** on a single charge (i.e., range of the vehicle). | ☐ | ☐ | ☐ | ☐ | ☐ |
| The ***size and seating capacity*** of electric vehicles. | ☐ | ☐ | ☐ | ☐ | ☐ |

7. **How many miles would an all-electric vehicle that could not be powered by gasoline need to travel on a single charge for you to be satisfied with the range and consider purchasing or leasing the vehicle?**

☐ Fewer than 50 miles

☐ 51-100 miles

☐ 101-150 miles

☐ 151-200 miles

☐ Over 200 miles

8. **Please indicate how likely or unlikely you are to select a Battery Electric Vehicle as your next vehicle lease/purchase.**

☐ Highly likely

☐ Likely

☐ Neutral

☐ Unlikely

☐ Highly unlikely

9. **Knowing fuel costs are significantly lower with electric vehicles, how much more are you willing to pay for a new Battery Electric Vehicle, in comparison to a conventional gasoline or diesel powered vehicle?**

☐ I am not willing to pay more.

☐ Up to $2,000

☐ Up to $5,000

☐ Up to $10,000

☐ Up to $15,000

☐ Up to $20,000

☐ Other: ____________________________________________________________

The following three questions pertain to **Battery Electric Vehicles** charging at your home and workplace. There are three main types of **Battery Electric Vehicle's** charging:

- **Level 1 charging** uses a standard 120V outlet to charge an electric vehicle. It takes about 9 hours to recharge about 40 miles of range (a typical daily commute), which can be easily done overnight. Every hour of charging recharges about 5 miles.
- **Level 2 charging** uses a 240V outlet to charge an electric vehicle and typically takes about 2 hours to recharge about 40 miles of range. Some examples of appliances that use a 240V outlets are electric dryer and oven outlets. Every hour of charging recharges about 26 miles.
- **DC Fast Charge** is a **Battery Electric Vehicles** -specific charging method that typically takes about 10 minutes to recharge about 40 miles of range. Every minute of charging recharges about 4 miles.

---

**10. Imagine if you owned a Battery Electric Vehicle (or if you already own one). Where would you most likely charge it?**

☐ At home

☐ At work

☐ Other (please specify): ________________________________________________________

---

**11. Imagine if you owned a Battery Electric Vehicle (or if you already own one). Would you install a Level 2 (240V outlet) charger in your home (about $2000)?**

☐ Yes

☐ No

**Please provide the zip code of your current residence:** ___________________________________

---

**12. Does your workplace offer dedicated EV charging [OPTIONAL] if yes, please provide the location and zip code)?**

☐ Yes

Location and Zip Code: ___________________________________________________

☐ No

☐ I don't know

**If yes, what type of charging does your workplace provide?**

☐ Level 1

☐ Level 2

☐ DC Fast Charge

☐ I don't know

The next set of questions will help us improve our outreach efforts across the City. Please note that these questions are entirely **optional**.

---

**13. (OPTIONAL) What is your current age?**

- ☐ Under 18
- ☐ 18 to 24
- ☐ 25 to 34
- ☐ 35 to 44
- ☐ 45 to 54
- ☐ 55 to 64
- ☐ 65 to 74
- ☐ 75 or older
- ☐ Prefer not to disclose

---

**14. (OPTIONAL) What is your gender?**

- ☐ Female
- ☐ Male
- ☐ Prefer to self-describe (please specify): ________________________________________
- ☐ Prefer not to disclose

---

**15. (OPTIONAL) What is your ethnicity? (Please check all that apply)**

- ☐ White
- ☐ Hispanic or Latino/a
- ☐ Black or African American
- ☐ Asian
- ☐ American Indian or Alaskan Native
- ☐ Middle Eastern or North African
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other Race/Ethnicity (please specify): ___________________________________________
- ☐ Prefer not to disclose

---

**16. (OPTIONAL) Please provide your council district. If unknown, then please provide your street address:**

_________________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

---

**17. (OPTIONAL) What is your name?** _____________________________________________________

**18. (OPTIONAL) How do you prefer to receive communications? (Please provide information for each option checked)**

☐ Email

What is your email? ______________________________________________

☐ Phone call

What is your phone number? ______________________________________________

☐ Text message

What is your phone number? ______________________________________________

☐ Mail

What is your mailing address? ______________________________________________

______________________________________________

______________________________________________

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# APPENDIX H. PUBLIC ENGAGEMENT SURVEY (SPANISH)

# Encuesta de Transporte de Vehículos Eléctricos de San Antonio

Esta encuesta está patrocinada por la ciudad de San Antonio. Su participación en esta encuesta contribuirá a una mejor comprensión de las tendencias regionales de transporte.

¡Gracias por su participación!

En la siguiente sección, le haremos una serie de preguntas relacionadas con tipos específicos de vehículos eléctricos y vehículos de gasolina convencionales. Los Vehículos Eléctricos con Batería [VEB] son 100% eléctricos y deben enchufarse a un toma de corriente para cargar la batería (por ejemplo, el Nissan LEAF o el Chevrolet Bolt) mientras que los vehículos con motor de combustión interna [VCI] usan un motor de combustión interna y deben ser reabastecidos con gasolina o diesel (el tipo de vehículo más común).

Marque o escriba la respuesta más apropiada para cada una de las siguientes preguntas. Seleccione solo una respuesta a menos que se indique lo contrario. Recuerde que no hay respuestas "correctas" o "incorrectas" para ninguna pregunta. Apreciamos su respuesta reflexiva y honesta a cada pregunta.

---

1. **En promedio, ¿cuántas millas viaja en su vehículo como parte de su viaje diario de ida y vuelta al trabajo y para mandadosocasionales?**

☐ Ninguna

☐ Menos de 5 millas

☐ 5-10 millas

☐ 11-30 millas

☐ 31-50 millas

☐ 51-75 millas

☐ Más de 75 millas

---

2. **Si está comprando, ¿cuánto planea gastar en la próxima compra de su vehículo? Si esta alquilando (“leasing”) ¿cuál es el valor aproximado de compra del próximo vehículo que planea arrendar (“lease”)?**

☐ $20,000 o menos

☐ $20,001 - $30,000

☐ $30,001 - $40,000

☐ $40,001 - $50,000

☐ $50,001 - $60,000

☐ $60,001 - $70,000

☐ $70,001 o mas

☐ No tengo planes de comprar o arrendar (“lease”) un nuevo vehículo en el futuro previsible.

☐ No lo sé

---

Las siguientes dos preguntas se refieren solo a los Vehículos Eléctricos con Batería [VEB] (100% eléctricos que debe enchufarse a un toma de corriente para cargar) Por favor responda a cada pregunta lo mejor posible. Incluso si no está muy familiarizado con esta tecnología, sus respuestas nos ayudarán a tener una mejor idea de la percepcion actual sobre este tema.

---

**3. En comparación con los vehículos tradicionales de gasolina o diésel, los requisitos de mantenimiento (cambio de aceite del motor, reemplazo de filtros de aire o bujías, condicion de las llantas, etc.) para Vehículos Eléctricos de Batería [VEB] son típicamente:**

☐ Más bajos

☐ Más altos

☐ Más o menos los mismos

---

**4. Cuál de las siguientes afirmaciones proporciona la comparación más precisa del costo de combustible por milla de un vehículo eléctrico en comparación con un vehículo convencional que funciona con gasolina o diesel? Los costos de combustible de un vehículo eléctrico son ...**

☐ Más o menos lo mismo

☐ 15-40% menos costoso

☐ 40-65% menos costoso

☐ 5-10% más caro

☐ 10-25% más caro

---

5. **¿Que tan de acuerdo o desacuerdo esta usted con las siguientes afirmaciones sobre vehículos eléctricos?**

| | Totalmente de Acuerdo | De Acuerdo | Neutral | En Desacuerdo | Totalmente en Desacuerdo |
|---|---|---|---|---|---|
| Estoy familiarizado con los vehículos eléctricos. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Podría usar un vehículo eléctrico para conducir a la mayoría de los lugares donde conduzco regularmente. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Los vehículos eléctricos ahorran dinero en combustible. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Los vehículos eléctricos son seguros. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Los vehículos eléctricos son una opción asequible para mí. | ☐ | ☐ | ☐ | ☐ | ☐ |
| En los próximos tres años, espero poseer o arrendar ("lease") un vehículo eléctrico. | ☐ | ☐ | ☐ | ☐ | ☐ |

6. **En una escala del 1 al 5 (1 = nada preocupado y 5= muy preocupado), ¿qué tan preocupado está usted con los siguientes aspectos de los Vehículos Eléctricos de Batería [VEB] (100% eléctricos que debe enchufarse a un toma de corriente para cargar)?**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **La fiabilidad de la batería de los vehículos eléctricos** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **La disponibilidad y conveniencia de la carga de vehículos eléctricos** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **El tiempo que toma cargar un vehículo eléctrico** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **La distancia que se puede recorrer con una sola carga (es decir, el alcance del vehículo)** | ☐ | ☐ | ☐ | ☐ | ☐ |
| **El tamaño y la capacidad de asientos de los vehículos eléctricos.** | ☐ | ☐ | ☐ | ☐ | ☐ |

**7. Cuántas millas necesitaría viajar con una sola carga un vehículo totalmente eléctrico que no funcione con gasolina , para que el rango lo satisfaga y considere comprar o arrendar (“lease”) el vehículo?**

- ☐ Menos de 50 millas
- ☐ 51-100 millas
- ☐ 101-150 millas
- ☐ 151-200 millas
- ☐ Más de 200 millas

---

**8. Indique que tan probable o improbable es que usted seleccione un Vehículo Eléctrico de Batería [VEB] como su próximo arrendamiento (“lease”)/ compra de vehículo.**

- ☐ Muy probable
- ☐ Probable
- ☐ Neutral
- ☐ Improbable
- ☐ Muy improbable

---

**9. Sabiendo que los costos de combustible son significativamente más bajos en los vehículos eléctricos, ¿cuánto más está usted dispuesto a pagar por un nuevo Vehículo Eléctrico de Batería [VEB] en comparación con un vehículo convencional de gasolina / diesel?**

- ☐ No estoy dispuesto a pagar más.
- ☐ Hasta $2,000
- ☐ Hasta $5,000
- ☐ Hasta $10,000
- ☐ Hasta $15,000
- ☐ Hasta $20,000
- ☐ Otro: ____________________________________________________________

---

Las siguientes tres preguntas se refieren a los conectores de carga de Vehículos Eléctricos de Batería [VEB] en su hogar y en su lugar de trabajo.

Hay tres tipos principales de conectores de carga para Vehículos Eléctricos de Batería [VEB]:

- **Carga de Nivel 1** utiliza un tomacorriente estándar de 120V para cargar un vehículo eléctrico. Tarda aproximadamente 9 horas en recargar 40 millas de alcance (un viaje diario típico), esto se puede hacer fácilmente durante la noche. Cada hora de carga recarga aproximadamente 5 millas.
- **Carga de Nivel 2** utiliza una toma de corriente de 240 V para cargar un vehículo eléctrico. Tarda aproximadamente 2 horas en recargar 40 millas de alcance. Algunos ejemplos de electrodomésticos que usan tomacorrientes de 240V son secadores eléctricos y hornos. Cada hora de carga recarga aproximadamente 26 millas.
- **Carga Rápida de CC** es un método de carga específico para Vehículos Eléctricos con Batería [VEB} que generalmente tarda unos 10 minutos en recargar 40 millas de alcance. Cada minuto de carga recarga aproximadamente 4 millas.

---

**10. Imagínese que tuviera un Vehículo Eléctrico con Batería [VEB] (o si ya tiene uno). ¿Dónde probablemente lo cargaría?**

☐ En casa

☐ En el trabajo

☐ Otro (especifique): ________________________________________________________

---

**11. Imagínese que tuviera un Vehículo Eléctrico con Batería [VEB] (o si ya tiene uno). ¿Instalaría un cargador de Nivel 2 (toma de 240 V) en su lugar de residencia (alrededor de $2000)?**

☐ Si

☐ No

**Proporcione el código postal de su lugar de residencia actual :**

___________________________________

---

12. **¿Su lugar de trabajo ofrece estaciones de recarga para Vehículos Eléctricos con Batería [VEB]? ([OPCIONAL] En caso afirmativo, proporcione la ubicación y el código postal)**

☐ Si

**Ubicación y el código postal** :

_____________________________________________________________

☐ No

☐ No lo sé

**En caso afirmativo, ¿qué tipo de carga proporciona su lugar de trabajo?**

☐ Nivel 1

☐ NIvel 2

☐ Carga Rápida de CC

☐ No lo sé

La próxima serie de preguntas nos ayudará a mejorar nuestros esfuerzos de divulgación de información en la Ciudad de San Antonio. Tenga en cuenta que estas preguntas son completamente **opcionales.**

---

**13. (OPCIONAL) ¿Cuál es su edad actual ?**

- ☐ Menor de 18
- ☐ 18 to 24
- ☐ 25 to 34
- ☐ 35 to 44
- ☐ 45 to 54
- ☐ 55 to 64
- ☐ 65 to 74
- ☐ 75 or older
- ☐ Prefiero no contestar

---

**14. (OPCIONAL) ¿Cuál es su género ?**

- ☐ Hombre
- ☐ Mujer
- ☐ Prefiere auto-describirse (especifique): ___________________________________________
- ☐ Prefiero no contestar

---

**15. (OPCIONAL) ¿Cuál es su origen étnico (marque todos los que correspondan)?**

- ☐ Blanco
- ☐ Hispano/Latino
- ☐ Negro o Afroamericano
- ☐ Asiatico
- ☐ Indio Americano o Nativo de Alaska
- ☐ Nativo del Medio Oriente o África del Norte
- ☐ Nativo de Hawaii u otras islas del Pacífico
- ☐ Otra Raza/Etnia (especifique): ____________________________________________
- ☐ Prefiero no contestar

---

**16. (OPCIONAL) Proporcione el distrito de su consejo (si no lo sabe, proporcione su dirección):**___________________________________________________________________________

________

___________________________________________________________________________________

___________________________________________________________________________________

---

**17. (OPCIONAL) Cual es su nombre?** ______________________________________________________

**18. (OPCIONAL) ¿Cómo prefiere recibir comunicaciones (proporcione información para cada opción marcada)?**

☐ Correo electrónico

Cuál es su dirección de correo electrónico?

_______________________________________________

☐ Llamada telefónica

¿Cuál es su número de teléfono? _______________________________________________

☐ Mensaje de texto

¿Cuál es su número de teléfono? _______________________________________________

☐ Correo

¿Cuál es su dirección postal? _______________________________________________

_______________________________________________

_______________________________________________

# City of San Antonio
# Electric Vehicle Fleet Conversion &
# City-Wide Electric Vehicle Infrastructure Study

Led by the City of San Antonio Office of Sustainability

with support from City of San Antonio Building & Equipment Services

Consultant Team: GKW Engineering, Cadmus, and MSE Group

December 2019