



**California  
Road Charge**



# **California Road Charge Four-Phase Demonstration**

FINAL REPORT | AUGUST 2022



The California Department of Transportation would like to thank the following partners for their commitment and continued collaboration on the California Four-Phase Demonstration.

- ▶ **The Federal Highway Administration**

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- ▶ **The California State Transportation Agency**

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- ▶ **The California Transportation Commission**

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- ▶ **The Road Charge Technical Advisory Committee**



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# EXECUTIVE SUMMARY

Since 2014, with the passage of Senate Bill 1077, California has been actively developing, exploring, testing, and documenting a realistic alternative to the gas tax for financing California's transportation system. The Road Charge Program serves as the scientifically driven test bed for a new potential tax structure to replace the gas tax.

## What is the Road Charge Program?

As Californians switch to more fuel-efficient and zero emission vehicles, these cars either consume less gas or no gas at all, which means funding California's highway and road repairs based on the gas tax becomes increasingly unviable. Ultimately, California will need to develop a funding system that supports our state's transportation future.

A road charge could serve as the gas tax replacement, as it is an alternative funding mechanism that allows drivers to support road and highway maintenance based on how many miles they drive, instead of how many gallons of gas they use. California is leading the way on new ways to resolve the gas tax problem, establishing the Road Charge Program as a way to develop, evaluate, and test different aspects of road charges before they are potentially deployed for broad use.





## Caltrans' Road Charge Four-Phase Demonstration

In 2017, California successfully demonstrated the general feasibility of the road charge concept as a potential replacement for the gas tax through the largest pilot in the nation to date. However, decision makers need more than general feasibility to act upon a substantial policy change like road charge. There are numerous aspects and nuances to how road charges could affect California's residents, visitors, and businesses that still need to be evaluated.

The California Department of Transportation (Caltrans) conducted the Four-Phase Demonstration to further test, inform, and shape an implementable road charge for potential use in the state, specifically studying how different technologies might create an easy taxpayer experience.

### The Four Phases were:



**Pay-at-the-Pump / Pay-at-the-Chargepoint.** The gas tax is paid by motorists when they refill their vehicles at fuel stations. As this is a familiar process, Caltrans tested how a road charge could be collected at fuel stations. Similarly, this phase also looked at how a road charge could be assessed at commercial charging stations for electric vehicles.



**Usage-Based Insurance.** Some insurance providers have begun to offer plans based on the number of miles driven instead of the more common fixed fee for motorists. This phase evaluated road charge collection as a concurrent per-mile fee added supplementing monthly vehicle insurance billing.



**Ridesharing.** Ridesharing services already assess fees on their customers based on mileage and travel demand. This phase looked at how well a ridesharing trip provider can assess a specific road usage charge.



**Autonomous Vehicle.** All indications are that vehicle automation is the way of the future, and the ability to assess a road charge in a fully automated environment warrants testing. This phase looked at how accurately an autonomous vehicle could assess such a road charge.

The demonstration project team compiled data for all phases through the Platform for Road charge Innovation and Mobility Evolution (PRIME) – a cloud-based data warehouse which combined private, sanitized participant data with other California data sources. Together, this data processing provided a series of operational dashboards that could eventually support interoperability as well as improve transportation planning, forecasting, and operations.

Additionally, Caltrans conducted a series of Communications Research activities, including twelve focus groups across the state with various geographic, socioeconomic, and workforce groups, nine (9) focus groups for pilot participants, and three (3) statewide opinion poll telephone screens in order to further understand Californian's priorities for a potential road charge system.



## Major Findings: Working with Business Providers

During the Four-Phase Demonstration, Caltrans worked directly with private, transportation-oriented business providers to evaluate how well their businesses could adapt to future large-scale road charge efforts. Using existing business systems (like points of sale, database structures, and customer portals and apps) is vital for reducing costs and enhancing confidence in the road charge collection process. By building off of an existing business models, it is easy for a business to add road charge as a service to their customers expanding their market access, easy for the taxpayer as a road charge is paired with a bill they are already paying, and making the administration of road charge more cost effective for the state.



California demonstrated that road charges could be collected easily, securely, and reliably through existing systems from well-established markets.

## Major Findings: Pay-at-the-Pump / Pay-at-the-Chargepoint

Motorists already pay their gas tax at the fuel station, so the most intuitive location for people to pay a road charge may likewise be the fuel station. The idea of being able to exactly copy the existing taxpayer experience under the fuel tax is appealing. However, Caltrans found that there is tremendous variety of technologies and processes at different fuel retailers that present real-world challenges to deploying a road charge at the pump. While the pay-at-the pump business partner, GasBuddy, provided a solution which resolved some aspects of these challenges, the business model is oriented towards financial transactions, not mileage reporting.

California expects technologies and business models to constantly evolve in the future life of a potential road charge system and intends to create a system structure that can adapt and absorb new approaches from third party commercial account managers. There will likely be a time that a potential commercial account manager will offer a pay-at-the-pump approach that will cost-effectively pass the state's certification requirements. At the present time, however, this is not an approach the state should spend more time on.

Part of the Demonstration's value has been learning that a road charge collection option does not have to exactly copy the fuels tax payment experience in order to copy its easiness





Similar to Pay-at-the-Pump, Chargepoint payments would connect the road charge to a similar mechanism of paying for roads. Although electric vehicles feature in-vehicle telematics that include mileage information, the demonstration confirmed that no mileage information is transferred between the electric vehicle and the charging station through the charging port. Furthermore, electric vehicle owners have multiple options to charge their vehicles outside of the retail charging environment, including at home. This provides an easy pathway to avoid payment of the road charge. Compounding the issue, although the demonstration was able to avoid the communication problem by using a third-party device, the onboard diagnostics port is not required in electric vehicles, making plug-in devices obsolete for this solution. The pay-at the charging station business partner Charge Point was able to demonstrate how road charge reporting and payment could be captured using their backoffice systems, but mileage data will still be needed to provide accurate assessment of per-mile charges.

## Major Findings: Usage-Based Insurance

The usage-based insurance business model aligns well with road charge. This approach already uses mileage data to assess insurance fees and is well-established and offered through multiple mediums including plug-in devices, smartphone apps, embedded telematics, and, as demonstrated in this pilot, odometer photo uploads. The demonstration's business partner, Mile Auto, deployed an odometer photo upload method for reporting miles. This system proved to be a reliable and easy-to-use solution that was supported by all participants' smartphones. Furthermore, the system relied on text messaging instead of a third-party app, reducing concerns about data consumption. Simulated road charges were included in the monthly insurance bill, so there was no extra bill to pay.



The odometer photo upload method only requires a smartphone to capture and upload odometer pictures over text messaging. This option proved viable as a technology-based reporting solution, but without the concern of privacy or location awareness.



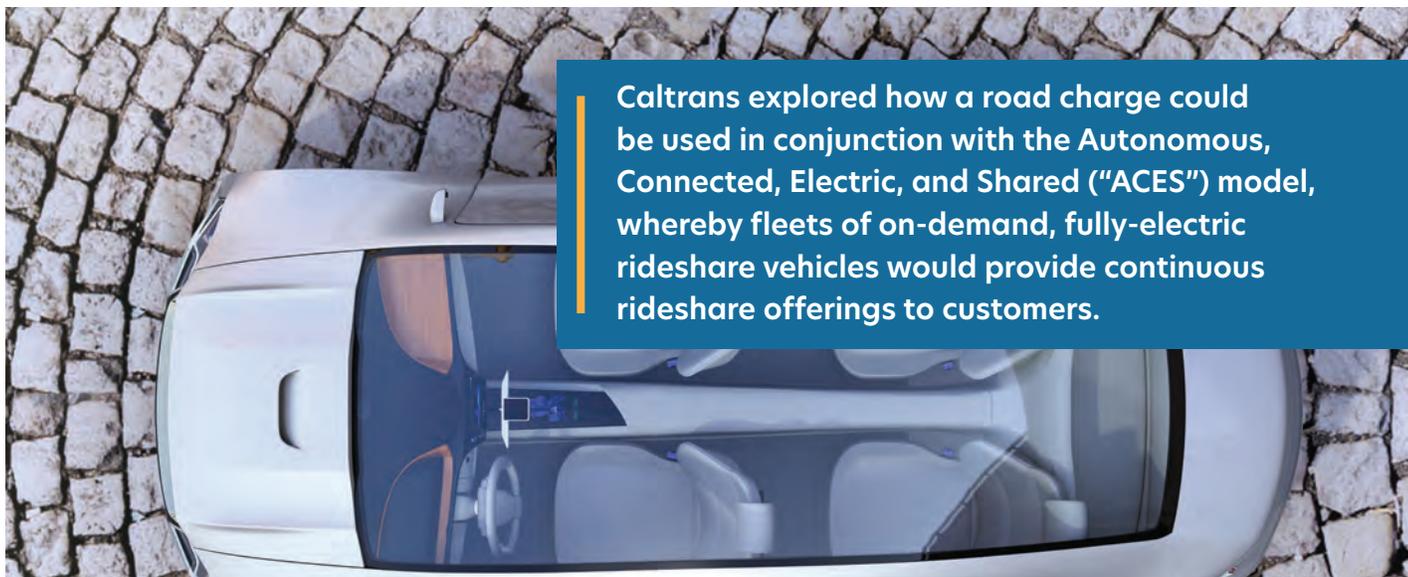
## Major Findings: Ridesharing

Ridesharing service providers, like the demonstration business partner Via, already collect mileage as part of their typical business operations, so integrating road charge capabilities proved operationally simple. Via's platform calculated the road charges and emailed participants a receipt showing the trip, the distance traveled, and the assessed road charge using the rideshare systems that their customers were already familiar with. Ridesharing companies could serve as road charge commercial account managers for their drivers, allowing them to provide a benefit to their drivers at low cost and facilitate tying the road use cost more directly to the end user.



## Major Findings: Autonomous Vehicles

The demonstration successfully showed that autonomous vehicles, through business partners EasyMile and Via, can reliably and accurately assess road charges. In an autonomous vehicle, highly detailed data collected for their operation exceeds that which a road charge would need. This detailed data introduces new possibilities for state departments of transportation, where the data can be used to enhance operations, traffic monitoring, trip planning, or ridesharing. This effort successfully showed how autonomous vehicle data could be used to assess a road charge.





## Major Findings: PRIME

PRIME presented a first-of-its-kind innovation for road charge. Private road charge data, with all Personally Identifiable Information removed, was successfully integrated with other data sources and used to inform dashboards that showed real-time information. Some of the situations that PRIME showcased included mileage traveled across Caltrans districts and metropolitan planning organizations, road charge revenue allocations based on geographic areas, and trip comparisons to similar transit, micromobility, and pedestrian options. As California continues to study the privacy implications of a road charge system, it is important to explore what can be done with data to inform the state's debate on what should be done with it.

PRIME was also used to demonstrate road charge interoperability. Road charge data from the California 2017 Pilot, was analyzed and shared across PRIME and the Oregon OReGO Road Usage Charge systems to show how road charge systems could both be interoperable, and road charge data and revenues can be allocated to the states where the miles are traveled. Working with the Oregon/California Regional Pilot Project, also funded through the federal STSFA program, allowed Caltrans to build upon and expand PRIME in real-time to further its scalable and interoperable clearinghouse functionality.

**PRIME was a first-of-its-kind offering that demonstrated how sanitized road charge data could be integrated with other transportation data sources to provide operational enhancements, dashboards, and fully interoperable data exchanges between states.**





## Major Findings: Communications Research

The Communications Research conducted for this demonstration was used to help further public understandings of transportation funding, gauge public familiarity with the road charge concept, and capture key concerns and issues with road charge and how it may impact their lives. Findings uncovered that the public first needs to understand how transportation is funded and explain the problems with the gas tax model. Fairness and equity were also identified as key points, with concerns over how road charge may disproportionately burden low-income, rural, and other drivers who had to drive long distances due to life circumstances. The need for quantifiable numbers clearly explaining how road charge would specifically impact individuals was another key takeaway. Also, commercial vehicles and fleets should be an active and visible part of the solution. Finally, effectively explaining the road charge concept across multiple geographic, demographic, and socioeconomic groups is key, but the messaging needs to be customized to each group, clearly explaining the specific impacts of how these groups may be affected by a road charge.



**In conclusion**, the California Road Charge Four-Phase Demonstration helped move California forward on its path to developing a fully implementable road charge program for Californians to consider. This project tested how road charge could integrate into some familiar related markets. The State learned important lessons about the value of building off of existing systems, learned more about the public's priorities for a road charge system, and further developed the foundations for an interoperable system.

The Usage-based Insurance and Rideshare markets seem the most ready to support road charge collection. Pay-at-the-Pump and Pay-at-the-Chargepoint will require updates to technologies that allow the transfer of road charge data from the vehicle to the pump/chargepoint, and are not paths the state intends to explore further at this time.

Next, the Public/Private Roads Project will test the viability of current GPS technology to differentiate between public and private roads in a road charge system and engage rural communities in a conversation about what road charge looks like for them. Following that, the Road Charge Collection Pilot will allow for more thorough testing of state administrative processes and potentially help further define likely administrative costs through the collection of actual revenue from pilot participants.



## Section 1

# INTRODUCTION AND BACKGROUND

This report provides a summary of the activities and corresponding results of the California Four-Phase Demonstration (“the Demonstration”) implemented from 2019 through 2021. The report begins by providing a background on road charge and an overview of the Demonstration. The report then details the activities taken by the Demonstration Team to design and prepare for implementation and describes operations and results. The report ends with sections discussing key issues for the future of road charge in California and recommendations on next steps for the program.

## 1.1 Introduction to Road Charge

Conceptually, road charge is a transportation funding mechanism that enables individuals to support road and highway maintenance through a per-mile fee based on each mile they drive rather than a per-gallon surcharge for each gallon they purchase to fuel their vehicle.<sup>1</sup> In application, road charge can be assessed and collected through several methods using different technologies and business models. This includes simple, low-tech approaches such as manual odometer readings, but various technologies might be used to automate the process. Such approaches typically follow a similar process:

1. Technology is used to collect necessary vehicle data including mileage, fuel consumption, and location (if required).
2. That data is transmitted to a back-end system hosted by the appropriate government agency or a private third-party commercial account manager.

3. The system calculates the miles traveled and calculates the road charge, subtracting credits for fuel taxes paid.
4. The taxpayer is invoiced and sends payment to the account manager, who provides it to the State.

Research projects and technology demonstrations have been explored by organizations across the United States, including California, as agencies seek alternatives to fuel taxes. More information on other states’ efforts can be found at <https://caroadcharge.com/partners/road-charge-across-the-u-s/>.



[1] California Road Charge, About. Caltrans, CalSTA, <http://caroadcharge.com/about/>. Accessed: Apr. 7, 2021.

## 1.2 Transportation Funding in California

The California Department of Transportation (Caltrans) owns and maintains the State Highway System, a collection of 52,265 miles of freeways and over 13,000 bridges.<sup>2</sup> Though various programs and revenue sources fund California infrastructure overall, the operation and maintenance of the California highway system is funded by the federal and state revenue sources (not including bonding) shown in **Table 1**.

**TABLE 1. Overview of California Transportation Funding Types and Sources<sup>3</sup>**

TYPE OF FUNDING	SOURCES OF FUNDING
<b>User Taxes and Fees</b>	<ul style="list-style-type: none"> <li>▶ <b>Federal fuel excise taxes</b> (18.4¢ per gallon gasoline, 24.4¢ per gallon diesel)</li> <li>▶ <b>State fuel excise taxes</b> (50.5¢ per gallon gasoline, 38.5¢ per gallon diesel in FY 2020-2021)</li> <li>▶ <b>State fuel sales taxes</b> (2.25 percent of sales on gasoline go to locals for general government purposes)</li> <li>▶ <b>State diesel sales taxes</b> (13 percent of sales on diesel for transit and other transportation purposes)</li> <li>▶ <b>Vehicle Weight Fees</b> (levied on commercial vehicles and varies based on gross vehicle weight)</li> <li>▶ <b>Tolls</b> (vary based on the implementing agency and particulars of the facility)</li> <li>▶ <b>Transportation Improvement Fee</b> (annual fee based on vehicle value that varies between \$27 to \$188)</li> <li>▶ <b>Zero-Emission Vehicle Registration Fee</b> (\$100 per year levied on electric vehicles)</li> <li>▶ <b>Vehicle license fee</b> (0.65 percent of the purchase price/value of the vehicle)</li> <li>▶ <b>Vehicle registration fees</b> (vary based on the type of vehicle, vehicle purchase price/value, city/county of residence, weight, and axle configuration)</li> <li>▶ <b>Driver license fees</b> (depending on the type, vary from \$35 to \$89)</li> </ul>
<b>Local and Other Funds</b>	<ul style="list-style-type: none"> <li>▶ <b>Local sales tax measures</b> (self-help counties)</li> <li>▶ <b>Transit fare revenues</b></li> <li>▶ <b>Property taxes</b></li> <li>▶ <b>Benefit assessment districts</b></li> <li>▶ <b>Developer fees</b></li> </ul>

Of the revenue sources shown in the table, the most significant in terms of funding are federal and state fuel taxes. Both of these taxes are excise taxes, meaning that they are assessed on the physical amount of a commodity as opposed to the purchase price. As of 2021, the federal fuel tax rate was 18.4 cents per gallon of gasoline fuel purchased and 24.4 cents per gallon of diesel fuel purchased. California levies its own state fuel excise tax at a current rate of 51.1 cents per gallon of gasoline purchased and 38.9 cents per gallon of diesel fuel purchased. The state also levies a 2.25 percent sales tax on gasoline and a 13 percent sales tax on diesel fuel. On average, individuals in California pay approximately \$280 per year in state fuel taxes.

Vehicle registration fees are also an important source of transportation revenue for the state. The Transportation Improvement Fee charges vehicle owners an annual fee based on the vehicle's market value while the Zero-Emission Vehicle Registration Fee charges an annual \$100 fee to owners of zero-emission electric vehicles.

[2] Transportation Funding in California 2020. Caltrans, Division of Transportation Planning, Transportation Economics Branch, <https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/transportation-economics/transportation-funding-booklet/2020-final-transportation-funding-a11y.pdf>. Accessed: Apr. 15, 2021.

[3] Transportation Funding in California 2020. Caltrans, Division of Transportation Planning, Transportation Economics Branch, <https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/transportation-economics/transportation-funding-booklet/2020-final-transportation-funding-a11y.pdf>. Accessed: Apr. 15, 2021.



## 1.3 The Rationale for Road Charge in California

As noted, the majority of funding for the operation and maintenance of transportation infrastructure in California is raised by state and federal fuel taxes. However, fuel tax revenues have diminished over the years as a result of several developments:

- ▶ Inflation causing a reduction in spending power of the dollars raised by fuel taxes.<sup>4</sup>
- ▶ An increase in average vehicle fuel efficiency from approximately 13 miles per gallon in 1975 to 24.9 miles per gallon in 2019,<sup>5</sup> meaning vehicles can drive more on fewer fuel thus raising fewer dollars from the same gallon of gas via the fuel tax. Put another way: Vehicles can drive more miles while contributing less to fuel taxes per mile to offset the wear that driving each mile produces on the transportation infrastructure.
- ▶ The increase of zero emission vehicles, which do not use gas and so pay nothing in fuel taxes.
- ▶ New policy goals, such as Governor Newsom's Executive Order to ban the sale of gasoline-powered vehicles by 2035 in the fight against climate change,<sup>6</sup> mean the viability of fuel taxes as the primary means to fund transportation infrastructure throughout California is coming to an end.

With this knowledge, California has been exploring alternative funding mechanisms such as a road charge to replace fuel taxes to fund the state's transportation infrastructure.



[4] 10-Year Breakeven Inflation Rate. St. Louis Federal Reserve, <https://fred.stlouisfed.org/series/T10YIE#0>. Accessed July 15, 2021.

[5] The 2020 Environmental Protection Agency Automotive Trends Report: Greenhouse Gas Emissions, Technology, and Fuel Economy Since 1975. Section 2: Fleetwide Trends Overview. United States Environmental Protection Agency, <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P1010U68.pdf>.

[6] Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change." Office of Governor Gavin Newsom, Sep. 23, 2020. <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/>. Accessed: Apr. 7, 2021.

## 1.4 Development of Road Charge in California

Over the last decade, California has advanced the road charge concept through research, legislation, and technology demonstrations.

### 1.4.1 Initial Research on Road Charge

Beginning in 2013, California government agencies began researching the road charge concept as a future revenue source for transportation infrastructure given the ongoing decline in fuel tax revenues. Specifically, California took several actions:

- ▶ In Fall 2013, California joined the RUC Americas (formerly known as the Western Road Usage Charge Consortium), to engage in joint research and deliberation on road charge concepts.
- ▶ In September 2013, officials from Caltrans and the California Division of the Federal Highway Administration (FHWA) met with officials from the Oregon Department of Transportation to learn from Oregon's road charge efforts that date back to 2001.
- ▶ In 2013, the California State Transportation Agency (CalSTA) formed the California Transportation Infrastructure Priorities Workgroup with a subgroup on road charge to further study future challenges and opportunities for California's transportation system. The Workgroup's final report found that revenues would not sustain California's transportation infrastructure in the future due to declining fuel tax revenues alongside other trends such as an increase in alternative fuel vehicles (e.g., electric vehicles.) One recommendation from the group was to develop and implement a road charge pilot.

### 1.4.2 Senate Bill 1077 & the 2017 Road Charge Pilot

In September 2014, the California State Legislature passed SB 1077 (DeSaulnier, 2014), which acknowledged the need to identify a long-term funding solution for the state's transportation system.<sup>7</sup> SB 1077 directed the chair of the California Transportation Commission (CTC) to consult with the Secretary of CalSTA and create a 15-member Technical Advisory Committee (TAC) to develop design recommendations and evaluation criteria for a road charge pilot for the purpose of determining the potential for road charge as an alternative to fuel taxes.<sup>8</sup>

Throughout 2015, the TAC met monthly to design the pilot program and consider various policy and technical issues associated with road charge. In December 2015, the TAC presented their final report recommending a road charge pilot design to CalSTA for implementation.

The 2017 California Road Charge Pilot ran from July 2016 to March 2017 with 5,129 vehicles participating statewide over those 9 months. During the pilot, each participant reported their vehicle miles traveled and took part in a simulated road charge payment through one of several mileage collection options, made possible through partnerships with four third-party vendors, and provided feedback on their participation in the pilot. Of the 5,129 vehicles:

- ▶ 4,000 reported data throughout the pilot,
- ▶ 87 percent were privately owned and registered in California,
- ▶ 7 percent were agency vehicles and out of state vehicles,
- ▶ 5 percent were light commercial vehicles,
- ▶ 1 percent were heavy commercial vehicles,

[7] SB-1077 Vehicles: road usage charge pilot program. California State Legislature, [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\\_id=201320140SB1077&search\\_keywords](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1077&search_keywords) . Accessed Apr. 5, 2021.

[8] Road Charge Technical Advisory Committee. California Transportation Commission, <https://catc.ca.gov/committees/road-charge>. Accessed Apr. 5, 2021.

- ▶ 79 percent of participants used the automated mileage reporting options, and
- ▶ 62 percent used location-based reporting options.

Ultimately, the 2017 Pilot was evaluated using the TAC's eight goals:

- ▶ **Revenue:** Ability of road charge to serve as a suitable replacement revenue source for fuel taxes.
- ▶ **Cost:** Costs associated with administering and collecting road usage charges, both from a participant perspective and from an agency perspective.
- ▶ **Operations:** How well road charge collections operate, both from customer and agency perspectives.
- ▶ **Participant Experience:** How participants interface with the road charge system.
- ▶ **Privacy:** Privacy protection measures built into the Pilot.
- ▶ **Data Security:** Security of participant data collected, transmitted, stored, and used in the pilot.
- ▶ **Equity:** Equity, perceived and real, along several dimensions.
- ▶ **Communications:** Communications with participants and the public.

Overall, the pilot successfully demonstrated the feasibility of a road charge system. Full results of the pilot can be found in the Final Report completed in December 2017.<sup>9</sup> The report identified several topics for further research including:

- ▶ Demonstrating pay-at-the-pump/ChargePoint technologies.

- ▶ Understanding the impact to revenue flows through state systems from actual collection (as opposed to mock invoices and payments).
- ▶ Understanding how emerging technologies, such as autonomous vehicles, play a role in road charge. Understanding the organizational considerations of administering a road charge.
- ▶ Further research on impacts to disadvantaged communities and rural drivers.

### 1.4.3 The Fixing America's Surface Transportation Act

At the federal level, the U.S. Congress passed the Fixing America's Surface Transportation (FAST) Act in December 2015 for the purpose of exploring sustainable revenue sources for the Highway Trust Fund.<sup>10</sup> Within the FAST Act, Congress established the Surface Transportation System Funding Alternatives (STSFA) grant program to further state-led research on alternative financing mechanisms (e.g., road charge) for the Highway Trust Fund.

The State of California applied to and was awarded funds from the STSFA program in 2016 to develop further research recommended in the 2017 Pilot Final Report.

### 1.4.4 Senate Bill 1 of 2017

At the same time the 2017 Pilot was underway, the California State Legislature developed and ultimately passed SB 1 (The Road Repair and Accountability Act of 2017) in January 2017 with Governor Brown signing the bill on April 28, 2017.<sup>11</sup> SB 1 was designed to invest approximately \$5.4 billion annually in transportation infrastructure projects across California.<sup>12</sup> The funding was raised through: (1) An increase to the gas excise tax, the diesel excise tax, and the diesel sales tax, (2) The establishment of the Transportation

[9] 2017 Road Charge Pilot. Caltrans, <https://dot.ca.gov/programs/road-charge/final-report>. Accessed Apr. 5, 2021.

[10] The Fixing America's Surface Transportation Act or "FAST Act." U.S. Department of Transportation, <https://www.transportation.gov/fastact>. Accessed Apr. 5, 2021.

[11] Senate Bill 1 (SB 1). Caltrans, <https://dot.ca.gov/programs/sb1>. Accessed Apr. 5, 2021.

[12] SB-1. State of California, <http://rebuildingca.ca.gov/>. Accessed Apr. 5, 2021.



Improvement Fee based on the market value of each vehicle, and (3) The creation of the Road Improvement Fee, a registration fee on zero emission vehicles (e.g., electric vehicles) of model year 2020 or later.<sup>13</sup> The excise taxes and registration fees were indexed to inflation.

## 1.5 Road Charge Developments Across the United States

Alongside efforts in California, several states have been researching road charge through studies, implementing technological demonstrations, and deploying active road charge assessment and collection systems for decades. States continue to explore road charge as a viable alternative to the fuel tax, but are doing so at various paces of implementation and research. This section will examine those states with active road charge programs, road charge coalition groups, previous road charge pilots, and upcoming road charge pilots.

### 1.5.1 Active Road Charge Programs

#### **Oregon Department of Transportation: OReGO**



**OREGO** Building on successful implementations of the 2006 Oregon Mileage Fee Concept and Road User Fee Pilot Program and the 2014 Truck Road Use Electronics demonstration, the Oregon developed OReGO

OReGO was deployed in July of 2015 with an initial participation target of 5,000 volunteers paying the charge in lieu of state fuel taxes. At the program's inception, the assessed rate was set at 1.5 cents per mile (now 1.8 cents per mile per Oregon House Bill 2017) and fuel taxes paid when refueling are credited against the assessed amount. Original participation in the program was limited based on fuel efficiency such that no more than 1,500 vehicles with a fuel efficiency of less than 17 miles per gallon (mpg), and no more than 1,500 vehicles with a fuel efficiency between 17 mpg and 22 mpg may participate. However, participation

is far below the current 5,000 vehicle limit. As of 2020, vehicles must be electric or have a combined rating of at least 20 mpg to be eligible for the program. Electric vehicles and vehicles with a combined mpg rating of at least 40 mpg can be exempted from paying additional registration fees if enrolled in the OReGO Program.

Volunteers sign up online and provide their vehicle identification number, odometer reading, and license plate number. From there, they select an account manager, who is responsible for providing a road metering device, assessing mileage, and collecting payment. The Oregon Department of Transportation (ODOT) acts as one account manager, and the device it provides is not equipped with a global positioning system (GPS), meaning that no location data is collected, and participants must pay for all mileage. Private vendors also offer a GPS-enabled device that allows for the crediting of out-of-state miles. The private account managers also provide several value-added services not offered by the ODOT-administered system, including visual trip logs, "achievements" for good driving behavior, safe zones that alert when the vehicle has crossed a user-defined zone, engine health, diagnostic and other telematics-based reports, advanced navigation, car finding service for use by smartphone, and remote vehicle use monitoring.

#### **Utah Road Usage Charge Program**

Beginning in 2018, the Utah State Legislature began passing legislation that would direct the Utah Department of Transportation to develop and implement a road usage charging program. SB 136, passed in 2018, required the Utah Department of Transportation to create a Road Usage Charge Advisory Committee and implement a road usage charging system as an alternative to the annual flat fee for electric and highly fuel-efficient vehicle owners (full electric vehicles, plug-in hybrid vehicles, and gasoline hybrid vehicles). In 2019, the Utah State Legislature passed SB 72 which gave the Utah Department of Transportation and the Utah Transportation Commission rule-making authority for

[13] SB 1 Has Doubled Major Source of State Funding for Local Streets and Roads. Legislative Analyst's Office, <https://lao.co.gov/Publications/Report/4142>. Accessed Apr. 5, 2021.

the Road Usage Charge Program. Additionally, in 2020 the Utah legislature passed SB 150 that directed the Utah Department of Transportation to develop and submit a plan for enrolling all vehicles in the program by December 31, 2031.

Utah's Road Usage Charge Program is a voluntary program for electric and highly fuel-efficient vehicle owners. In Utah, owners of highly fuel-efficient vehicles are required to remit an alternative fuel flat fee at the time of annual registration. Drivers of these vehicles are given the option to enroll the Utah Road Usage Charge Program and instead pay a 1.5 cents per-mile fee in place of the annual flat fee. Road usage charge fees for these drivers are capped equivalent amount of the annual flat fee, meaning the driver never pays more than the annual alternative fuel flat fee.

As part of the program, participants are asked to sign up with a third-party account manager that selects a mileage reporting mechanism (embedded telematics, on-board diagnostic, or smartphone app) collects and reports mileage, establishes a prepaid wallet that is used to pay road usage charging fees, and. At the end of 2020, there were 1,469 electric, 446 plug-in electric, and 1,773 gas hybrid vehicles enrolled in the program.

### **Virginia Department of Transportation**

In 2020, the Virginia General Assembly passed a series of legislative measures that authorized changes to the state's transportation funding system. Changes to chapters 1230 and 1275 resulted in the establishment of the Highway Use Fee and a voluntary Mileage-Based User Fee program.

The Highway Use Fee, a fee on highly efficient and electric vehicles, was implemented with the goal of ensuring fairness in transportation funding by requiring vehicles that consume less gasoline, and therefore pay less in fuel taxes, to pay an additional fee. The fee is calculated by taking 85 percent of the amount of taxes paid on gasoline by a vehicle with a fuel economy of 23.7 mpg driven 11,600 miles per

year (the average annual miles driven by a passenger vehicle in the state of Virginia).<sup>14</sup> The Highway Use Fee became effective on July 1, 2020.

In addition to the Highway Use Fee, the Virginia General Assembly also established a voluntary mileage-based user fee program as an alternative to the Highway Use Fee. Participants in the program pay a fee based on actual miles traveled as opposed to the assumed 11,600 annual mileage average in the Highway Use Fee. The legislation directed the Virginia Department of Motor Vehicles to establish a working group to assist in the development of the Mileage-Based User Fee program. The program became operational on July 1, 2022.

## 1.5.2 Road Charge Coalition Groups

### ***The Eastern Transportation Coalition (Formerly Known as the I-95 Corridor Coalition)***



The Eastern Transportation Coalition, formerly known as the I-95 Corridor Coalition, is comprised of 17 states and the District of Columbia along the I-95 corridor and represents 40 percent of the U.S. population and Gross Domestic Product. The Eastern Transportation Coalition brings the eastern seaboard's perspective to conversations regarding the development of road charge pilots and programs. The organization has recently implemented three pilots.

- ▶ The 2018 passenger vehicle pilot included 155 participants throughout Delaware and Pennsylvania to research four areas of study were identified in the pilot including: (1) Managing out-of-state mileage, (2) Interoperability with tolling, (3) Value-added benefits (trip logs, safe driving scores, and engine conditions), and (4) Multistate trucking. The study used a combination of three mileage reporting devices to collect participant driving data: (1) Plug-in devices with location which

[14] Virginia Department of Motor Vehicles. (July 2021). Mileage-Base User Fee Program Interim Report. <https://rga.lis.virginia.gov/Published/2021/RD255/PDF>

76 percent of participants chose, (2) Plug-in devices without location, which 16 percent of participants chose, and (3) Android smartphone with location, which 8 percent of participants chose.

- ▶ A 2019 passenger pilot study with nearly 900 participants, with 80 percent residing in Delaware or Pennsylvania, that ran from July 2019 through October 2019. Similar to the first study in 2018, 80 percent of participants selected a mileage reporting plug-in device with GPS location. More than 3 million miles were driven by participants across 42 states and Canada with out-of-state mileage representing 13 percent of the total, demonstrating the importance of interstate interoperability.
- ▶ A multistate trucking pilot that ran from October 2018 through May 2019 that evaluated issues specific to the trucking industry, including rate setting and compatibility with the existing regulatory framework.

### RUC America



RUC America, formerly RUC West, is a voluntary coalition of nineteen western states that have pooled funding and other resources to explore road charge options that might be implemented on a multistate basis.<sup>15</sup> RUC America generally uses its pooled funds to support various policy and planning studies related to the implementation of multistate road charge systems. In 2021, RUC America completed a Regional RUC Pilot Project demonstrating the functions of a road usage charge clearinghouse to accommodate multiple sets of road charge requirements, processes, systems, and rates from across different states and/or jurisdictions. RUC Americas views such clearinghouse data

aggregation and distribution functions as necessities for scalability of road charge systems across the country. The pilot involved the states of California and Oregon, including vehicle identification numbers and simulated travel data and payment information (data was sanitized where appropriate). The system successfully generated reports that differentiated travel data and revenue by jurisdiction and account manager. System functions were verified as accurate. The project team was able to take real-time lessons from this STSFA-funded effort and apply it to the Demonstration's development of PRIME.

### 1.5.3 Completed Road Charge Pilots

#### Colorado Road Usage Charge Pilot Program



#### Road Usage Charge Pilot Program

Colorado initially began exploring road charge as an infrastructure financing option in 2007 when then-Governor Bill Ritter appointed the Transportation Finance and Implementation Panel to study transportation infrastructure needs and revenue sources.<sup>16</sup> One recommended area of study was road charge. Over the years, Colorado performed several studies that eventually resulted in the Road Use Charge Pilot Project.

Colorado's Road Use Charge Pilot Project occurred from 2016 to 2017. The Colorado Department of Transportation planned, designed, implemented, and evaluated a four-month pilot project to test the feasibility of collecting and assessing a road charge. The pilot provided participants with the option of three reporting methods: (1) Manual odometer reporting by participants via a website or mobile app, (2) Non-GPS based technology via a plug-in device inserted into the vehicle that collected fuel consumption and mileage data but not location data and (3) GPS based technology inserted into their vehicle that collected mileage, fuel consumption, and

[15] RUC West. RUC West, <https://www.rucwest.org/>. Accessed Apr. 22, 2021.

[16] History of RUC in Colorado. Colorado Department of Transportation, <https://www.codot.gov/programs/ruc/history> Accessed Apr. 22, 2021.



location data. The pilot included 147 participating vehicles made up of electric vehicles, gas hybrid vehicles across 27 Colorado counties.<sup>17</sup> The pilot demonstrated that road charge was a technically feasible option for transportation finance and found strong support for the road charge concept among participants. Upon completion of the pilot, it was recommended that Colorado continue research and development of a road charge through collaboration with state and federal organizations.

### **Hawaii Department of Transportation Road Usage Charge Demonstration**



In 2019, the Hawaii Department of Transportation began a three-year, six-phase demonstration project building on existing state infrastructure to collect annual odometer readings as the basis for road charge assessment.<sup>18</sup> Rather than test in-vehicle technology as other states have, this project establishes and implements an accounting system to provide prototypical invoices for miles driven. The Hawaii Department of Transportation is directing communications and outreach on transportation revenue to over one million motorists that includes mock invoices featuring personalized information about motorists' road use, corresponding road charge, fuel taxes paid, and other fees. These simulated driving reports were sent beginning in 2019. In 2020, the Hawaii Department of Transportation conducted surveys of drivers to obtain feedback on potential tools for the system to inform development of technologies and reporting methods for a future pilot. The final report is expected in early 2022.

### **Minnesota Distance-Based Fees Pilot**



#### **DEPARTMENT OF TRANSPORTATION**

The Minnesota Department of Transportation is currently conducting a 12-month distance-based user fee demonstration to confirm the ability to collect travel data accurately and securely from shared mobility providers' vehicle fleets and connected and automated vehicles to assess a road charge for use of the roads.<sup>19</sup> More results are expected as the pilot concludes in 2021.

### **Washington State Road Usage Charge Assessment**



#### **Washington State Transportation Commission**

From February 2018 to January 2019, the Washington State Transportation Committee launched a 12-month road charge pilot. The pilot included over 2,000 Washington registered vehicles and a small pool of drivers from neighboring states of Oregon and Idaho, as well as the Canadian province of British Columbia, to test the ability to distribute revenues back to their source jurisdiction.<sup>20</sup> Participating vehicles included gasoline, hybrid, and electric-powered vehicles with 28 percent of participants residing in rural areas.

Study participants were required to complete surveys prior to, during, and following the conclusion of the pilot. Approximately 50 participants also participated in focus groups to assess acceptance of the system. This research showed that participation in the pilot increased user acceptance of the system, with 68 percent of respondents preferring (or feeling similar acceptance of) a road charge relative to the fuel tax. Only 19 percent of participants preferred the fuel tax as a funding mechanism following participation in the pilot. Furthermore, the number of participants who were neutral toward road charge at the beginning of the pilot dropped from 26 percent to 8 percent by the end of the pilot.

[17] Colorado RUCPP 2017. Colorado Department of Transportation, <https://www.codot.gov/programs/ruc/2017-rucpp>. Accessed Apr. 22, 2021.

[18] Hawaii Road Usage Charge Demonstration. Hawaii Department of Transportation, <https://hiruc.org/>. Accessed Apr. 22, 2021.

[19] Distance Based Fees. Minnesota Department of Transportation, <https://dbf.dot.state.mn.us/pilot>. Accessed Apr. 22, 2021.

[20] The Eastern Transportation Coalition. The Eastern Transportation Coalition, <https://tetcoalitionmbuf.org/>. Accessed Apr. 22, 2021.



### 1.5.4 Upcoming Road Charge Pilots

In March 2021, The U.S. Department of Transportation’s FHWA announced STSFA grant awards for states to continue exploration of road charging. The grant awardees (shown in **Table 2**) represent upcoming road charge pilot demonstrations that will advance complex road charging concepts and identify key lessons learned. An additional round of grants is expected in 2022, and the recently enacted federal infrastructure bill extends the STSFA program for another five years.

**TABLE 2. 2021 Surface Transportation System Funding Alternatives Grant Awardees**

STATE AGENCY	PILOT DESCRIPTION
California Department of Transportation (Caltrans)	Caltrans will test the viability of current global positioning system technology to determine which roads are part of a public network and may be subject to a fee.
Eastern Transportation Coalition	The pilot demonstration, conducted in conjunction with the Eastern Transportation Coalition, will demonstrate and test paths for road charging in the Washington D.C. metro area and seven states (Delaware, Maryland, Maine, North Carolina, New Jersey, Pennsylvania, and Virginia.)
Hawaii Department of Transportation	The pilot demonstration will investigate the current state and completeness of digital mapping data to determine which roads are part of a public network and may be subject to a fee.
Kansas and Minnesota Departments of Transportation	The joint pilot demonstration will explore the impacts of road charging implementation in the Midwest. The demonstration will focus on rural and agricultural populations, intrastate and interstate commercial freight, and supply chain operators.
Ohio Department of Transportation	The pilot demonstration will use data for a large-scale outreach program geared toward educating the public about road charging.
RUC America	RUC America will host a conference with the Federal Highway Administration and the National Conference of State Legislatures that will explore opportunities and barriers to interoperability, expand knowledge about RUC, and foster new partnerships.
Texas Department of Transportation	The pilot demonstration will assess the feasibility and technological capability of utilizing smartphone technology to understand travel patterns and development of an accounting framework.
Utah Department of Transportation	The pilot demonstration will develop and validate road charge-specific customer service improvements designed to enhance public acceptability and increase voluntary participation.





**Section 2**

# GENERAL OVERVIEW OF THE DEMONSTRATION

The Demonstration evaluated the feasibility of four emerging technologies in assessing a road charge, with the goal of identifying principles of easy user experience. The Demonstration project (timeline shown in Figure 1) began in 2019 with design and preparation activities, ran live operations in several regions across California from January 2021 through June 2021, was independently evaluated between August 2021 and January 2022, and was completed with the final report released summer 2022.

**FIGURE 1.** Demonstration Timeline



Throughout the Demonstration, technology partners collected travel data for vehicles and participants, processed the collected data into transactions, applied appropriate rates, credit fuel taxes, and calculated net road charges due. All charges were simulated during the Demonstration; no real monies were collected. The Demonstration had four phases:

**Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint** - The pay-at-the-pump and pay-at-the-chargepoint phase operated at fueling stations and electric vehicle charging stations throughout California. The Business Partners, GasBuddy and ChargePoint, collected mileage and fuel or charge data from participating vehicles, applied rates, and posted the net road charge transactions to participant accounts.

**Phase 2: Usage-Based Insurance** - Demonstrated how usage-based insurance companies could use existing systems and processes for managing usage-based insurance policies to manage road charge activities. The Business Partner Mile Auto, used participants' usage-based insurance mileage data to calculate the net road charge balance and provided simulated invoices to each participant based on the simulated road charge balance.

**Phase 3: Ridesharing** - Business Partner Via operated this phase through its wholly owned subsidiary, Nomad Transit. Via collected data for trips taken by participating riders through existing vehicle and Ridesharing technologies, processes, and systems. Participants who scheduled and took rides with Via received trip receipts with a simulated road charge line item.

**Phase 4: Autonomous Vehicles** - This phase evaluated the potential to integrate road charge with AV technologies in partnership with the Business Partner, EasyMile. EasyMile collected data from one of its autonomous shuttles operating in California and transmitted the data to Via, who processed the data, applied road charge rates, and calculated the simulated net road charge balance.

Each of the technologies deployed in the four phases was specifically chosen to address emerging trends in transportation technologies and business models. The Demonstration was designed to comply with and meet the required objectives of the STSFA funding used to fund the project.

## 2.1 Demonstration Vision, Goals, and Objectives

The Demonstration was required to meet federal objectives set by the STSFA program. Building on these objectives, Caltrans then created a vision and set of goals for the overall Demonstration and for each phase of the Demonstration.

### 2.1.1 Demonstration Objectives

#### *STSFA Objectives*

Given that the Demonstration was funded in part by the STSFA grant program, Caltrans was required to ensure that the Demonstration met the STSFA grant program objectives. Specifically, the language stated: "Per FHWA ([FAST Act § 6020(d)(2)]), the activities carried out under the STSFA grant project shall meet the following goals:

- ▶ Test the design, acceptance, and implementation of user-based alternative-revenue mechanisms.
- ▶ Improve the functionality of such user-based alternative-revenue mechanisms.
- ▶ Conduct outreach to increase public awareness regarding the need for alternative funding sources for surface transportation programs and to provide information on possible approaches.
- ▶ Provide recommendations regarding adoption and implementation of user-based alternative-revenue mechanisms.
- ▶ Minimize the cost of any potential user-based alternative-revenue mechanisms.
- ▶ To minimize the administrative costs associated with the collection of fees.

The demonstration must address implementation, interoperability, public acceptance, and other adoption issues; protection of personal privacy; the use of vendors to collect fees and operate the mechanism; market-based congestion mitigation impacts; equity concerns; ease of compliance; and the reliability and security of technologies used. The demonstration may also address the flexibility and choices available for user payments; administrative costs; and the ability to audit and enforce compliance. With these requirements, Caltrans developed a set of vision statements and goals for the overall Demonstration and for each of the four phases.”

## 2.1.2 Demonstration Vision and Goals

Caltrans, through their STSFA grant applications for Fiscal Years 2016, 2017, and 2018, identified key visions and goals for the overarching road charge program, as well as each of the four phased technology platforms.

### **Overarching Road Charge Demonstration Vision and Goals**

- ▶ Address implementation, interoperability, public acceptance, and potential hurdles to further explore the adoption of a demonstrated user-based alternative-revenue mechanism.
- ▶ Incorporate measures to support privacy protection, including governance and accountability provisions exploring model protection provisions that comply with the California Consumer Privacy Act of 2018.
- ▶ Use independent and private third-party vendors.

- ▶ Consider how road charge may impact congestion mitigation on a limited scale, using available technologies that support location data collection.
- ▶ Explore and analyze equity concerns (including impacts on differing income groups, various geographic areas, and relative burdens on rural and urban drivers) to promote equitable distribution across the population.
- ▶ Test mileage reporting methods that promote ease of user compliance and shift a considerable amount of responsibility for compliance to the end-user and the Business Partners.
- ▶ Enlist technology that uses and promotes reliability and security, including stringent data security measures such as: authentication, authorization, data modification notification, data masking, encryption, data storage, data transmittal, data destruction, general IT network security, and third-party data security system verification.
- ▶ Provide users the choice of mileage reporting methods, manual and automated technologies, as well as different types of Business Partners.
- ▶ Examine the system, administrative, and organizational cost of administering the system, evaluating each mileage reporting method and estimating the costs associated with implementing a statewide system.
- ▶ Perform limited auditing and identifying areas for system improvements.



**Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint, Vision and Goals**

**Vision:** Motorists currently pay fuel taxes by paying at the pump, albeit indirectly. Drivers are familiar with paying for gasoline at fueling stations, and many are familiar with the concept of fuel tax, even if they know little about how much it is or how the revenues are used. Can we recreate this easy user experience?

- ▶ **Goal 1:** Develop a method for paying the road charge at fueling stations or chargepoints by communicating mileage driven from the vehicle or device to the infrastructure.
- ▶ **Goal 2:** Select technologically and economically viable pay-at-the-pump and pay-at-the-chargepoint alternative(s) that provide a similar user experience as the current fuels tax collection for further development.
- ▶ **Goal 3:** Demonstrate the effectiveness of the software or applications to support a pay-at-the-pump/pay-at-the-chargepoint alternative(s).
- ▶ **Goal 4:** Deploy new software or application(s) in a live pilot.

**Phase 2: Usage-Based Insurance, Vision and Goals**

**Vision:** Can vehicle insurance companies can act as commercial Business Partners for a road charge in a cost-effective, non-invasive, and mutually beneficial alternative to the fuels tax? Does this partnership create an easy user experience?

- ▶ **Goal 1:** Demonstrate the feasibility of auto insurance companies (those currently using usage-based insurance) acting as Business Partners in the collection of a road charge.
- ▶ **Goal 2:** Assess the cost effectiveness of auto insurance companies (those currently using usage-based insurance) acting as Business Partners in the collection of a road charge.
- ▶ **Goal 3:** Build partner and public awareness of this type of road charge model.

**Phase 3: Ridesharing, Vision and Goals**

**Vision:** Can sophisticated fleet management and fare-charging systems at ridesharing companies make the addition of a road charge simple, effective, and efficient? Does this create an easy user experience?

- ▶ **Goal 1:** Demonstrate the feasibility of collecting a road charge through ridesharing.
- ▶ **Goal 2:** Assess the cost effectiveness of collecting a road charge through ridesharing.
- ▶ **Goal 3:** Build partner and public awareness of this type of road charge model.

**Phase 4: Autonomous Vehicles, Vision and Goals**

**Vision:** Applying a road charge to AVs is feasible and straightforward due to onboard vehicle technology. AVs provide a method of phasing in a road charge over time as this market segment grows.

- ▶ **Goal 1:** Identify road charge opportunities that stem from AV usage of California roadways.
- ▶ **Goal 2:** Build partner and public awareness of this type of road charge model.

With these vision and goals, Caltrans designed and prepared for Demonstration activities.

## 2.2 Demonstration Stakeholders

Several types of stakeholders held specific roles and responsibilities throughout the Demonstration to ensure its successful completion. The types of stakeholders included:

- ▶ Demonstration Owners
- ▶ TAC
- ▶ Demonstration Technical Team
- ▶ Business partners and Technology Providers
- ▶ Participants

Within each of these stakeholder types were individual stakeholders with specific roles.

## 2.2.1 Demonstration Owners



U.S. Department  
of Transportation

**Federal Highway  
Administration**

**Federal Highway Administration (FHWA):** The FHWA administers the STSFA grant program, which funded 50 percent of the Demonstration. The FHWA's Office of Operations oversees each of the road charge demonstrations funded by STSFA across the United States, including the Demonstration. The FHWA and their team of independent evaluators were highly interested in the outcomes of this Demonstration, the lessons learned that could be applied to other states, how this model could be deployed on a larger scale, and how road charge is progressing at the state and federal level as an alternative funding mechanism for the nation's transportation network.



**California State Transportation Agency (CalSTA):** CalSTA is a cabinet-level agency focused on transportation-related initiatives in the state. CalSTA oversees the operations of several transportation-related entities in California including Caltrans and the Department of Motor Vehicles. As established in SB 1077, CalSTA is also responsible for studying road charge alternatives, gathering public comment on road charge, and making road charge recommendations. CalSTA engaged in the road charge program to set the program's direction and worked with the CTC and Caltrans to advance road charge activities.



**California Department of Transportation (Caltrans):** Caltrans is the lead department responsible for the success of the program. Caltrans advanced the vision, goals, and objectives of the road charge Demonstration concept. Caltrans was ultimately responsible for the success of the Demonstration by overseeing and guiding every component of the Demonstration, including design, development, implementation, operations, and evaluation. Caltrans also served as the point of contact for legislators, other California state agencies, the road charge TAC, and the FHWA.

## 2.2.2 Technical Advisory Committee



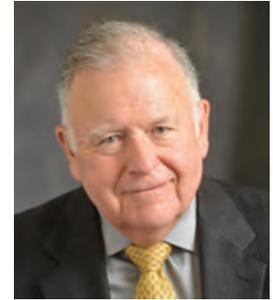
California  
**Transportation  
Commission**

**California Transportation Commission (CTC):** The CTC is responsible for programming and allocating funds for the construction of highway, passenger rail, transit, and active transportation improvements throughout California. The CTC also advises and assists the secretary of CalSTA and the Legislature in formulating and evaluating state policies and plans for California's transportation programs. The CTC also operate the Road Charge TAC, which provides advice on policy considerations on road charge issues.

The California Road Charge Technical Advisory Committee is a 15-member committee, created by SB 1077, to explore alternatives to the fuels tax and provide design recommendations and evaluation criteria for the 2017 Pilot. Membership is shown below in **Table 3.**<sup>21</sup> Throughout the Demonstration, Caltrans provided Demonstration status updates during the regularly scheduled TAC quarterly meetings. TAC members provided subject matter expertise and input on elements of the Demonstration on issues such as social equity, technology performance, and protection of participant privacy.

[21] <https://catc.ca.gov/committees/road-charge/>

In 2021, the California transportation industry lost one of its most valuable leaders and thinkers with the passing of Dr. Martin Wachs. Dr. Wachs served as a member of the California Road Charge TAC and, over his years of service, played an immense role in guiding road charge development in the state. Caltrans wishes to celebrate his extraordinary life of public service and his immeasurable contributions to the state of California. He will be greatly missed.



**TABLE 3. Road Charge Technical Advisory Committee Members**

NAME	ORGANIZATION	TITLE	AREA OF REPRESENTATION
Joseph Lyou (Chair)	California Transportation Commission	Commissioner	California Transportation Commission
Stephen Finnegan (Vice-Chair)	Automobile Club of Southern California	Manager of Government and Community Affairs	Highway User Groups
Laura Friedman	California Assembly	Assembly Member	Legislature
Eric Sauer	California Trucking Association	Chief Executive Officer	Highway User Groups
James Madaffer	Public Member		
Josh Newman	California Senate	Senator	Legislature
Lee Tien	Electronic Frontier Foundation	Senior Attorney	Privacy Rights Advocacy
Lisa Bartlett	Orange County	Supervisor	Regional Agency
Loren Kaye	Foundation for Commerce and Education	President	Business and Economy
Asha Agrawal	Sane Jose State University	Director, Mineta National Transportation Finance Center	Academic
Pam O'Connor	Public Member		Regional Agency
Axel Santana	PolicyLink	Associate	Social Equity
Robert Poythress	County of Madera	Supervisor, Madera County	Regional Agency
Stacy Atkins-Salazar	Private Member	Mayor, City of Arcata	Rural Communities
Terry Benzel	University of Southern California Information Sciences Institute	Director	Data Security and Privacy Industry

### 2.2.3 Demonstration Technical Team and System Administrators

The Demonstration Technical Team and System Administrators included organizations that actively managed and administered the Demonstration and associated systems and processes. As part of the Project Team, System Administrators oversaw the integration and administration of technology systems, established technical interfaces, conducted data queries on collected data, and provided expertise on how road charge technology systems needed to access the State of California–owned systems and technologies. A subgroup of the System Administrators was the Demonstration Technical Team who supported all technical design, development, testing, and operations for the Demonstration.



**WSP USA Inc. (WSP):** WSP was the lead for the Demonstration Technical Team and the System

Administrators responsible for supporting all technical design, development, testing, and operations for the Demonstration.

**Mercury. Mercury Public Affairs (Mercury):** Mercury

supported all communications activities including strategy, messaging development, and providing strategic consulting services as needed.



**EMC Research (EMC):** EMC supported and implemented the communications research activities including surveys, focus groups, and public opinion polling.



**Highlands Consulting Group (Highlands):** Highlands provided risk analysis, economic research, and performed the independent evaluation of the Demonstration.



**University of California, Berkeley Transportation Sustainability Research Center (UC Berkeley):** UC Berkeley supported the risk analysis, market research, and equity considerations for the Demonstration.

### 2.2.4 Business Partners and Technology Providers

The Business Partners and Technology Providers included organizations that provided hardware, systems, technologies, and services to operate the Demonstration. They provided data collection technologies and mechanisms to participants, supported the establishment, maintenance, and closeout of participant accounts; calculated road charge transactions; supported the collection of simulated road charges; and performed customer service activities as needed. The Business Partners also collected, aggregated, sanitized, retained, and transferred Demonstration data to repositories and other associated systems for further analysis and reporting. In each phase, the responsibilities of the Business Partners were to provide the necessary technologies and services to collect, calculate, assess, and report road charge during each phase. Additionally, Business Partners provided the technologies and services for a participant to view simulated road charged and simulate road charge payments, if required per the phase. Business partners included:



**GasBuddy:** GasBuddy was the Phase 1A:

Pay-at-the-Pump Business Partner responsible for providing all technologies and services necessary to implement Phase 1A of the Demonstration.



**ChargePoint:**

ChargePoint was the Phase 1B: Pay-at-the-Chargepoint Business Partner responsible for providing all technologies and services necessary to implement Phase 1B of the Demonstration.



**Danlaw:** BitBrew, a Danlaw company, provided the

plug-in devices to support Phase 1A and 1B of the Demonstration.



**Mile Auto:** Mile Auto was the Phase 2 Usage-Based Insurance Business Partner responsible for providing necessary technologies and services to implement Phase 2 of the Demonstration. For Phase 2: Usage-Based Insurance, Mile Auto operated under a simulated instance of their usage-based insurance





## Section 2. General Overview of the Demonstration

platform as Road Charge Simulated UBI to provide simulated usage-based insurance offerings for the Demonstration.



**Nomad Transit (Via):** Via was the Phase 3: Ridesharing Business Partner responsible for providing all technologies and services necessary to implement Phase 3 of the Demonstration for Ridesharing Participants. For Phase 3: Ridesharing services, Via operated under its wholly owned subsidiary, Nomad Transit, for West Sacramento ridesharing services. Via also supported Phase 4 of the Demonstration by providing the technologies and services necessary to calculate and simulate road charge for the data collected from the AV Business Partner.



**EasyMile:** EasyMile was the Phase 4: Autonomous Vehicle Business Partner responsible for providing necessary AV technologies to implement Phase 4 of the Demonstration, which included the operation of an AV. EasyMile was supported by Via who provided backend systems and technologies to process data collected from the AVs.



**Snowflake:** Snowflake provided cloud-based data warehouse and data integration services throughout the Demonstration.

### 2.2.5 Participants

Participants were the individuals who participated in the Demonstration either by owning a vehicle used in the Demonstration or by being an active customer of one of the Business Partners involved in one of the four Demonstration phases. Participants were required to complete surveys throughout the Demonstration to provide insight on their experience with the Demonstration and their overall attitudes toward road charge. As part of the Demonstration, participants created an account with a Business Partner, accessed Business Partner systems, engaged in services, and reviewed simulated road charges. Each phase had a unique goal for the total number of participants per phase:



Further detail on the pilot participants can be found in Section 4: Demonstration Operations.

Additional descriptions of Demonstration stakeholders beyond those described above can be found in the Concept of Operations located in Appendix B.



### Section 3

# DEMONSTRATION DESIGN AND PREPARATION

With their vision, goals, and objectives set, Caltrans directed the Demonstration Technical Team to create the technology systems required to implement the Demonstration. The Demonstration Technical Team first developed system requirements followed by the actual technological systems. Technology systems then ran through testing and a security audit to validate acceptance for use in the live Demonstration.

Demonstration design and preparation occurred from January 2020 through January 2021. Activities included procuring road charge technology and services, system development and testing, and participant recruitment. Additional project activities included communications research, risk management, and state and federal reporting.



## 3.1 Procuring Road Charge Technology and Services

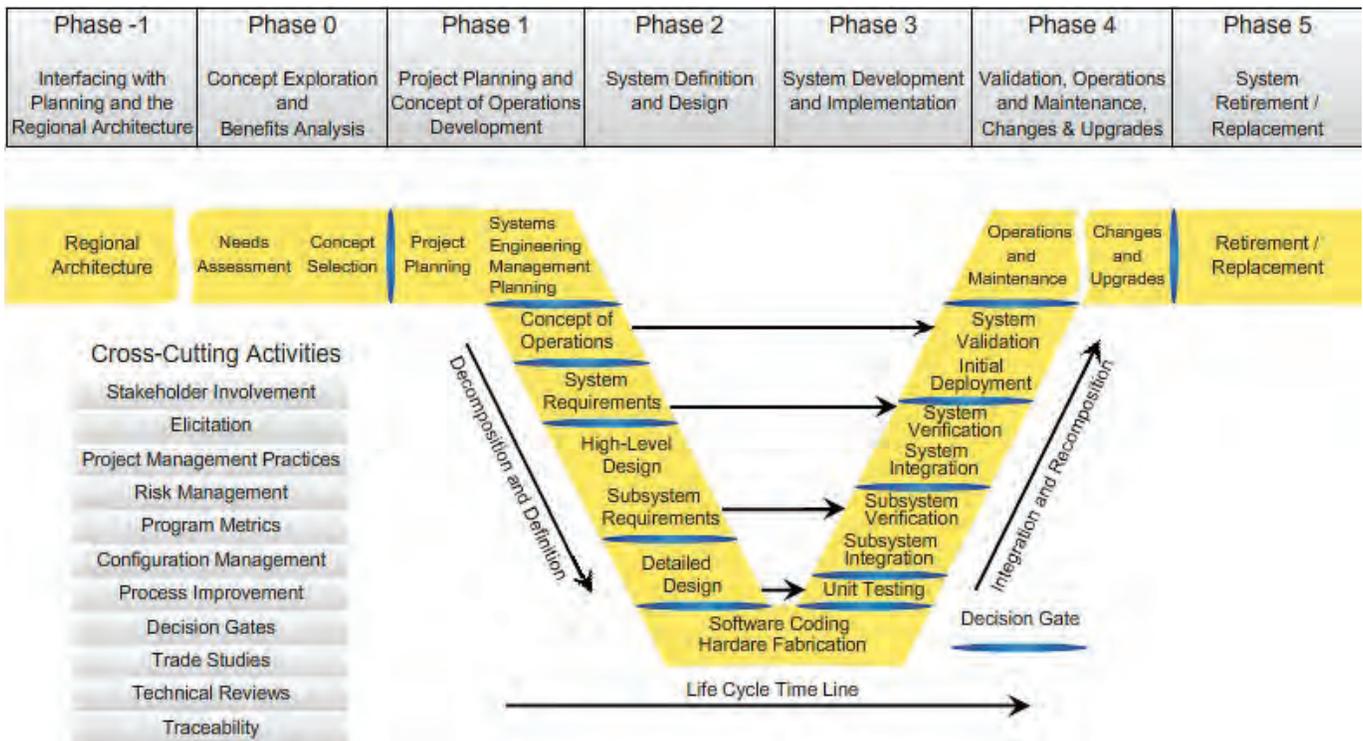
Once Caltrans had defined the Demonstration vision, goals, and objectives, the agency moved to contract with Business Partners and Technology Service Providers to further develop and implement the Demonstration.

Note that before the Demonstration began, one Business Partner left the Demonstration team and had to be replaced with a new Business Partner. The Demonstration Technical Team adjusted the Demonstration's operational concept as necessary to accommodate the new Business Partner's business model.

## 3.2 System Design

In alignment with the Demonstration vision, goals, and objectives, the Demonstration Technical Team began the design of the Demonstration system and processes. The design followed the FHWA Intelligent Transportation Systems Engineering "V" Diagram planning approach shown in **Figure 2**.

**FIGURE 2.** Systems Engineering V-Diagram



Throughout this approach, the Demonstration Technical Team created the following documents as required by the approach to define the Demonstration:

- ▶ **Concept of Operations:** Provided Demonstration needs and objectives, stakeholders, roles, and responsibilities, and the operational and administrative scenarios for the Demonstration.
- ▶ **High-Level Functional Architecture:** Defined key elements and functions of the system from a business perspective.
- ▶ **System Architecture Diagrams for each Demonstration Phase:** Detailed the functionality within each subsystem's components and how data flows through the system.
- ▶ **System Requirements Specifications:** Defined the system and technical requirements for the Demonstration, as well as requirements for each subsystem, its components, and their functions.
- ▶ **Business Requirements Document:** Defined the business and operational requirements for the Demonstration.
- ▶ **Interface Control Document:** Defined how subsystems communicate with one another, including communications protocols, data fields, format, and frequency.
- ▶ **Implementation Plan:** Described the key tasks associated with system preparations ahead of Demonstration deployment.
- ▶ **Customer Support Plan:** Defined the processes associated with communications to support participants.
- ▶ **Test Plans:** Outlined the methodology and strategy used for evaluating all systems, processes, and interfaces needed to operate the Demonstration, to ensure alignment with requirements.
- ▶ **Verification Cross Reference Index:** Also known as the requirements traceability matrix, this is the template for tracking system verification and expectations for how each requirement should/could be validated for compliance.

## 3.3 System Development

In system development, the Demonstration Technical Team defined Demonstration needs, functional and system architecture, and its major components in collaboration with Caltrans, System Administrators, and the phase-specific Business Partners and Technology Providers.

### 3.3.1 Demonstration Needs

The Demonstration Technical Team developed a set of needs for each Demonstration stakeholder to govern how the system was designed; how participants, System Administrators, Business Partners, and Caltrans accessed the system; and how the system was deployed and operated.

#### System Needs

The road charge system was designed and implemented as a scalable, flexible, and innovative platform that supported the Demonstration goals and objectives. The system was designed to be:

- ▶ **Flexible:** Standards-based approach where relevant data was collected and processed without using proprietary protocols, creating a technology and vendor agnostic platform.
- ▶ **Accurate:** Travel data and calculations were verifiably accurate to confirm quality of data, prevent fraud, and support confidence in the system.
- ▶ **Reliable:** Systems and networks were consistently available and functioning properly to support the Demonstration.
- ▶ **Secure:** Systems and networks were safeguarded against unauthorized access to or dissemination of data.
- ▶ **Efficient:** Existing systems and technologies were leveraged to reduce the burden to the state, private sector partners, and participants.
- ▶ **Scalable:** Open system design accommodated evolving private sector partners, business models, and technologies used to support road charge assessment, and the potential to expand to additional jurisdictions.

#### State Needs

The State of California required the Demonstration not only prove the technological feasibility of the four phases but also prove the programmatic feasibility of administering a larger version of the program in the future. With this in mind, State needs were determined to include:

- ▶ Public outreach and education
- ▶ Cost effective to administer and manage
- ▶ Collaboration to improve cost effectiveness and public acceptance
- ▶ Enforceable
- ▶ Auditable

#### Participant Needs

Given that the success of road charge programs depended on participant acceptance of the program and their experience with the Demonstration itself, a set of needs were developed for participants. Each Participant needed the Demonstration to:

- ▶ Be understandable
- ▶ Be easy to use
- ▶ Offer choice
- ▶ Be transparent

#### Business Partner Needs

Each Business Partner had common and unique needs. At a high level, Business Partner needs required that the system:

- ▶ Be easily integrated with existing systems
- ▶ Be non-intrusive to current operations
- ▶ Provide improved collaboration with the state
- ▶ Be market-driven

A detailed description of these needs can be found in the Concept of Operations in Appendix B.

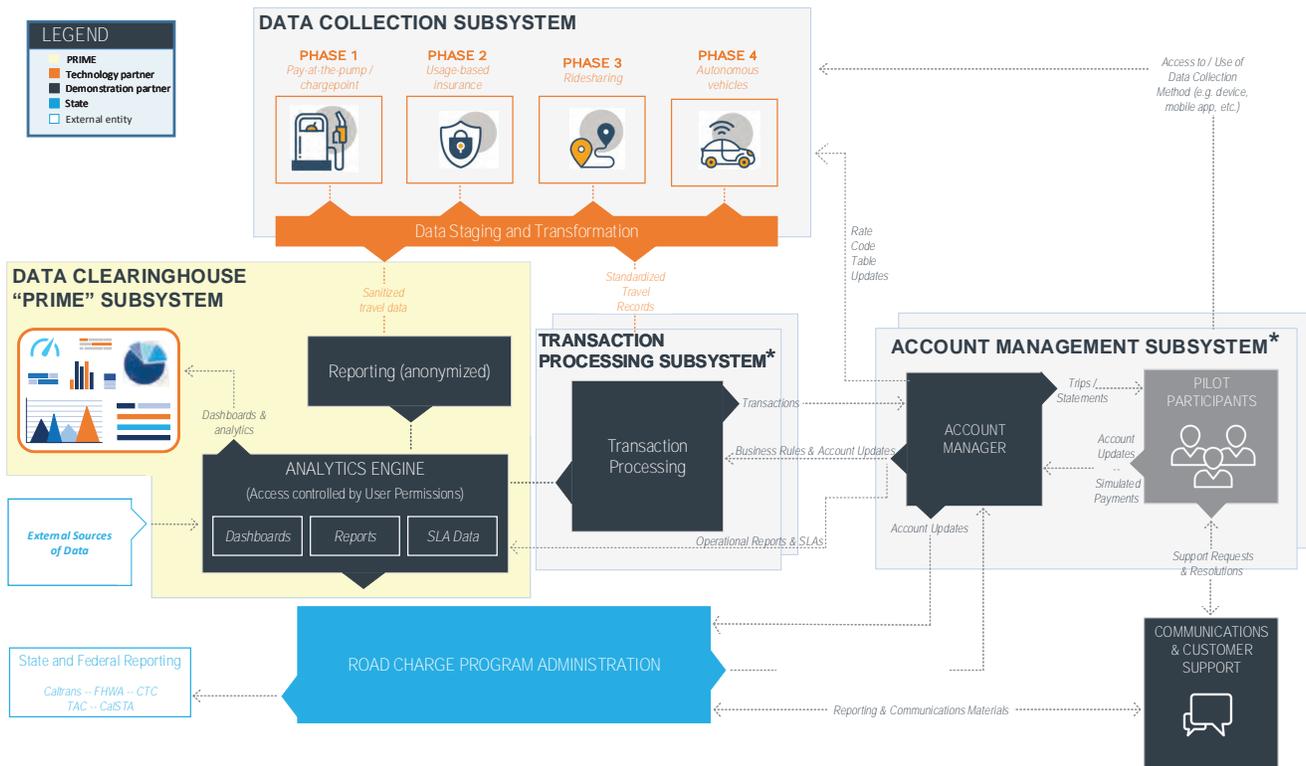


### 3.3.2 Demonstration Functional Architecture

At its core, the Demonstration was a technical feasibility study of how road charge could be assessed through four emerging transportation technologies and trends in four phases: **Phase 1A:** Pay-at-the-Pump and **Phase 1B:** Pay-at-the-Chargepoint; **Phase 2:** Usage-Based Insurance; **Phase 3:** Ridesharing; and **Phase 4:** Autonomous Vehicles.

In each phase, Business Partners collected travel data for vehicles and participants, processed the collected data into transactions, applied appropriate rates, credited fuel taxes, and calculated net road charges due. All charges were simulated with no real monies collected from participants. To enable the overall Demonstration and each phase, the overarching Demonstration Functional Architecture shown in **Figure 3** was developed.

**FIGURE 3.** The Demonstration Functional Architecture



\* Each phase has a separate Transaction Processing and Account Management subsystem instance

The overarching functional architecture was divided into logical groupings of systems and functions called subsystems. The system included five subsystems: Data Collection, Transaction Processing, Account Management, Administration, and Data Clearinghouse (Platform for Road charge Innovation and Mobility Evolution [PRIME]). Each of these subsystems performed a series of functions to enable and support the Demonstration. Subsystem communications were standardized per the Interface Control Document found in the Appendix G. Each subsystem is briefly described below.

- ▶ **Data Collection Subsystem:** This subsystem interfaced with Demonstration vehicles to collect vehicle and travel data such as vehicle unique identifier, data/time, mileage, fuel consumption, and location. This data was then sent to the Transaction Processing Subsystem. There were four forms of data collection demonstrated for the Demonstration:
  - **Phase 1A: Pay-at-the-Pump and 1B: Pay-at-the-Chargepoint** used vehicle telematics to report mileage and relayed trip data through an aftermarket plug-in device that collected data from a vehicle’s computer area network bus.

- **Phase 2: Usage-Based Insurance** used changes in odometer readings to calculate miles traveled provided through uploading odometer pictures to a secure portal.
- **Phase 3: Ridesharing** leveraged proprietary mobile apps to collect mileage and related trip data.
- **Phase 4: Autonomous Vehicles** used existing AV technologies (telematics, sensors, etc.) within the vehicle to report the number of miles traveled and related trip data.

▶ **Transaction Processing Subsystem:** Using the data transmitted by the Data Collection Subsystem, the Transaction Processing Subsystem calculated and summarized the road charge, credited paid fuel taxes based on the number of gallons consumed, and routed the calculated road charge to the Account Management Subsystem.

▶ **Account Management Subsystem:** The Account Management Subsystem received transactions transmitted by the Transaction Processing Subsystem and posted the transactions to the appropriate participant's account. The subsystem also maintained participant account information, handled Tier 2 customer service, and coordinated with the Administration Subsystem to manage communications with participants.

The subsystem enabled participants to interact via web portals, mobile apps, and customer support services (web forms, email, call centers).

▶ **Administration Subsystem:** This subsystem provided an interface for stakeholders managing the Demonstration to access Demonstration information, results, and reports. Functions included certifying Business Partner compliance with requirements, verifying participant eligibility, setting per-mile rates, managing business rules, and accessing PRIME to view dashboards of the Demonstration data collected.

▶ **Data Clearinghouse (PRIME) Subsystem:** The Data Clearinghouse Subsystem was the central data repository for collecting all sanitized Demonstration data. It consisted of a central database structured to allow secure upload and transfer of Demonstration data. The subsystem also housed the PRIME analytics engine which provided analytics and informational dashboards on the Demonstration, the simulated road charge revenues, and other transportation-related metrics. Business partners for each phase transmitted sanitized, raw, and aggregated travel data from participating vehicles and accounts to PRIME. PRIME then processed the incoming data for each phase into the appropriate data storage buckets. Access to the Data Clearinghouse was controlled through secure protocols to prevent unauthorized access.

A full description of each subsystem along with supporting materials can be found in Appendix B.

### 3.3.3 Demonstration Requirements

Building on the overarching Demonstration needs, the Demonstration Technical Team developed two sets of requirements that the systems and processes used for the Demonstration would have to meet. The requirements detail what the system must do and how the system is expected to meet those needs. The requirements included two categories: (1) System Requirements and (2) Business Requirements.

#### **System Requirements**

The "system" included all subsystems, components, and functions of all parties providing systems, services, and processes needed to successfully operate the Demonstration. System requirements were documented in the System Requirements Specification, and defined specific requirements for each subsystem, component, and function, and support system, as well as operational performance. Overarching system specifications for system requirements are listed as follows:



- ▶ **Security:** Systems and networks are safeguarded against unauthorized access to and/or dissemination of data.
- ▶ **Data Privacy Protection:** The system will keep private the personally identifiable information (PII) of participants (such as registration address or travel behavior), private sector partner proprietary information (or data that could be used to derive trade secrets, proprietary algorithms, etc.), and potential state information that requires protection from public disclosure.
- ▶ **Reliability and Availability:** Travel data and calculations are verifiably accurate to confirm quality of data, prevent fraud, and support confidence in the system. Systems and networks are consistently available and functioning properly to support the Demonstration.
- ▶ **Auditability:** Demonstration data will be retained for the duration of the Demonstration to support auditing functions and will be purged following the Demonstration to reduce potential infringement on data privacy.
- ▶ **Safe and Reliable Operations:** Systems and technologies used for the Demonstration will not compromise the safety of vehicles, drivers, passengers, or operators. Systems and processes will not negatively impact normal business operations.

System requirements applied to all aspects of the Demonstration system and had to meet or exceed industry standards and applicable federal and state laws.

### **Business Requirements**

Business Requirements included several key activities the Business Partners were expected to perform to provide services and support for the Demonstration. The business requirements were documented in the Business Requirements Document, and included the following activities:

- ▶ Terms and conditions
- ▶ Enrollment and onboarding
- ▶ Account management
- ▶ Account closures
- ▶ Customer service
- ▶ Billing and payments
- ▶ Reporting

The complete list of system and business requirements can be found in the System Requirements Specifications (Appendix D) and Business Requirements Document (Appendix E).

### **3.3.4 Demonstration Phase Flows**

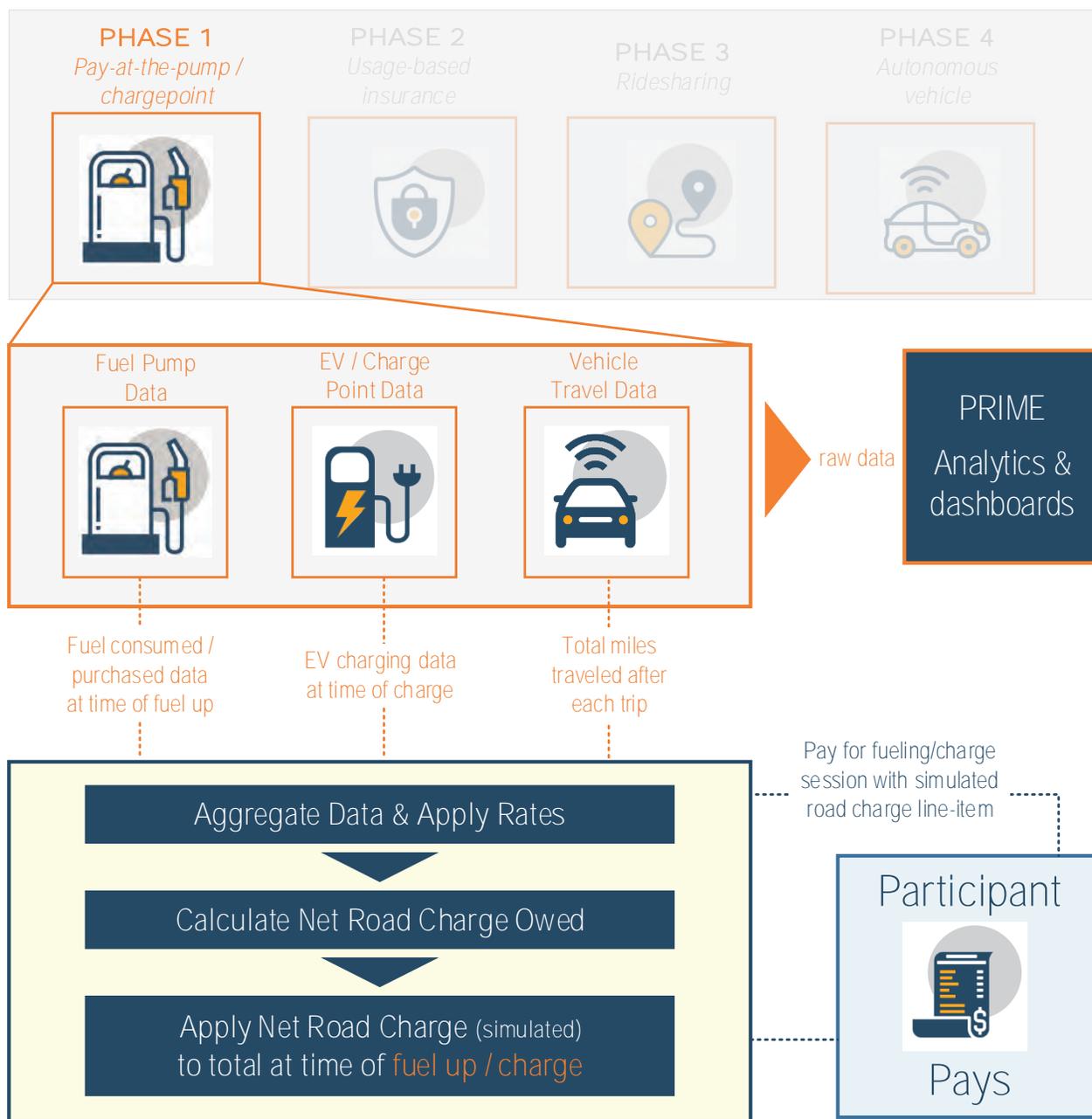
To support the Demonstration architecture and requirements, the Demonstration Technical Team developed a phase flow for each phase to further detail technological Demonstration operations.

#### **Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint**

Participant vehicles were outfitted with data collection technology and mobile apps to collect the necessary road charge data. When a vehicle visited a specific fuel pump or chargepoint and initiated a fuel purchase or

battery charge, the session data collected from the data collector was transmitted to the pay-at-the-pump and pay-at-the-chargepoint Transaction Processor. The Transaction Processor received the collected mileage data via the plug-in device, assessed the per-mile rate to the chargeable miles, calculated the assessed road charge, and credited any state motor fuel taxes based on fuel consumption. A notification was sent to the participant on the road charge due either via a phone notification and/or email. The pay-at-the-pump and pay-at-the-chargepoint Business Partners also collected and aggregated these individual transactions for monthly reporting to the Administration Subsystem. Additional data beyond that required for road charge, such as electric vehicle battery state-of-charge or fuel pricing trends or locations, was also collected and transmitted to the Data Clearinghouse Subsystem for analysis using the PRIME analytics engine. See **Figure 4** for a functional diagram for the pay-at-the-pump and pay-at-the-chargepoint phases of the Demonstration.

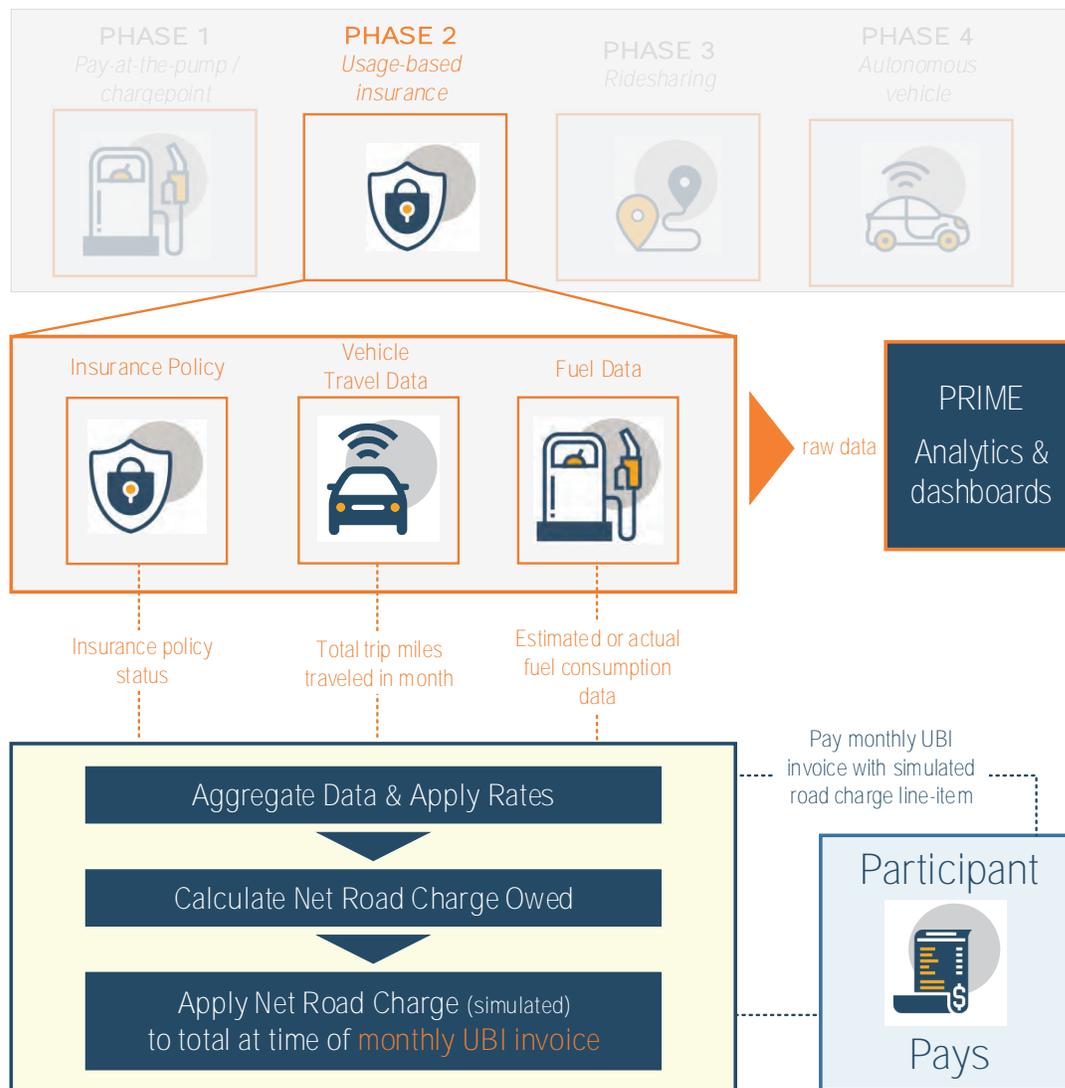
**FIGURE 4.** Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint Demonstration Phase Flow



**Phase 2: Usage-Based Insurance**

In Phase 2, participants completed an online enrollment process, where they provided their vehicle identification number, which is used to determine vehicle specific information (e.g., make, model, year, trim package), and a picture of their participating vehicle's odometer. On a monthly basis, participants received a notification from the usage-based insurance provider asking them to take and upload a new picture of their odometer to the usage-based insurance provider's secure website via a texted link. Uploaded pictures were then transmitted to the Usage-Based Insurance Business Partner's transaction processing portal. Once that picture was received, the Transaction Processor Subsystem calculated the difference in odometer readings from the most recent picture to the previously uploaded picture. The calculated difference was then used to determine the overall road charge to be assessed based on miles traveled. Fuel tax credits were calculated using the U.S. Environmental Protection Agency (EPA) mpg rating estimates for the vehicle make, model, year, and trim package that were determined during enrollment. An invoice for the simulated road charge due was then presented to the participants via email from the Account Management Subsystem. This mileage and road charge information was also provided to the Administration Subsystem for monthly reporting, and to the Data Clearinghouse Subsystem for further analysis by the PRIME analytics engine. **Figure 5** provides a functional diagram for the Usage-Based Insurance Phase of the Demonstration.

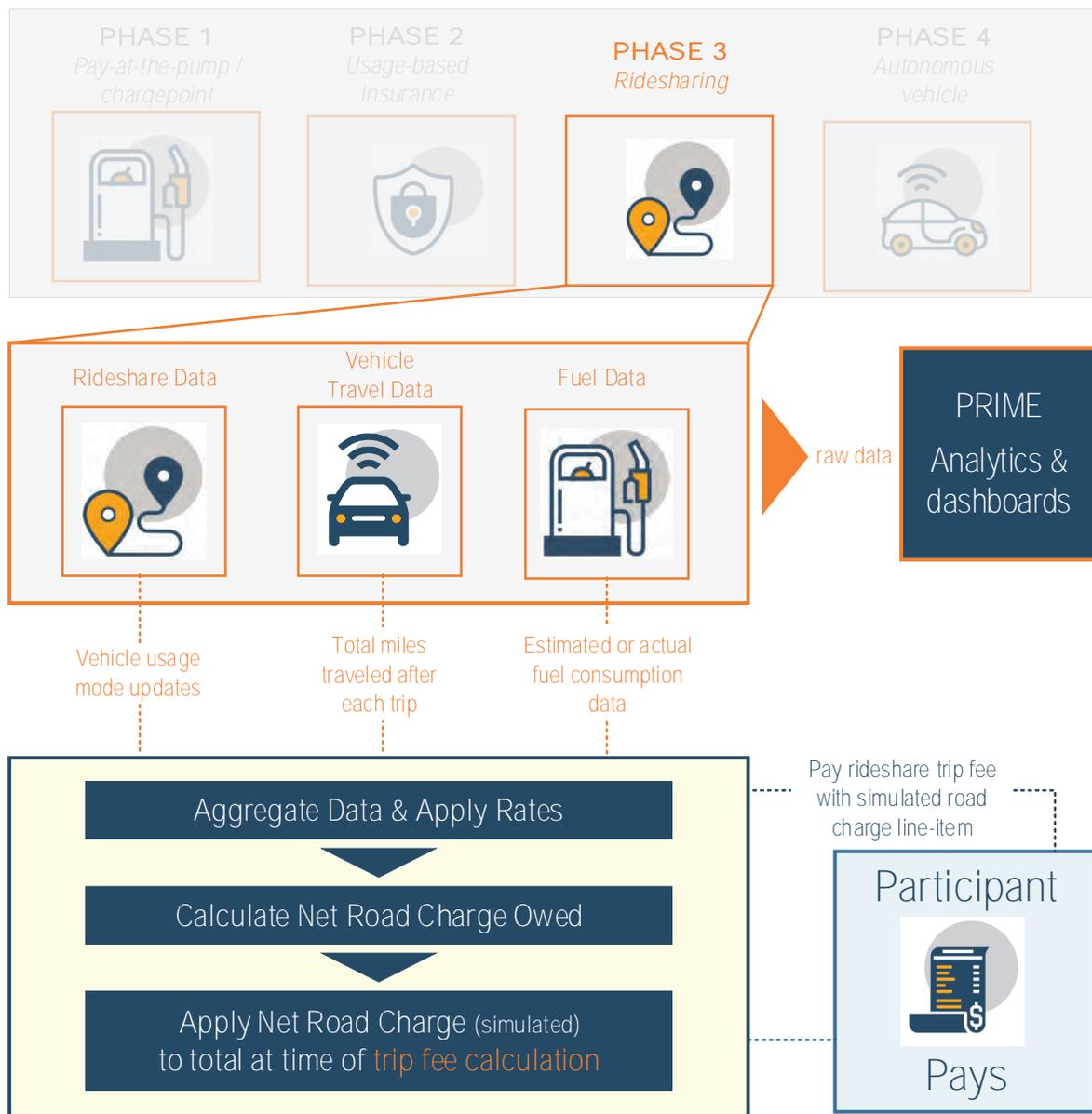
**FIGURE 5.** Usage-Based Insurance Demonstration Phase Flow



### Phase 3: Ridesharing

The Ridesharing Phase collected road charge data using technology already incorporated into real-time ride hailing applications used by the Ridesharing Business Partner. Participants registered with the Ridesharing Business Partner and downloaded the appropriate mobile app. Periodically during the phase, participants summoned a ride with the Ridesharing Business Partner using the app. During the trip, Via rider and driver mobile app technology within the vehicle logged the mileage, fuel consumption, and location for the trip, and uploaded that data to the Transaction Processing Subsystem. The Transaction Processing Subsystem then calculated the road charge based on the miles traveled, credited any applicable fuel taxes, and presented the simulated road charge due to the participant via email. The Ridesharing Business Partner also aggregated these individual transactions for monthly reporting to the Administration Subsystem. Additional information was also be uploaded to the Data Clearinghouse for reporting and analysis by PRIME. The Ridesharing Phase functional diagram is shown in **Figure 6**.

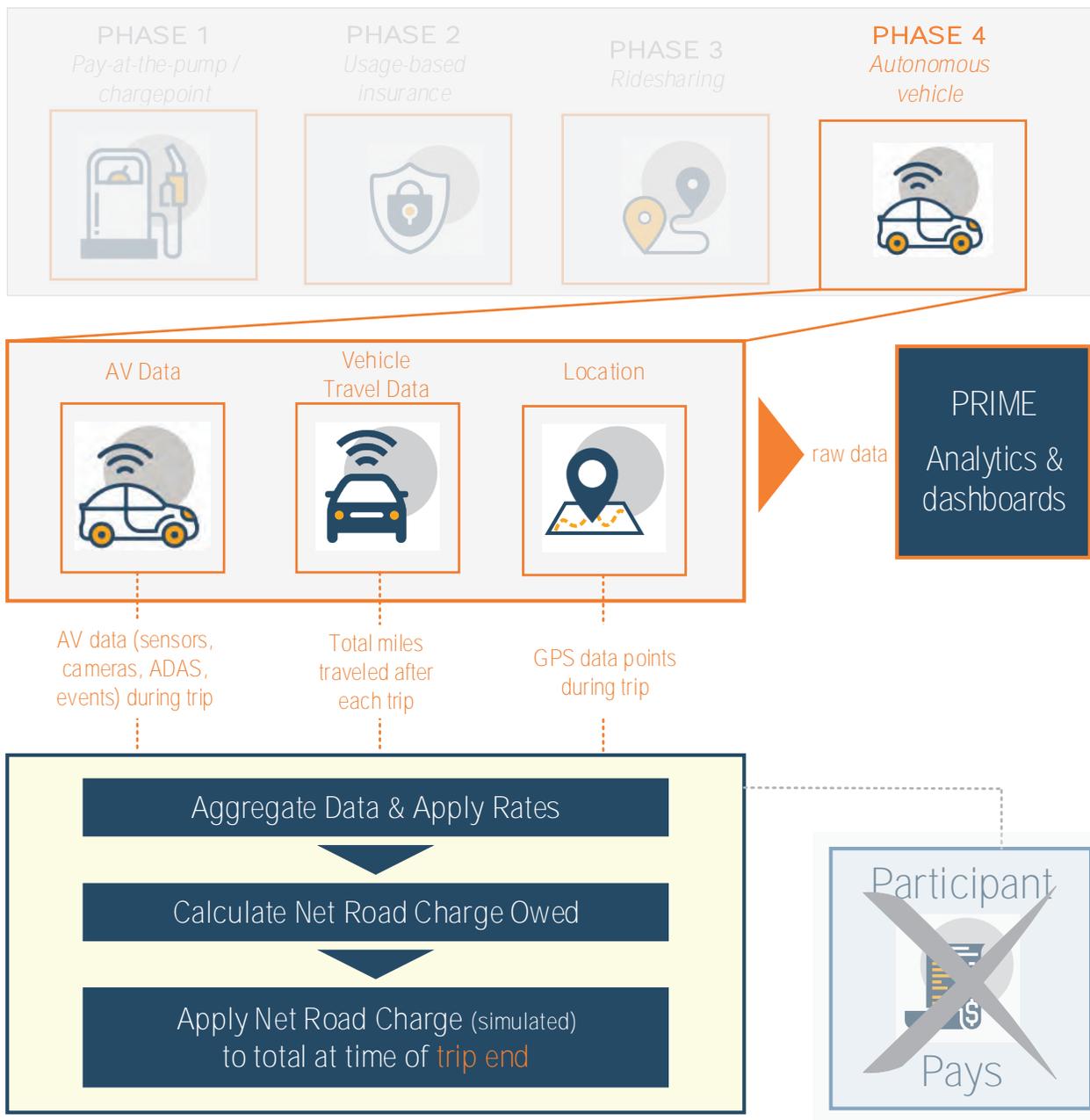
**FIGURE 6.** Ridesharing Demonstration Phase Flow



**Phase 4: Autonomous Vehicles**

The AV phase demonstrated how road charge data can be collected, reported, and assessed from an AV. No participants were involved in Phase 4. The AV traveled on a fixed route on a prescribed schedule, and the onboard technology within the AVs collected mileage, location, charge information (participating AVs were fully electric), and other vehicle-related data from onboard AV systems. The collected data was transmitted to the Business Partner's Data Collection, Transaction Processor, and Account Management Subsystems for integration, processing, and reporting. Once completed, a mock road charge invoice was provided via the Account Management Subsystem using the same methods identified in Phase 3. AV data was also transmitted to the Data Clearinghouse Subsystem for further analytics. **Figure 7** shows the functional diagram for the AV phase of the Demonstration.

**FIGURE 7.** Autonomous Vehicles Demonstration Phase Flow



### 3.4 System Testing

All systems, technologies, and processes used to implement the Demonstration were tested prior to live operations. Testing was completed in stages, with the successful completion of one stage serving as the entrance criteria for the next. **Table 4** describes each testing stage, what it proves in the testing process, and the inputs, outputs, and duration of each testing phase in preparation to launch the Demonstration. More information on the testing methodology, strategy, plan, and cases used to verify system and operational functionality prior to Demonstration launch can be found in the Test Plan, included in Appendix H.

**TABLE 4. System Testing Overview**

TESTING STAGE	UNIT TESTING	INTEGRATION TESTING	ACCEPTANCE TESTING	DRY RUN
<b>Description</b>	Detailed testing of each component to ensure the component meets all requirements	Validation that components work together and communicate with each other and the system	Brief end-to-end verification of the Demonstration system	Full end-to-end system dry run in a real-world scenario
<b>What it proves</b>	Each individual system, technology, and process meets its respective requirements	Systems can talk to each other in the right format	Systems and processes work together as expected	All systems and processes are ready to launch into operations
<b>Who Does What</b>	Business Partner produces materials; Project Team reviews/validates	Business Partner initiates message transmissions; System validates; Project Team confirms results	Business Partner operates systems and processes; Project Team acts as testers and validators	Business Partner operates systems and processes; Project Team acts as testers and validators
<b>Inputs</b>	Test procedures and test results; policies, processes, procedures, manuals, specification sheets, etc.	System messages and packets (in XML, JSON, or other related formats) sent to appropriate system interface (e.g., an API)	Small group of testers walk through end-to-end process to verify each step functions as expected, and moving from step to step occurs as expected	Large group of testers interact with the system as if it were operational—enroll, participate, report, communicate Testers also try to 'break' the system to find gaps/issues
<b>Outputs</b>	Requirements Traceability Matrix, with test results for every requirement	Pass/fail system responses for format, data, and business rule validations	Simulated enrollment, operations, invoices/statements, customer support, etc. that meet expectations and requirements	Actual enrollment, operations, invoices/statements, customer support, etc. that meet expectations and requirements
<b>Duration</b>	1–2 months	1–3 days	3–5 days	2 weeks + regression testing as needed

### 3.4.1 Test Results

The results of testing and validating compliance for each Business Partner are documented below. Requirement compliance for each testing stage is documented in the “Test Results” tables, with requirements compliance status as follows:

- ▶ **Total:** Total number of business and system requirements the Business Partner must confirm compliance status for.
- ▶ **Compliant:** Business partner successfully proved compliance with the requirement, through testing, demonstration, documentation, or inspection.
- ▶ **Non-Compliant:** Business partner proved noncompliance with the requirement, through testing, demonstration, documentation, or inspection. A requirement is deemed noncompliant when there is positive confirmation that the Business Partner has implemented a solution in a manner that cannot comply with the requirement (e.g., Requirement states “Demonstration data shall be encrypted in-transit with AES 256-bit encryption or stronger”; Business Partner confirms they do not encrypt data in-transit and do not plan to do so).
- ▶ **Not Applicable:** A requirement may be considered not applicable because it does not apply to the Business Partner’s service offering or technology (e.g., an electric vehicle chargepoint provider does not need to meet requirements related to capturing fuel consumption, since Phase 1B is for all-electric vehicles that do not consume any fuel). Additional information on why some requirements were considered not applicable for a Business Partner for each respective testing stage is also documented below.

A detailed description of test results can be found in the Vendor Testing Results Report and End-to-End Dry Run Results Report in Appendix I.

#### **Phase 1A: Pay-at-the-Pump – GasBuddy**

The results of each stage of testing for GasBuddy are shown in **Table 5**.

**TABLE 5. Phase 1A, GasBuddy Test Results**

TESTING STAGE	TOTAL	COMPLIANT	NON-COMPLIANT	NOT APPLICABLE
Unit Testing	209	134	0	75
Integration Testing	209	19	0	190
Acceptance Testing	209	134	0	75
Dry Run	209	134	0	75

As shown, GasBuddy was found to be compliant with all required tests. Some requirements were considered not applicable for GasBuddy in one or more testing stages, due to how the GasBuddy system was implemented or the nature of the Demonstration phase.

- ▶ PRIME provided the mileage reporting option component of the Data Collection Subsystem for Phase 1A: Pay-at-the-Pump (plug-in devices), on behalf of GasBuddy. Therefore mileage reporting option interface requirements were considered not applicable for GasBuddy. GasBuddy did prove compliance with its ability to transmit fuel purchase transactions to PRIME.

- ▶ PRIME provided transaction processing functions on behalf of GasBuddy (compiling trip mileage and fuel purchase data into a transaction). Therefore, transaction processing-related requirements were considered not applicable. GasBuddy did prove compliance with its ability to interface with PRIME's transaction processing function.
- ▶ PRIME provided operational and financial reporting functions on behalf of GasBuddy. Therefore, operational and financial reporting-related requirements were considered not applicable.

### **Phase 1B: Pay-at-the-Chargepoint – ChargePoint**

The results of each stage of testing for ChargePoint are shown in **Table 6**.

**TABLE 6. Phase 1B: ChargePoint Test Results**

TESTING STAGE	TOTAL	COMPLIANT	NON-COMPLIANT	NOT APPLICABLE
Unit Testing	209	121	0	88
Integration Testing	209	19	0	190
Acceptance Testing	209	121	0	88
Dry Run	209	121	0	88

As shown, ChargePoint was found to be compliant with all necessary tests. Some requirements were considered not applicable for ChargePoint in one or more testing stages, due to how the ChargePoint system was implemented or the nature of the Demonstration phase.

- ▶ PRIME provided the mileage reporting option component of the Data Collection Subsystem for Phase 1B: Pay-at-the-Chargepoint (plug-in devices), on behalf of ChargePoint. Therefore mileage reporting option interface requirements were considered not applicable for ChargePoint. ChargePoint did prove compliance with its ability to transmit electric vehicle charging sessions to PRIME.
- ▶ PRIME provided transaction processing functions on behalf of ChargePoint (compiling trip mileage into a transaction). Therefore, transaction processing-related requirements were considered not applicable. ChargePoint did prove compliance with its ability to interface with PRIME's transaction processing function.
- ▶ PRIME provided operational and financial reporting functions on behalf of ChargePoint. Therefore, operational and financial reporting-related requirements were considered not applicable.
- ▶ The chargepoint portion of Phase 1B included electric vehicles only, so requirements related to fuel usage and fuel tax credit calculations and assessment were considered not applicable for ChargePoint.

### **Phase 2: Usage-Based Insurance – Mile Auto**

The results of each stage of testing for Mile Auto are shown in **Table 7**.

**TABLE 7. Phase 2, Mile Auto Test Results**

TESTING STAGE	TOTAL	COMPLIANT	NON-COMPLIANT	NOT APPLICABLE
Unit Testing	209	184	0	25
Integration Testing	209	38	0	171
Acceptance Testing	209	184	0	25
Dry Run	209	184	0	25

As shown, Mile Auto was found to be compliant with all necessary tests. Some requirements were considered not applicable for Mile Auto in one or more testing stages, due to how the Mile Auto system was implemented or the nature of the Demonstration phase.

- ▶ Mile Auto captured miles traveled using odometer readings (via photo upload). No geographic travel location information was collected. Therefore, requirements related to differentiating location were considered not applicable for Mile Auto.
- ▶ Various requirements were considered not applicable for Mile Auto based on its implementation/ offering, such as requirements related to continued connectivity between the mileage reporting option and the data collection component. Mile Auto did not require continued connectivity, only the continued availability of the data collection component to receive odometer photo uploads from a participant's smartphone at any given time.
- ▶ Mile Auto was not required to comply with interface specifications for two interfaces, since Mile Auto was managing all of the subsystems involved. The two interfaces were the Data Collection to Transaction Processing Subsystem ("mileage message") and the Transaction Processing to Account Management subsystem ("transaction summary message"). Mile Auto was still required to comply with the intent of the interface and ensure all the necessary data transferred from subsystem to subsystem.

### Phase 3: Ridesharing – Via

The results of each stage of testing for Via are shown in **Table 8**.

**TABLE 8. Phase 3: Via Test Results**

TESTING STAGE	TOTAL	COMPLIANT	NON-COMPLIANT	NOT APPLICABLE
Unit Testing	209	204	0	5
Integration Testing	209	38	0	171
Acceptance Testing	209	204	0	5
Dry Run	209	204	0	5

As shown, Via was found to be compliant with all necessary tests. Some requirements were considered not applicable for Via in one or more testing stages, due to how the Via system was implemented or the nature of the Demonstration phase:

- ▶ Requirements related to mileage reporting option replacement and return were considered not applicable for Via because the mileage reporting option used by Via for Phase 3: Ridesharing was a mobile app, which did not require replacement or return.

- ▶ Via was not required to comply with interface specifications for two interfaces, because Via was managing all of the subsystems involved. The two interfaces were the Data Collection to Transaction Processing Subsystem (“mileage message”) and the Transaction Processing to Account Management subsystem (“transaction summary message”). Via was still required to comply with the intent of the interface and ensure all the necessary data transferred from subsystem to subsystem.

#### Phase 4: Autonomous Vehicles – EasyMile

The results of each stage of testing for EasyMile are shown in **Table 9**.

**TABLE 9. Phase 4, EasyMile Test Results**

TESTING STAGE	TOTAL	COMPLIANT	NON-COMPLIANT	NOT APPLICABLE
Unit Testing	209	76	0	133
Integration Testing	209	14	0	195
Acceptance Testing	209	76	0	133
Dry Run	209	76	0	133

As shown, EasyMile was found to be compliant with all necessary tests. Some requirements were considered not applicable for EasyMile in one or more testing stages, due to how the EasyMile system was implemented or the nature of the Demonstration phase:

- ▶ Phase 4 Autonomous Vehicles included electric vehicles only, so requirements related to fuel usage and fuel tax credit calculations and assessment were considered not applicable for EasyMile.
- ▶ Via provided transaction processing functions on behalf of EasyMile (compiling trip mileage into a transaction). Therefore, transaction processing-related requirements were considered not applicable. EasyMile did prove compliance with its ability to interface with Via's transaction processing function.
- ▶ Via provided account management and reporting functions on behalf of EasyMile. Therefore, account management and reporting-related requirements were considered not applicable.

### 3.5 Participant Recruitment

The recruiting plan was designed to meet overall road charge demonstration as well as phase-specific goals and objectives as defined in Section 2, General Overview of the Demonstration of this report. Recruitment objectives for all phases were developed as follows:

- ▶ Recruit approximately 115 Demonstration participants to support three of the four Demonstration phases.
- ▶ Recruit both targeted and general population parties to participate in the Demonstration.
- ▶ Select approximately 30 percent of participants for each phase from a targeted recruitment list and 70 percent from the general population that has indicated an interest in participating.
- ▶ Recruit participants from a wide array of geographic and socioeconomic backgrounds.
- ▶ Recruit participants that will provide a wide array of perspectives, attitudes, and experiences for communications research activities.

Additional phase-specific goals and objectives were subsequently identified and are summarized in **Table 10**.

**TABLE 10. Phase-Specific Recruitment Goals**

PHASE	RECRUITMENT TARGETS	GEOGRAPHY
Phase 1A: Pay-at-the-Pump Phase 1B: Pay-at-the-Chargepoint	30 to 50 participants At least 10 participants should own an electric vehicle	Statewide
Phase 2: Usage-Based Insurance	30 to 40 participants	Statewide
Phase 3: Ridesharing	10 to 25 participants	Sacramento metropolitan area
Phase 4: Autonomous Vehicles	0 participants, technical feasibility study only	Livermore, California

### 3.5.1 Intake Process

The overall process for recruitment and eventual enrollment in the Demonstration proceeded as follows:

#### 1. Demonstration Website and Intake

**Portal:** The Demonstration developed an informational website describing the road charge concept and providing information on the four Demonstration phases.<sup>22</sup> Included on the website's landing page were callout graphics and text directing interested individuals to the intake page. The website was included on social media postings, fact sheets, a press release, and other communications materials developed and distributed in support of Demonstration activities. Demonstration Technical Team members directed individuals to the website in conversations with stakeholders, policy makers, the media, and other potentially interested parties.

The website also contained an intake page with a survey where individuals interested in participating in the Demonstration provided information for subsequent screening and selection.<sup>23</sup> The intake page was linked to the main page through a callout box with prominent lettering directing

interested individuals to click the link for more information about participating. The landing page for the intake page contained information on Demonstration participation and included a form for potential participants to provide information to the Demonstration Technical Team.

#### 2. Obtain Information for Selection and

**Stratification:** Upon landing on the intake page, individuals received information on the Demonstration phases, timing, expectations, and requirements for participation. Those who wished to participate completed a survey that was used for screening. This survey and the screening process are discussed later in this section.

#### 3. Acknowledge Receipt of Information:

Following the input of their information, interested parties were shown a screen acknowledging completion of the intake process and received an email at the listed contact thanking them for their time and confirming their interest in the Demonstration. Information submitted through the intake page online form was loaded into a database the Demonstration Technical Team used to

[22] California Road Charge. Caltrans, CalSTA, <http://caroadcharge.com/>. Accessed Apr. 27, 2021.

[23] California Road Charge, About Us. Caltrans, CalSTA, <http://caroadcharge.com/engage/contact-us/>, Accessed Apr. 27, 2021.

manage public comments and Demonstration-interested parties. In some cases, recruitment occurred through in-person or telephone conversations by the Demonstration Technical Team. In such cases, the Technical Team member either directed the interested party to the website or collected the required information from the individual and manually entered it into the database.

4. **Maintain Log of Interested Parties:** Each interested party who completed the intake questionnaire was captured in a tracking log maintained by MailChimp. This log was part of the existing participant list previously captured during the 2017 Pilot. Interested parties and their responses to the intake questionnaire were monitored and used by Caltrans and members of the Demonstration Technical Team to identify and prioritize participants. This process is discussed in a subsequent section.
5. **Develop Incentive Payout Schedule:** Caltrans and the Demonstration Technical Team developed a payout schedule for incentives provided to participants. This included identifying Demonstration milestones for each phase, assigning payout amounts to completion of each milestone, and determining when payouts would be provided. A matrix was developed for each participant to monitor their completion of each of the associated milestones to ensure that accurate payouts were provided.
6. **Participant Vetting by Demonstration Technical Team:** The Demonstration Technical Team compiled all interested parties, evaluated their responses to the intake process, and vetted their participation against the goals and objectives established for the Demonstration. This vetting involved comparing vehicle types against technology constraints, comparing participant locations against geographic constraints, and evaluating any socioeconomic responses against soft goals for equity and diversity.

The Demonstration Technical Team selected the number of participants necessary to fulfill the obligations of each phase while placing participants into the phases they preferred to participate in subject to phase participation limits.

7. **Notification of Selection:** Upon finalization of the participant list, the Demonstration Technical Team notified participants of their acceptance through their identified email addresses.
8. **Participant Onboarding:** Each selected participant received a unique login identification and code to the Demonstration Website Participant Portal. This portal, developed and hosted by the Demonstration Technical Team, acted as a centralized location for participants to connect with customer service, electronically sign the Demonstration participant agreement, and access Demonstration information. Through this portal, each participant began the onboarding process, which included establishing accounts with their phase technology service provider, installing hardware (Phase 1A and 1B participants only), downloading the appropriate apps, and completing the required activities necessary to finish the Demonstration.





### 3.5.2 General Public Recruiting

The Demonstration Technical Team planned for 70 percent of the participants to come from the California general population. To achieve this goal, the Demonstration Technical Team undertook several tactics to publicize the Demonstration and generate interest among potential participants:

- ▶ Caltrans issued a press release, published newsletters, and created posts on Caltrans social media accounts (Facebook, Twitter, and Instagram) announcing the launch of the California Road Charge Phased Demonstration and providing a link to the newly rebranded website.<sup>24</sup>
- ▶ Caltrans issued an email announcement to all previous pilot participants and interested parties in the MailChimp database developed for the state’s first pilot. This database currently contains 2,669 contacts who could be considered for participation in the Demonstration. The announcement directed interested parties to the public-facing road charge website to complete an intake form and enter the pool of potential participants.
- ▶ The Phase 3: Ridesharing Business Partner contacted their existing customer base through an electronic mailer containing a link to the website and directions for accessing the special interest list to identify interested parties that already used the Ridesharing partner’s West Sacramento ridesharing service.

### 3.5.3 Targeted Recruitment

Targeted recruits were individuals identified as a priority for participation based on some factor such as their organizational affiliation or interest in road charge development in California. This approach was intended to provide firsthand experience for policymakers by demonstrating, in a personal manner, that the road charge concept is technologically feasible.

The Demonstration Technical Team initially planned for targeted recruits account for up to 30 percent of the total participant pool. Key policymaker groups that were considered are shown in **Table 11**.

**TABLE 11. The Demonstration Targeted Participant Organizations**

POLICYMAKERS CONSIDERED
Governor’s Office
California State Transportation Agency
California Transportation Commission
Department of Motor Vehicles
Technical Advisory Committee
State Transportation Committee Members
Key Legislative Caucuses
Federal Highway Administration

Targeted recruits were contacted directly by Caltrans staff to gauge their interest in the Demonstration. As with the general public, the targeted recruits were directed to the road charge website and asked to complete the special interest survey. Members of the Demonstration Technical Team identified these recruits and entered them in the screening tool for the screening and selection process.



[24] California Road Charge. Caltrans, CalSTA, <http://caroadcharge.com/>. Accessed Apr. 27, 2021.

### 3.5.4 Selection and Stratification of General Public Recruits

Information used in the screening and selection of participants was obtained through the intake page survey located on the Demonstration website. Information collected on the survey included the following:

- ▶ Name (first and last)
- ▶ Organization (if applicable)
- ▶ Email address
- ▶ Phone number
- ▶ Zip code of residence
- ▶ Confirmation of interest to participate in the pilot (yes/no)
- ▶ Ownership of vehicle (yes/no)
- ▶ Vehicle make, model, year, and fuel type (if a vehicle is owned)
- ▶ Age range
- ▶ Income level
- ▶ Gender
- ▶ Ethnicity
- ▶ Education level
- ▶ Demonstration phase of interest (Pay-at-the-Pump/ Pay-at-the-Chargepoint, Usage-Based Insurance, Ridesharing, Usage-Based Insurance, or multiple phases)

Information was maintained on a continually updated spreadsheet and used by the Demonstration Team in screening and selection processes. Using this spreadsheet, the Project Team selected potential participants individually and monitored the change in geographic and demographic composition of the participant pool with each successive choice. Each selection of a new participant was done such that their characteristics would maintain the desired distribution of the pool. Multiple rounds of recruiting were required, and in each case new recruits were selected after accounting for the composition of the current pool of confirmed participants. Geographic and demographic targets are discussed in the next sections.

#### High-Level Participation Targets

The Demonstration Team's initial screening activity established goals for each phase's participant pools in terms of the desired number of participants, the number of general public participants, and the number of targeted participants. The Team also established limits on how many participants in the Demonstration could be participants from the previous state pilot. These initial participation targets are summarized in **Table 12**.

**TABLE 12. Demonstration Participation Targets**

PHASE	Recruiting Target					Final Participant Pool			
	GENERAL PUBLIC	TARGETED	PRIOR PILOT PARTICIPANTS	MIN. TOTAL	MAX. TOTAL	GENERAL PUBLIC	TARGETED	PRIOR PILOT PARTICIPANTS	TOTAL
PATP	28	12	2	20	40	22	11	8	33
PATCP	9	1	1	5	10	8	1	5	9
UBI	28	12	2	20	40	25	4	3	29
RS	18	8	1	5	25	6	6	3	12
<b>Total</b>	<b>83</b>	<b>33</b>	<b>6</b>	<b>50</b>	<b>115</b>	<b>61</b>	<b>22</b>	<b>19</b>	<b>83</b>

Key: Pay-at-the-Pump (PATP); Pay-at-the-Chargepoint (PATCP); Usage-Based Insurance (UBI); Ridesharing (RS)

As the table shows, the minimum number of participants was recruited for each phase. The most significant deviation from the original Demonstration goals occurred with the number of participants who had previously participated in the California Road Charge Pilot. All four phases featured more previous pilot participants than was originally planned. In the case of Phase 1A and 1B, response rates for invitations to participate were very low,

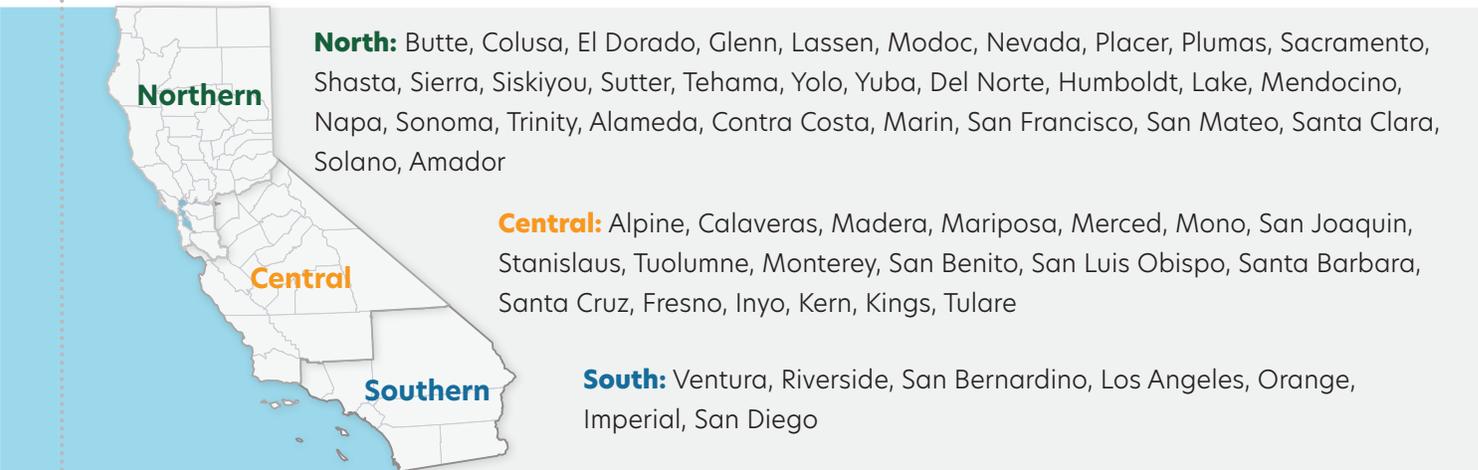


and the Demonstration Technical Team exhausted its options for recruiting a diverse participant pool from the existing list of interested parties who had never participated in a pilot. As such, participants from the previous pilot had to be recruited to achieve other recruiting objectives. In the case of Phase 3, the potential participant pool was geographically constrained to the Business Partner's service area. To achieve the minimum participation threshold, the Technical Team had to invite all interested parties within that service area without regard for their status as a prior participant.

### Geographic Targets

The Technical Team sought to achieve geographic diversity for the statewide phases (Phase 1A and 1B and Phase 2) and divided the state into three sections: North, Central, and South. The Demonstration Technical Team then assigned counties aligning with this segmentation as summarized in **Figure 8**. City and county of residence was not collected on the special interest survey. However, the Demonstration Technical Team used a commercial database to convert user-input zip codes to a city of residence, which was then assigned to the appropriate geographic code.

**FIGURE 8.** Segmentation of California Counties



**Table 13** summarizes the geographic composition of the Phase 1A and 1B, Phase 2, and Phase 3 participants relative to goals established by the Demonstration Technical Team. Phase 3 was conducted only in Sacramento, so there were no statewide participants in that phase. As the table shows, the Demonstration Technical Team was generally able to achieve its distribution goals. While participation from southern areas of the state were lower than the goal, this part of the state still had a plurality of participants in Phase 1A and 1B and Phase 2. Participants classified geographically as “other” were targeted participants who did not reside within California.

**TABLE 13.** Geographic Distribution of Demonstration Participants

REGION	GOAL	PHASE 1A/1B	PHASE 2	PHASE 3
North	30%	31%	34%	100%
Central	20%	24%	14%	0%
South	50%	43%	41%	0%
Other	N/A	2%	11%	0%

### Demographic Stratification

Participants were screened to achieve participant pools that were as representative of the California general population as possible. In setting demographic targets, the Demonstration Technical Team relied on information from the U.S. Census Bureau's 2019 American Community Survey (ACS). In some cases, demographic classifications used by the ACS differ slightly than what was used by the Demonstration Technical Team during its intake and screening processes. Such deviations from ACS methodologies were due to a desire to simplify the questions asked of interested parties. In the following sections, actual participant demographics are shown alongside the ACS-derived goals for participation.

**Table 14** summarizes the income distribution of Demonstration participants relative to California's demographic data from the 2019 ACS. As the table shows, the recruiting pool skews slightly toward higher income earners; however, it is generally representative of state income demographics.

**TABLE 14. Income Distribution of Demonstration Participants**

INCOME CATEGORY (2019 ACS)	STATE DISTRIBUTION	INCOME CATEGORY (RECRUITING)	PHASE 1A/1B DISTRIBUTION	PHASE 2 DISTRIBUTION	PHASE 3 DISTRIBUTION
\$200,000 or more	14%	\$150,000 or more	21%	24%	17%
\$100,000–\$200,000	27%	\$100,000 - \$149,000	33%	28%	8%
\$50,000–\$99,999	28%	\$50,000 - \$99,999	24%	24%	50%
< \$50,000	32%	< \$50,000	21%	24%	25%

**Table 15** summarizes the distribution of Demonstration participants' ethnicity relative to California's overall demographic from the 2019 ACS. As the table shows, the recruiting pool is generally diverse in terms of ethnic composition; however, Asian Americans were more heavily represented while Hispanics and Black or African Americans were underrepresented relative to the California population.

**TABLE 15. Ethnic Distribution of Demonstration Participants**

ETHNICITY	STATE DISTRIBUTION	PHASE 1A/1B	PHASE 2	PHASE 3
American Indian or Alaskan Native	2%	5%	0%	9%
Asian	16%	19%	28%	9%
Black or African American	7%	5%	7%	0%
Hispanic or Latino	37%	26%	31%	0%
Native Hawaiian or Pacific Islander	<1%	0%	0%	0%
Other	N/A	7%	0%	9%
White	38%	38%	34%	73%

**Table 16** and **Table 17** summarize the distribution of participants by gender and age, respectively. As the table shows, the participant pools for Phase 1A/1B and Phase 2 were generally evenly split in terms of gender, although there was a slight skew in both phases toward men. Over two-thirds of Phase 3 participants were women. All age ranges were well represented across the Demonstration's three phases, although there were slight differences from phase to phase. Age-related goals were not set, but the Project Team sought to have all ranges represented when possible.

**TABLE 16. Distribution of Demonstration Participant Gender**

GENDER	PHASE 1A/1B	PHASE 2	PHASE 3
Women	43%	45%	67%
Men	57%	52%	33%
Non-binary	0%	3%	0%

**TABLE 17. Distribution of Demonstration Participant Age**

AGE RANGE	PHASE 1A/1B	PHASE 2	PHASE 3
18–29	21%	18%	9%
30–39	14%	21%	18%
40–49	26%	14%	27%
50–64	26%	25%	36%
65+	12%	21%	9%

### 3.6 Rate Setting

Road charge is currently being evaluated in California as a replacement for the fuel tax, although it could theoretically be structured to achieve any number of revenue or system performance related goals and objectives. With fuel tax replacement as a primary funding objective, the Demonstration Technical Team worked to establish a rate for the Demonstration that was revenue neutral. Revenue neutrality can be viewed from different perspectives. For example, the state may set rates so as to generate the same amount of revenue that would have been generated by fuel taxes. The state may also set rates such that average drivers pay no more than they would normally pay under the fuel tax. Both perspectives were considered in setting a base rate for the Demonstration.

Another key consideration in rate setting is which of the State's revenue streams would be transitioned to

a road charge. While the gas excise tax provides a large majority of state transportation revenue, there is also the diesel excise tax, the diesel sales tax, the Road Improvement Fee, the Transportation Improvement Fee, and weight fees. To keep things simple, for this Demonstration only, the revenue from the gas excise tax was used to establish a per-mile road charge rate. However, different combinations may be considered for future pilots or programs.

**Table 18** gas tax revenues from July 2018 through June 2019 (state fiscal year 2018-19) as divided by vehicle miles traveled in that timeframe in order to obtain a "gas tax per-mile" average of 2.2 cents per mile. This was used as the road charge per-mile rate in the pilot to simulate road charge revenue replacing gas tax revenue. The gas tax revenue data was obtained from the California Department of Tax

and Fee Administration.<sup>25</sup> State vehicle miles traveled (VMT) data was obtained from the California Air Resource Board's Emissions FACTor (EMFAC) model.<sup>26</sup>

Fiscal year 2018-19 was chosen as the most current indication of gasoline consumption from regular driving patterns in California. Fiscal year 2019-20 gasoline tax revenue was not chosen because gasoline consumption was much lower that year as a result of COVID-19 pandemic travel restrictions issued by the state.

**TABLE 18. Rate Calculation Considering Fuel Tax Revenues Collected**

FISCAL YEAR	GAS TAX REVENUES	VEHICLE MILES TRAVELED	TAXES PAID PER MILE
2018-2019	\$6,400,551,000	288,419,000,000	\$0.022

The 2017 Road Charge Pilot calculated a road charge rate of 1.8 cents per mile using a different method. The fluctuating gas tax rates for the five-year period from 2011 thru 2016 were averaged to a gas tax rate of 35.4 cents per gallon. The average fuel economy of the California fleet was computed at 20 miles per gallon. Then an average "gas tax per-mile" was calculated by dividing 35.4 cents per gallon by 20 miles per gallon resulting in 1.8 cents per-mile. Rather than reflecting a five-year trend, the Four-Phase Pilot's approach reflects a one-year snapshot reliant on recently released data from the California Air Resources Board to assess current fleet fuel efficiency trends and calculate an associated fuel tax credit. However, this approach is likely not feasible in the longer term given SB 1 mandated inflation-based increases to the state's fuel excise taxes.

The first two pilots performed in California show that a road charge rate can be set to generate a similar amount of annual gas tax revenues, or set to approximate what the average vehicle fuel economy would pay in gas tax. Road charge rate setting in future pilot studies could also consider objectives to fund additional transportation system needs in addition to replacement of fuel tax revenues.



[25] Gasoline Tax Data. California Department of Tax and Fee Administration, <https://www.cdtfa.ca.gov/DataPortal/dataset.htm?url=FuelGasJetStats>. Accessed Apr. 27, 2021.

[26] Welcome to EMFAC. California Air Resources Board, <https://arb.ca.gov/emfac/>. Accessed Apr. 27, 2021.



## 3.7 Public Communications Activities

Given the small scale of the Demonstration relative to the previous California Road Charge Pilot, a smaller-scale public communications effort was envisioned. The general objective of this public communications effort was to educate the public on the Demonstration and provide updates on Demonstration activities to the public, stakeholders, and policymakers. Several outreach channels were used to support these objectives: newsletters, social media, and website updates. General educational materials, were prepared and the public website revised to support future general education efforts.

### 3.7.1 Newsletters

Email newsletters are frequently used to keep key audiences informed and engaged on issues that matter to them. Two broadly general audiences were targeted for the Demonstration Technical Team for communications through email newsletters:

- ▶ The 83 Demonstration participants who were recruited and onboarded as participants in the Pay-at-the-Pump, Pay-at-Chargepoint, Usage-Based Insurance, and Ridesharing phases of the Demonstration.
- ▶ Interested parties, including those who may have participated in the previous pilot program, people who were interested in participating but were not selected for the

current Demonstration, and other stakeholders who had voluntarily subscribed to the road charge email list.

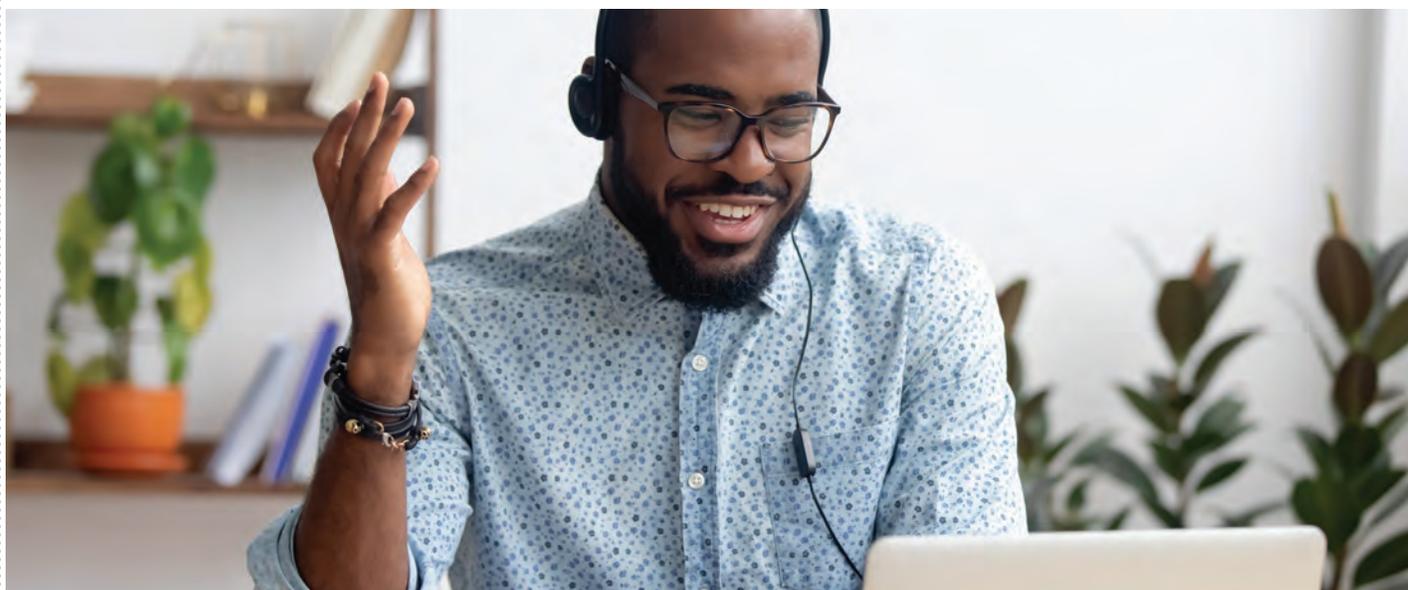
In autumn 2020, the Demonstration Technical Team and Caltrans began issuing quarterly newsletters from the [info@caroadcharge.com](mailto:info@caroadcharge.com) email account. Newsletters were sent to the current 2,665 subscribers captured in the mailing list created following the first California road charge pilot. The last time the road charge program contacted these individuals was in December 2017. Newsletters were sent to the mailing list on a quarterly basis.

### 3.7.2 Social Media

Road charge–branded social media handles were not deployed during the Demonstration. For example, Demonstration-specific Twitter, Instagram, and Facebook pages were not developed for social media interaction. Rather, the Demonstration’s social media strategy leveraged the strength of Caltrans’s existing social media platforms to achieve two main goals:

- ▶ Support public participant recruitment.
- ▶ Inform the public about the Demonstration’s progress and ultimate findings.

Recognizing that most social media posts would be posted to Caltrans-owned and managed social media properties, the Demonstration Technical Team



and Caltrans Public Affairs collaborated to deploy a minimal social media strategy to support recruiting and information dissemination while maintaining compliance and conformance with existing social media branding and content guidelines set forth by Caltrans. The Caltrans social media team, in coordination with the Demonstration Technical Team, issued several social media postings that mirrored the content provided in the newsletters with a primary focus on major project announcements and calls for volunteers.

### 3.7.3 Website Updates

The project website was redesigned based on communications research and current state trends in transportation issues. It is updated with new material on a continual basis to provide:

- ▶ Information on the pilot and its various phases.
- ▶ Background information on state transportation funding.
- ▶ Background information on the road charge concept.
- ▶ Links to previous California road charge documents and reports.

- ▶ Information on other Caltrans projects and pilots.
- ▶ Information on how to become an active participant in the Demonstration.
- ▶ Information on the Demonstration partners.
- ▶ A road charge calculator tool.
- ▶ Demonstration updates.
- ▶ News and information from other states exploring road charge.
- ▶ Links to a database of road charge-related research housed at the Mineta Transportation Institute.

The website also hosted a series of informational videos produced by the Demonstration Technical Team on topics including:

- ▶ How the transportation system is currently funded.
- ▶ The problem with the gas tax.
- ▶ Basic explanation of the road charge concept.





**Section 4**

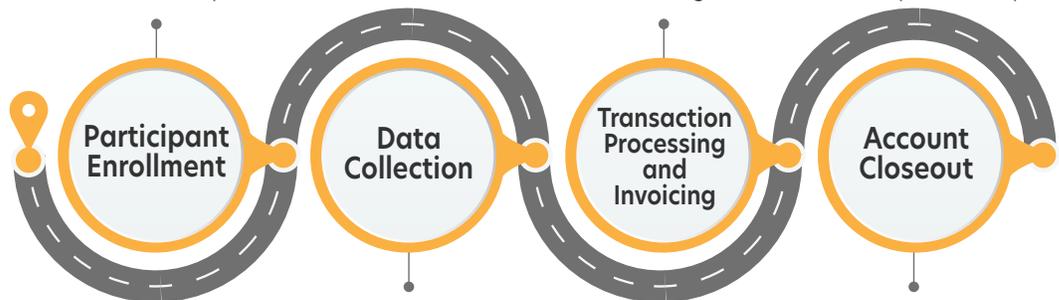
# DEMONSTRATION OPERATIONS

With the Demonstration design and preparation complete, the Demonstration began live operations. This included a number of activities, as illustrated in Figure 9 and summarized in the following subsections, that included:

- ▶ Participant Enrollment
- ▶ Participant Communications
- ▶ Data Collection
- ▶ Customer Service
- ▶ Website administration
- ▶ Data Analytics and Dashboarding
- ▶ Participant Surveys
- ▶ System Management

**FIGURE 9.** Demonstration Operations Overview

- ▶ Participant portal login and participant agreement acknowledgement
- ▶ Enrollment with service provider
- ▶ Calculate gross road charge, gross fuels tax credit (if applicable), and net balance
- ▶ Simulate road charge statements and provide to participants



- ▶ Calculate distance traveled
- ▶ Calculate fuel usage (if applicable)
- ▶ Close of demonstration accounts on behalf of the participants
- ▶ Returned of devices by participant (if applicable)

<b>Pre-Survey</b>	▶ Administered to participants prior to the start of the phase demonstration
<b>Mid-Survey</b>	▶ Administered to participants midway through their participation
<b>Post-Survey</b>	▶ Administered to participants at the conclusion of their participation ▶ Required for the issuance of incentives

## 4.1 Participant Enrollment

As noted in the participant recruiting section of this report, the Demonstration Technical Team selected participants for each Demonstration phase based on demographic and geographic diversity, where able. Two notable exceptions were Phase 3: Ridesharing, where participation was geographically limited, and Phase 4: Autonomous Vehicles, where there were no human participants.

The following tables (**Table 19**, **Table 20**, **Table 21**, and **Table 22**) outline the enrollment status for each phase throughout the course of the Demonstration. Key information from each table includes the following:

- ▶ **Invited:** Count of participants selected from the interested party list, to participate in a specified Demonstration phase, based on demographic and geographic parameters and their interested in the specified phase.
- ▶ **Enrolled:** Count of participants who completed the enrollment process for their phase.
- ▶ **Dropped:** Count of invited participants who have been dropped/removed from the Demonstration and are no longer able to complete the enrollment process. Participants may have been dropped from enrollment upon request or by not completing the enrollment process in the time allotted.

**TABLE 19. Demonstration Participant Enrollment Status - Phase 1A: Pay-at-the-Pump**

Phase 1A: Pay-at-the-Pump (GasBuddy)			
MONTH, YEAR	INVITED	ENROLLED	DROPPED
January 2021	40	10	0
February 2021	34	14	50
March 2021	39	9	30
April 2021	-	-	-
May 2021	-	-	-
June 2021	-	-	-
<b>Total</b>	<b>113</b>	<b>33</b>	<b>80</b>

**TABLE 20. Demonstration Participant Enrollment Status - Phase 1B: Chargepoint**

Phase 1B: Pay-at-the-Chargepoint (ChargePoint)			
MONTH, YEAR	INVITED	ENROLLED	DROPPED
January 2021	11	5	0
February 2021	5	4	7
March 2021	2	0	2
April 2021	-	-	-
May 2021	-	-	-
June 2021	-	-	-
<b>Total</b>	<b>18</b>	<b>9</b>	<b>9</b>

**TABLE 21. Demonstration Participant Enrollment Status - Phase 2: Usage-Based Insurance**

Phase 2: Usage-Based Insurance (Mile Auto)			
MONTH, YEAR	INVITED	ENROLLED	DROPPED
January 2021	-	-	-
February 2021	47	16	23
March 2021	55	8	38
April 2021	-	5	12
May 2021	-	-	-
June 2021	-	-	-
<b>Total</b>	<b>102</b>	<b>29</b>	<b>73</b>

**TABLE 22. Demonstration Participant Enrollment Status - Phase 3: Ridesharing**

Phase 3: Ridesharing (Via)			
MONTH, YEAR	INVITED	ENROLLED	DROPPED
January 2021	-	-	-
February 2021	-	-	-
March 2021	49	7	15
April 2021	5	3	29
May 2021	2	2	0
June 2021	-	-	-
<b>Total</b>	<b>56</b>	<b>12</b>	<b>44</b>

The number of dropped enrollees in each phase highlights the challenge of transitioning those interested in participating to actual participants.

In Phases 1A and 1B, 2, and 3 participants were provided unique accounts in the Demonstration's Participant Portal to complete necessary enrollment steps, which included completing enrollment steps with their respective Business Partner. The Participant Portal enrollment page (example shown in **Figure 10**) provided information to participants on the steps of enrollment, requirements for participating in the respective phase, an overview of how the phase will operate over the Demonstration, and how to contact customer support.

**FIGURE 10.** Participant Portal Enrollment Steps Example - Chargepoint

**California Road Charge**

English Español f t

About Road Charge Our Partners Road Charge Projects Engage

## Phase 3 Transportation Network Companies

**Step 1**  
Login to Portal

**Step 2**  
Acknowledge Agreement

**Step 3**  
Complete enrollment with Via

**Thank you for participating in the California Road Charge Demonstration!**

We are happy to have you on the team. Your participation is vital to the Road Charge Demonstration's success.

You are a participant in **Phase 3 Transportation Network Companies (TNC)**

Your service provider is **Via**

Phase 3 TNC runs **March through June 2021**

**The Road Charge Demonstration is almost complete!**

The last day of the demonstration will be June 30, 2021. Starting on July 1, we will coordinate with Via to begin closeout activities. You should receive a "demonstration closeout" email the first week of July with instructions on what you need to do to close out your participation. Here's a quick snapshot of what demonstration closeout will look like:

- ▶ **Your Via Account** - We will close out your road charge demonstration account's connection with your Via ridesharing account. If you are interested in keeping your Via ridesharing account open after the demonstration closes, we will provide instructions on how to do that in the July demonstration closeout email. Note: Closing your account is a \$5 incentive-eligible activity.
- If you have not completed your 5 incentive-eligible rides using your Via account in West Sacramento, you have until June 30th to finish those up!
- ▶ **Post-Demonstration Survey** - We want to capture your final thoughts on your experience in the demonstration and will send a link to complete a short post-demonstration survey by July 31, 2021. Note: Completing the post-demonstration survey is a \$15 incentive-eligible activity.
- ▶ **Participation Incentives** - We will tally up your completed demonstration incentive-eligible activities (including closing your account and completing the post-demonstration survey) and determine your total incentive amount owed.

**You can select your preferred incentive payout method now on the Incentives Tracker page in this portal (click on the "Incentives Tracker" link in the right-side navigation towards the top of the page).** You can select to receive your incentive via electronic VISA gift card or a mailed check.

*Please note that incentives are only available to those participants who are not employed by the California State Transportation Agency or one of its departments.*

**Incentive-Eligible Activities**

To be eligible for up to \$100 in participant incentives, you must complete a few simple activities:

**NOTE: Employees of CalSTA or its departments are not eligible to receive any demonstration incentives.**

- ▶ Schedule and take at least 5 trips with Via over the course of the 4-month demonstration period using the Via app and your established account in their West Sacramento service area. We'll incentivize you \$10 for each trip, up to \$50 total.
- ▶ Complete participant surveys - 3 total (pre, mid, and post demonstration surveys). We'll incentivize you \$15 for each survey completed, up to \$45 total for completion of all three

**Participant Portal**

[Portal Home](#)

[Incentive Tracker](#)

[Participant FAQs](#)

[Change Password](#)

[Logout](#)

**Participant Questions**

Submit your questions or comments to the project team during any phase of the Road Charge Demonstration.

Comment:

[Submit](#)

**Or you can call us at (833) 651-1281**

*Hours of Operation: Monday thru Friday 8:30 am - 5:30 pm Pacific Time*

For Phase 1A and 1B, once a participant completed their enrollment steps in the Participant Portal and with their respective fueling or charging Business Partner, the Demonstration Team shipped the participant a plug-in device for mileage capture. The participant received a small device (**Figure 11**) to plug into the onboard diagnostic port of their vehicle to capture mileage and related travel data. The shipment included device installation instructions, shown in **Figure 12**. Phase 1A and Phase 1B were the most difficult to get participants to fully enroll in. It had the most steps in the enrollment process, including a need to wait for the plug-in device to arrive in the mail. These extra steps and delays may have been a factor in lower satisfaction rates among Phase 1A and Phase 1B participants, compared to other phases.

**FIGURE 11.** Onboard Diagnostic Plug-in Device



**FIGURE 12.** Phase 1A plug-in device installation instructions



### DEVICE INSTALLATION INSTRUCTIONS

1. Plug the device in to your onboard diagnostics (OBD) port in your car

If you're not sure where your OBD port is, you can look it up here:

[www.carmd.com/obd-port-location](http://www.carmd.com/obd-port-location)

2. Let the device sit for about 30 to 60 seconds (a series of colored lights will flash)
3. Turn your car on and take it for a spin

**That's it! You're ready to go!**

Questions? Email [info@caroadcharge.com](mailto:info@caroadcharge.com) or call (833) 651-1281

## 4.2 Phase Operations

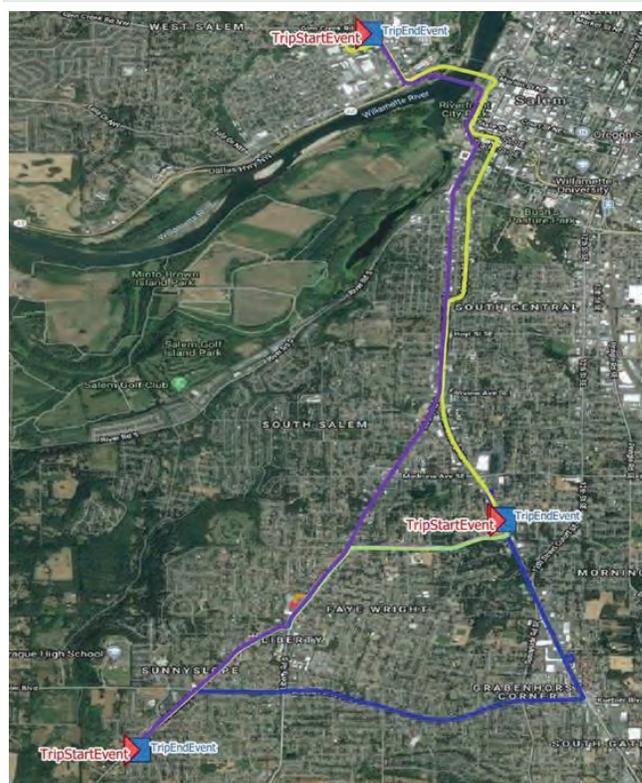
In each phase of the Demonstration, Business Partners collected travel data for vehicles and participants to process the collected data into transactions, apply appropriate rates, credit fuel taxes, and calculated net road charges due. The Business Partner in each phase used a unique approach to collecting and reporting the necessary data to assess a road charge.

### 4.2.1 Phase 1A: Pay-at-the-Pump

**Phase 1A:** Pay-at-the-Pump used a plug-in device to capture mileage and related trip data, as well as fueling session data from the Phase 1A Business Partner to calculate net road charges. Phase 1A operated from January 2021 through June 2021.

Each trip the participant took in the participating vehicle was captured by the plug-in device and sent to GasBuddy's back-end processing systems. The device captured trip-level data (**Figure 13**), including distance (miles) traveled (via an end-of-trip odometer value and second-by-second speed over time to derive distance traveled).

**FIGURE 13.** Visual Example of Trip-level Data Captured by Plug-in Devices

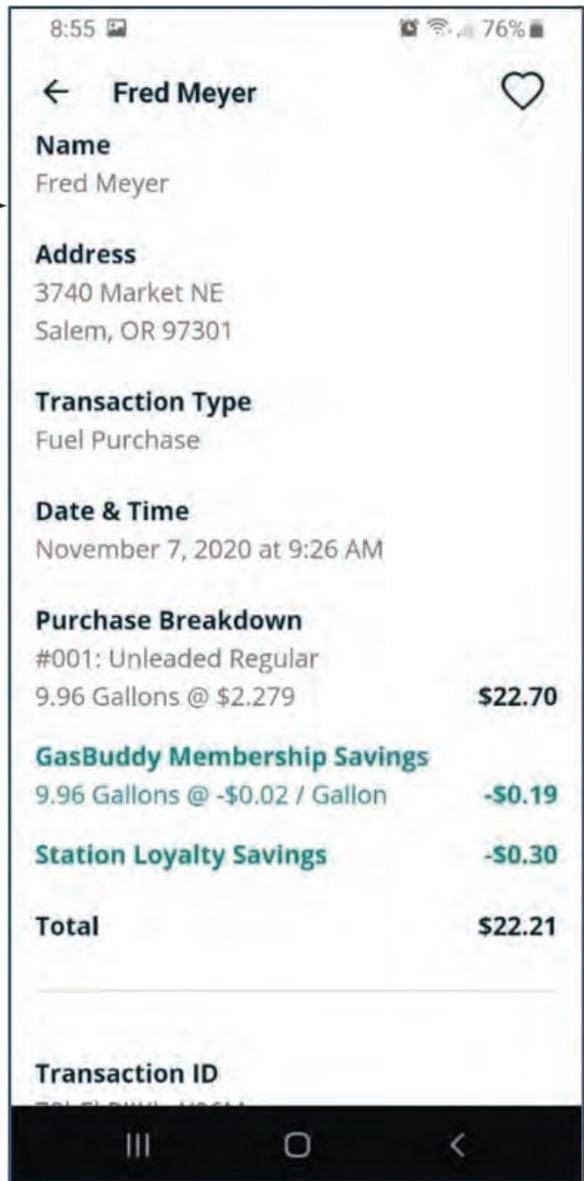
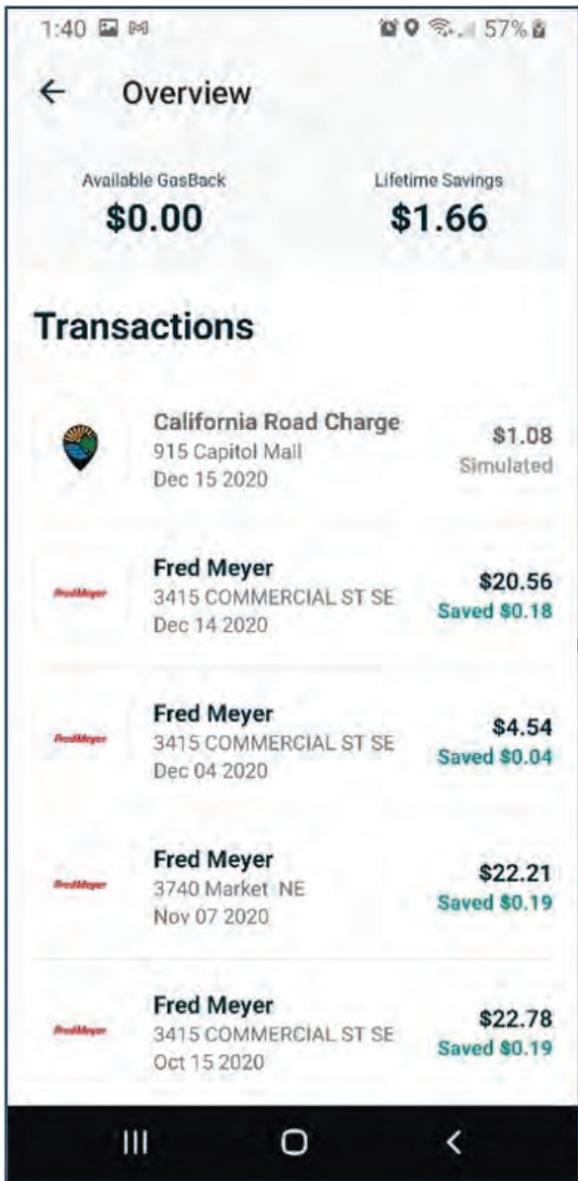




Participants were instructed to use their Pay with GasBuddy payment card each time they fueled their participating vehicle, to capture the fueling transaction. For participants who used the GasBuddy payment card, GasBuddy captured the fueling transaction, including the total gallons of fuel purchased which was used to calculate the fuels tax credit paid (example shown in **Figure 14** and **Figure 15**). GasBuddy was unable to capture fueling transactions if the participant did not use the Pay with GasBuddy payment card (some participants forgot to use the payment card each time or were unable to due to limitations, such as fueling at a location that did not accept the card).

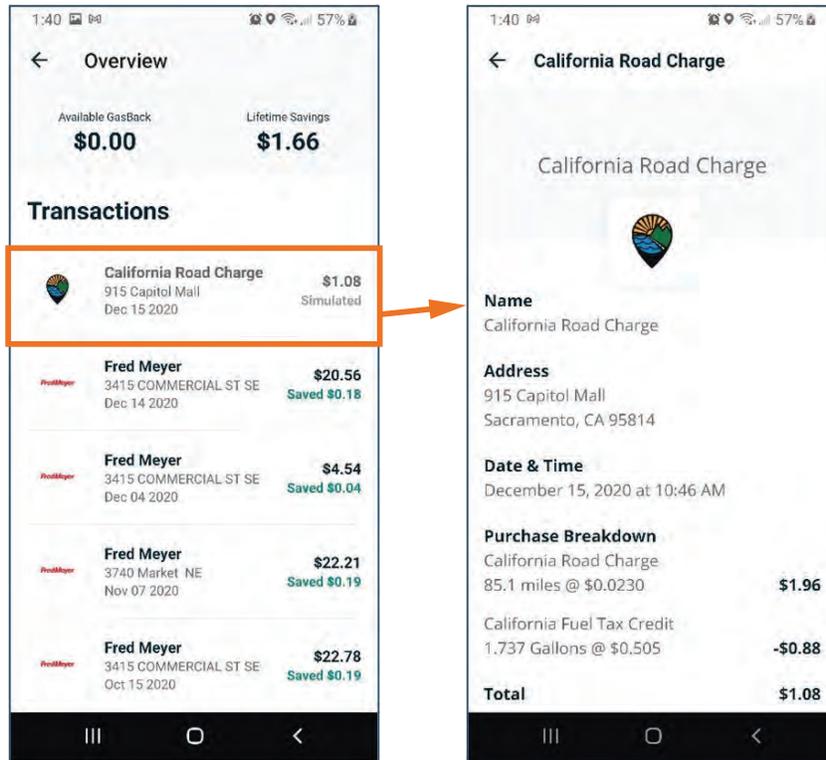
**FIGURE 14.** Example of GasBuddy in-app transactions list

**FIGURE 15.** Example of GasBuddy in-app fuel session transaction detail

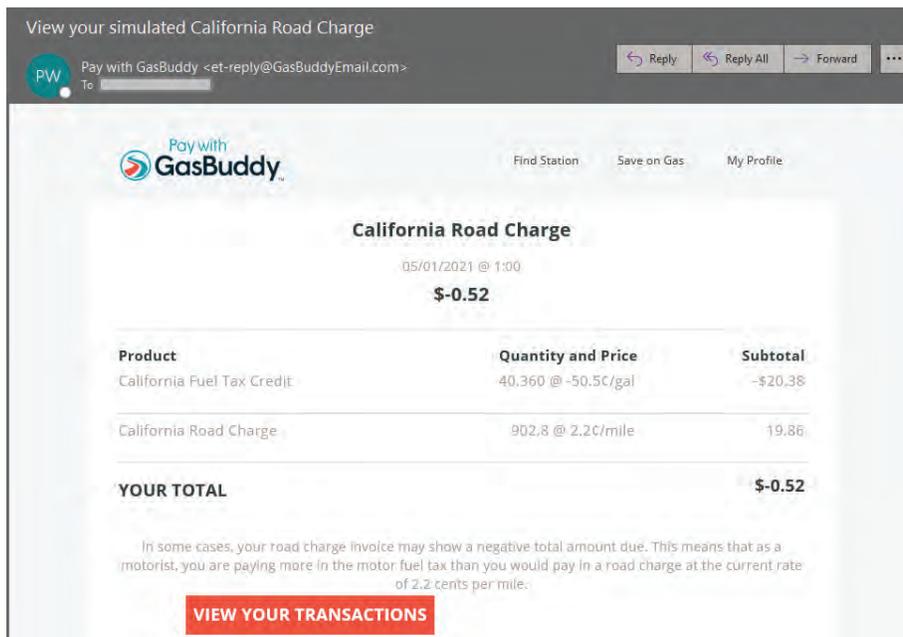


At the beginning of each month during the Demonstration, GasBuddy used the data from the plug-in device and gas payment card from the previous month to create a simulated road charge transaction for miles traveled, fuel purchased (using the Pay with GasBuddy payment card), gross road charge, gross fuels tax credit, and simulated net road charge assessed. GasBuddy then generated a road charge transaction in the participant's account, displayed in the mobile app, and emailed a copy of the road charge transaction to the participant (Figure 16 and Figure 17 below).

**FIGURE 16.** GasBuddy mobile app road charge transaction example



**FIGURE 17.** Pay-at-the-Pump Monthly Road Charge Simulated Invoice Example



In addition to Phase 1A operations, the Demonstration Team evaluated the variance between the mileage captured by the plug-in devices and the Phase 1A Business Partner's mobile app feature that captured mileage for 5 participants that voluntarily turned on this mobile app feature during the Demonstration. The mobile app feature calculated distance traveled (in miles) using mobile phone technology and location data to determine when the phone is in a traveling vehicle, and how much distance the vehicle travels during an active trip, starting a trip after approximately two minutes of constant motion. All 5 vehicles logged more miles and trips from the plug-in device than from the mobile app mileage feature, resulting in the following findings:

- ▶ There were some trips captured by the mobile app that were not captured by the plug-in device, indicating the participant had their mobile phone in a non-participating vehicle during travel.
- ▶ The plug-in device captured more trips than the mobile app feature, indicating the mobile app did not activate for every trip. This could be because the app was turned off, location services were turned off, or the phone was not in the vehicle when the trip occurred.
- ▶ The plug-in device captured more miles than the mobile app feature. Beyond any miles traveled in a trip the mobile app did not capture at all, the first two minutes of a trip may not be captured by the mobile app because the mobile app feature may wait up to two minutes before considering a sensed motion an actual vehicle trip. Another potential reason for missing miles may be the technology and sensors used by the mobile app are not accurately capturing distance traveled by the vehicle (underestimating how fast the vehicle is traveling, therefore undercalculating distance traveled).

#### 4.2.2 Phase 1B: Pay-at-the-Chargepoint

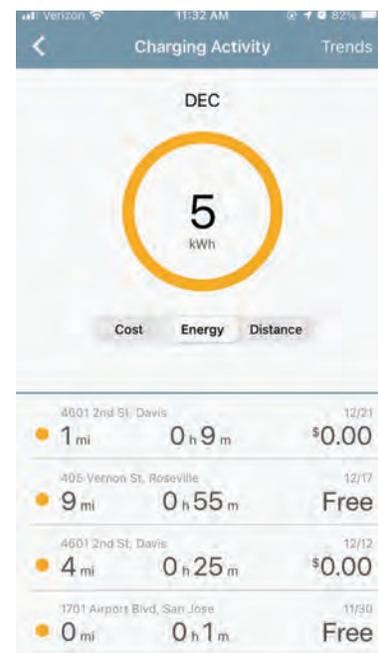
**Phase 1B:** Pay-at-the-Chargepoint used a plug-in device to capture mileage and related trip data, calculate net road charges, and collect electric vehicle charging session data from the Chargepoint Business Partner. Phase 1B operated from January 2021 through June 2021.

Each trip taken in a participating vehicle was captured by the plug-in device and sent to ChargePoint's back-end processing systems. The device captured trip-level data, including distance (miles) traveled (via an end-of-trip odometer value and second-by-second speed over time to derive distance traveled).

Each time participants charged their participating electric vehicles, they were instructed to use their ChargePoint account at a networked ChargePoint electric vehicle charging station. ChargePoint captured valid charging sessions and linked the session to their ChargePoint Demonstration account (example shown in **Figure 18**). Charging session information included on the location of the charging station, type of charge, and energy added to the vehicle during the session.

At the beginning of each month during the Demonstration, ChargePoint used the data from the plug-in device from the previous month to create a simulated road charge transaction for miles traveled and simulated net road charge assessed. ChargePoint emailed a monthly road charge summary to the participant (**Figure 19**).

**FIGURE 18.** ChargePoint Mobile App - Charging Session Log Example





**FIGURE 19.** ChargePoint Monthly Road Charge Simulated Invoice Example

# California Road Charge

## Demonstration Project

Thanks for driving electric and participating in this important research!

February Summary	
Energy added via ChargePoint account	25.654 kWh
Distance measured by plug-in device	146.9 miles
Simulated road charge (miles x \$0.022)	\$3.23

**\*\* This is NOT a bill \*\***

California Road Charge is working to develop a fairer, more transparent, and more sustainable way to fund road and highway repairs based on how many miles Californians drive, regardless of the kind of car they own.

You are participating in this project voluntarily, and this summary shows what your road charge *could* be if one went into effect. **You do not need to pay this simulated road charge.** Your fees for EV charging are not affected by the simulated road charge and are billed through the normal process.

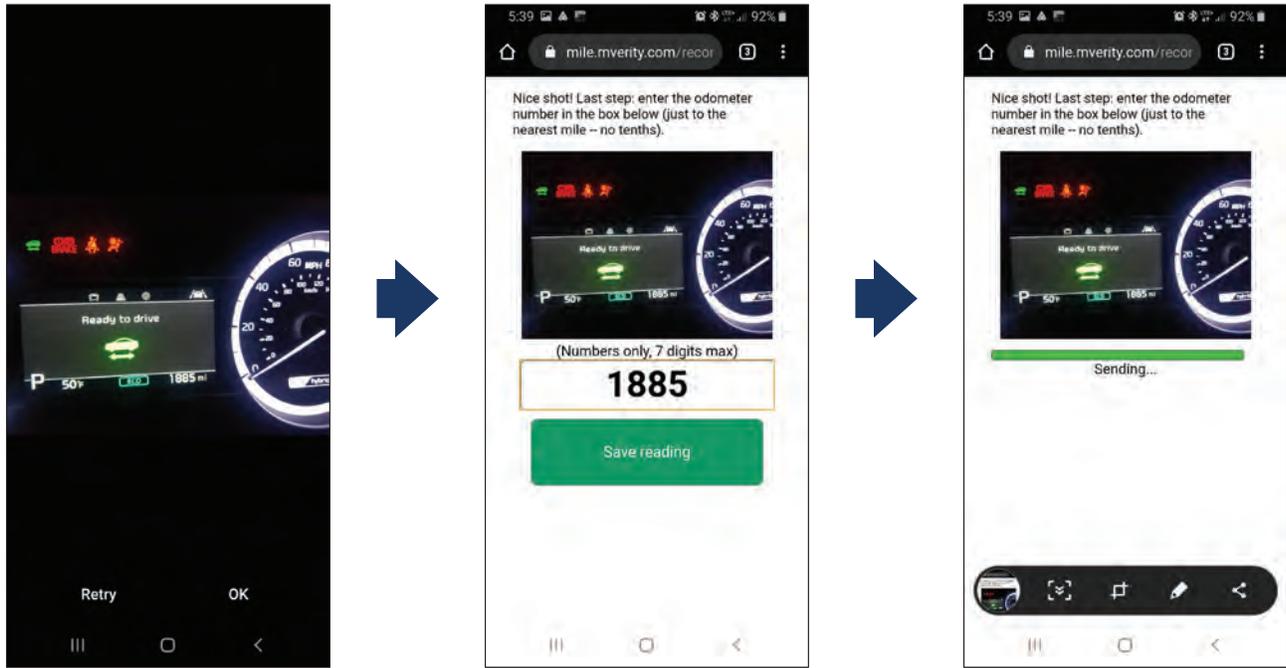
You'll receive these monthly notifications until the six-month demonstration is complete. If you have any questions, please contact the California Road Charge Demonstration team at [info@caroadcharge.com](mailto:info@caroadcharge.com)

### 4.2.3 Phase 2: Usage-Based Insurance

**Phase 2:** Usage-Based Insurance used an odometer image capture and upload process, leveraging smartphone technology and connectivity, to calculate miles traveled between odometer readings. Phase 2 operated from February 2021 through June 2021.

At the end of each month, Mile Auto sent the participant a mobile text notification to upload another odometer photo to the system (**Figure 20**). Mile Auto then used information collected from the images to calculate the miles traveled based on the difference between the uploaded odometer readings and estimate the fuel gallons consumed based on the miles traveled using the EPA published fuel economy in mpg for the participant's enrolled vehicle. Mile Auto calculated the net road charge owed and emailed the participant a mock usage-based insurance monthly invoice that included the simulated usage-based insurance per-mile insurance premium and simulated per-mile road charges (**Figure 21**).

**FIGURE 20.** Phase 2 Usage-Based Insurance Monthly Odometer Upload Process



**FIGURE 21.** Phase 2 Usage-Based Insurance Monthly Mock Road Charge Invoice

## California Road Charge Demonstration Invoice

Markell Moffett  
2204 Maplewood Drive South  
Salem, OR 97306

**ROAD CHARGE ACCOUNT:** 9876543-1  
**INVOICE NUMBER:** 9876543-1-0321-01  
**INVOICE DATE:** MARCH 31, 2021  
**TOTAL DUE:** \$5.66

**\*\* SIMULATED INVOICE – DO NOT PAY \*\***

### Invoice Detail

**VEHICLE #1 - 2020 Kia Niro (VIN KNDCB3LC6L5413207)**

Starting Odometer:	3,158 (Feb 27, 2021)	
Ending Odometer:	3,634 (Mar 26, 2021)	
Miles Driven:	476	
Estimated Fuel Usage:	9.52 gallons (Based on EPA Combined 50 mpg)	
Total Road Charge:	(476 miles @ \$0.022 per mile)	\$10.47
Fuel Tax Credit:	(9.52 gallons @ \$0.505 per gallon)	-\$4.81
<b>VEHICLE #1 - NET ROAD CHARGE</b>		<b>\$5.66</b>

In some cases, your road charge invoice may show a negative total amount due. This means that as a motorist, you are paying more via the motor fuel tax than you would pay via a road charge, based on the current road charge rate of 2.2 cents per mile.

### Your Account Services Provider:

roadchargesimulated**UBI**™

help@roadchargeinsurance.com



### 4.2.4 Phase 3: Ridesharing

**Phase 3:** Ridesharing leveraged existing technology and mobile apps to calculate miles traveled during each ridesharing trip. Phase 3 operated from March 2021 through June 2021.

Participants used the Via mobile app to schedule, take, and pay for rides with Via in the West Sacramento area. Along with the rider's normal Via trip receipt, which the participant received shortly after each ride is completed, Via emailed a daily road charges summary for any rides taken the previous day (**Figure 22**).

**FIGURE 22.** Via Simulated Road Charge Receipt



31-00 47th Ave., 3rd Floor, Long Island City, NY 11101  
[ridewithvia.com](http://ridewithvia.com) | [support@ridewithvia.com](mailto:support@ridewithvia.com) | [Unsubscribe](#)

You are receiving this email because you signed up for  
or expressed interest in Via's service.

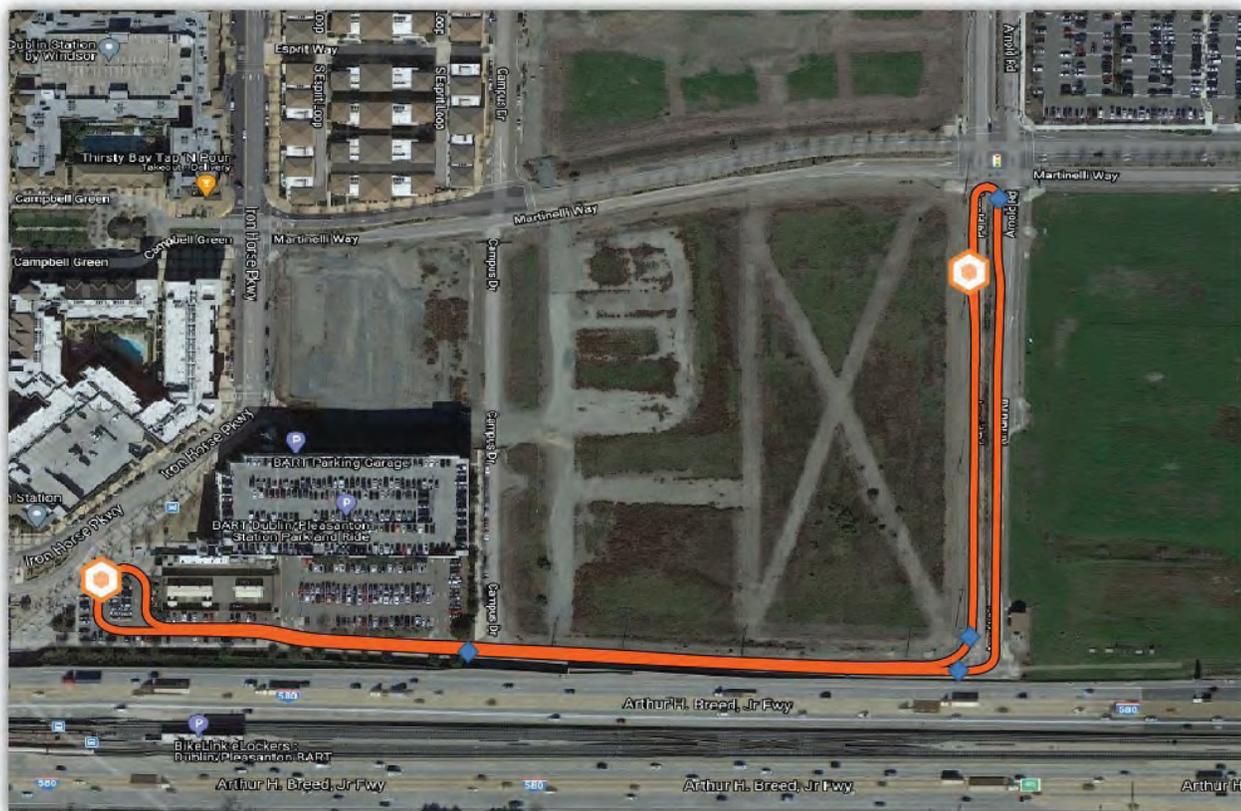
Via collected travel data via the Via “Rider” mobile app and “Driver” mobile app. The Rider mobile app collected reservation-level information. The Driver mobile app collected vehicle travel information. Via used these two sets of data to create unique trips for each participant. Via calculated the estimated fuel gallons consumed based on miles traveled, using the EPA published fuel economy in mpg for the vehicle used for the respective trip. Via then applied the gross road charges and fuel tax credits, and the new (simulated) road charge owed and generated a road charge transaction for the trip.

Mileage shown on the participant’s trip receipt was estimated based on the pickup and drop-off coordinates selected by the rider. Within 24 hours, Via processed the actual location data from the vehicle and mobile app to calculate actual miles traveled. This resulted in minor discrepancies in some participants’ receipts, between what the participant saw on the trip receipt immediately after the trip ended and the simulated road charge summary email received the following day. A disclaimer was added to Via’s simulated road charge summary emails to provide clarity on this topic.

#### 4.2.5 Phase 4: Autonomous Vehicles

**Phase 4:** Autonomous Vehicles Business Partner companies used onboard AV technologies to collect AV data and Ridesharing Business Partner technologies to process that data and simulate a road charge. Phase 4: Autonomous Vehicles operated between April 2021 and June 2021. This phase of the Demonstration involved an autonomous low-speed shuttle operating on a fixed route in Dublin, California (**Figure 23**). This fixed route was approximately 1 mile, operating two days per week, from 9 a.m. to 5 p.m. Pacific Time (the COVID-19 pandemic conditions and restrictions reduced operating days/hours from original scope). The autonomous shuttle leveraged sensors on the vehicle to capture travel data and transmit that data to a repository.

**FIGURE 23.** AV Shuttle Fixed Route for Demonstration



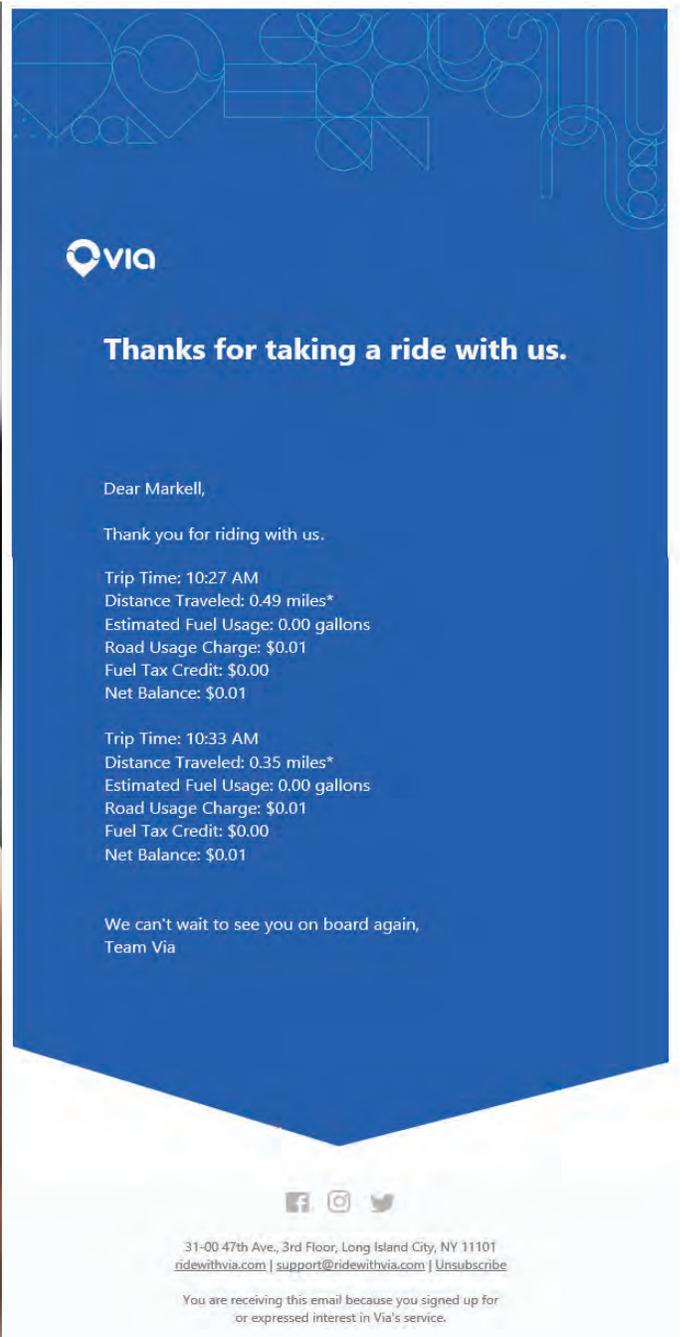
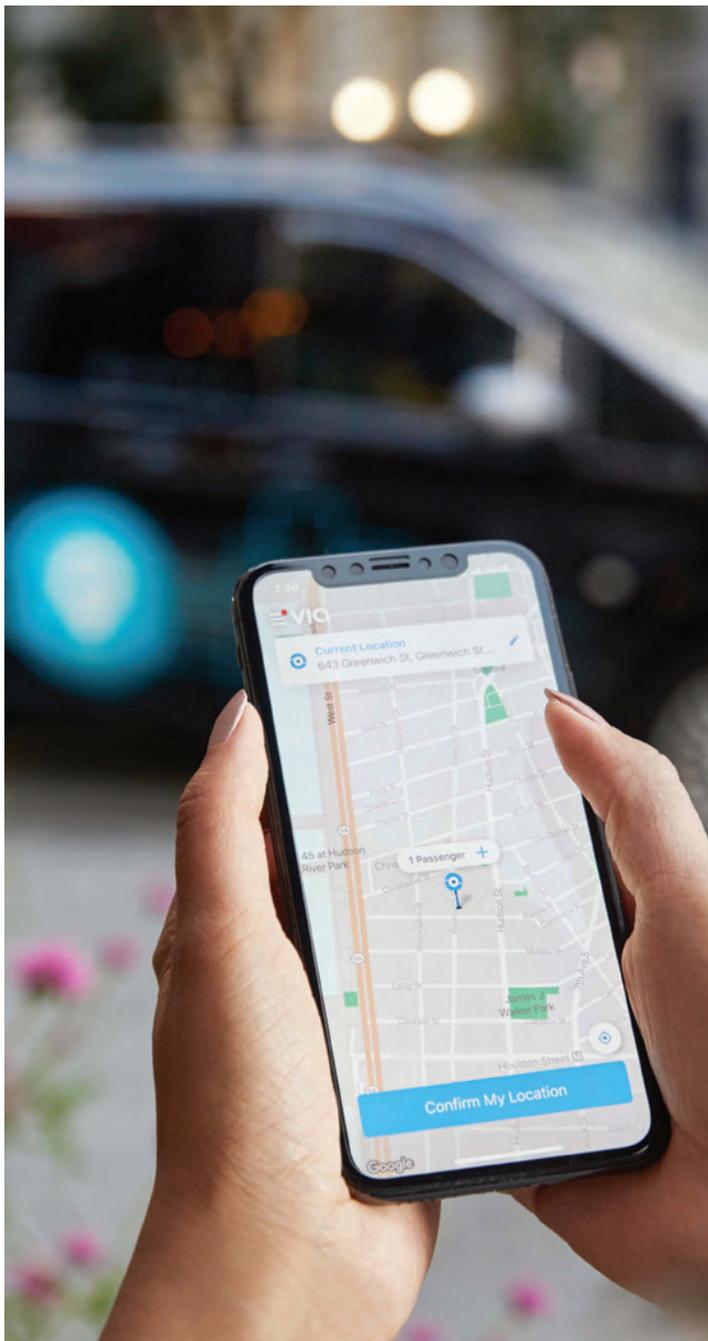


## Section 4. Demonstration Operations

The collected and validated data was then transferred to the Ridesharing Business Partner's Transaction Processing Subsystem. Once transferred, the Ridesharing Business Partner's systems calculated the simulated assessed road charge and generated a road charge receipt (**Figure 24**), showing how the AV operation could be applied to a ridesharing application. The Demonstration Technical Team also uploaded the captured AV data to PRIME for further analyses.

There were no participants in Phase 4: Autonomous Vehicles. Members of the public rode in the participating autonomous shuttle during its normal operations in Dublin, California, but were in no way associated with this Demonstration. No autonomous shuttle riders were surveyed or received any simulated road charge information.

**FIGURE 24.** Road Charge Receipt for Simulated Participant in Phase 4: Autonomous Vehicles





## 4.3 Participant Communications

### 4.3.1 Communications to Participants

The Demonstration customer service team communicated to participants (Phase 1A and 1B, 2, and 3) throughout the operations period, providing information and instructions to participants to encourage enrollment, perform operations tasks, and complete incentive activities. Phase 1A and 1B participants received communications from the Demonstration customer service team for various types of information and requests for action, including:

- ▶ Participant Selection and Enrollment Steps – Requests to complete, and reminders
- ▶ Participant Surveys – Requests to complete, and reminders
- ▶ Demonstration Updates
- ▶ Incentives Tracking and Payout Method Selection
- ▶ Plug-in Device Not Reporting Properly (**Figure 25**) (Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint only)
- ▶ Demonstration Completion and Incentive Payout Information
- ▶ Frequently Asked Questions (FAQs) Fact Sheets for Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint

**FIGURE 25.** Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint Participant Communication Example - Device Not Reporting

CA Road Charge Demo - Device Not Reporting


 California Road Charge Demonstration <info@caroadcharge.com>  
 To [redacted]

↩ Reply ↩ Reply All → Forward ⋮

Hi XXXXX,

Thanks for participating in the pay-at-the-pump phase of the California Road Charge Demonstration!

Our records indicate that your plug-in device has not logged its first trip yet. Your plug-in device captures your miles traveled for the demonstration, so we want to make sure it is plugged in and working properly!

If you have not plugged the device in yet, please do so – you should have received a quick installation guide with your device to guide you through the process (if you did not, please let us know and we can walk through the installation process with you). If your device is plugged in, it may not be seated properly in the onboard diagnostics port. If this is the case, please unplug the device and plug it back in, making sure its connection in the port is snug.

If you have any questions, please let us know at [info@caroadcharge.com](mailto:info@caroadcharge.com). We're glad to have you on the team!

Thanks and have a great day.

The Road Charge Demonstration Team

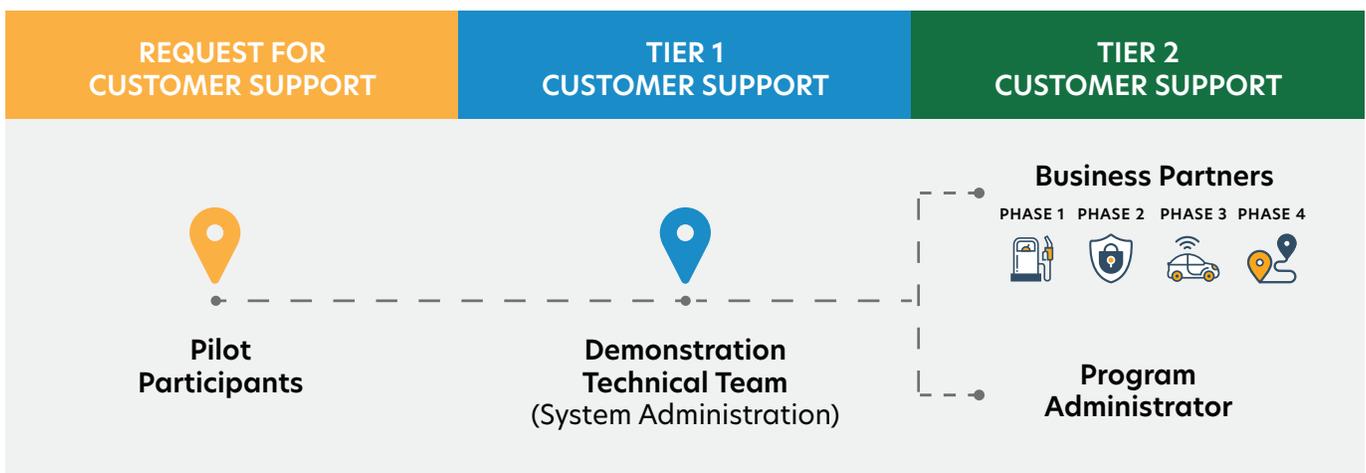
### 4.3.2 Customer Service

The Demonstration Technical Team developed a customer support framework to assist Demonstration participants with various issues, such as enrollment and onboarding, reporting and calculation questions, invoicing inquiries, technical support, and other issues and inquiries. This framework was provided only for the road charge activities, as each Business Partner already maintains a customer service mechanism for their existing services. The Demonstration’s approach to customer service was consistent across all three of the participant-based Demonstration phases, with two progressive tiers of support established:

- ▶ **Tier 1 Customer Support:** Administered by the Demonstration Technical Team, Tier 1 customer support managed incoming participant inquiries and requests for customer support, resolved inquiries and requests where possible, or escalated inquiries and requests to Tier 2 customer support as appropriate.
- ▶ **Tier 2 Customer Support:** Involving the Program Administrator and the Business Partners of each phase, Tier 2 customer support received incoming participant inquiries and request for customer support escalated from Tier 1 customer support, resolved inquiries and requests where possible, or redirected to Tier 1 customer support for further action as appropriate.

**Figure 26** illustrates the general flow of requests for customer support from participants. Participants would initially request support through customer support channels (discussed later in this section). Tier 1 customer support was managed by the Demonstration Technical Team and involved initial screenings of customer support requests to determine the appropriate course of action. The Team would resolve the issues they could, including answering requests for information on the Demonstration and how each phase worked, explaining calculations and simulated invoices, coordinating account updates with Business Partners (where able), and providing other general Demonstration customer support. If issues could not be resolved in Tier 1, requests were escalated to Tier 2. Depending on the specific nature of each issue, escalation to Tier 2 was directed to either one of the Business Partners or to Caltrans. In general, issues related to the typical operations of Business Partner services, or those that related to the technical function of Demonstration components, were directed to the relevant Business Partner. Issues that were broader in scope, such as those related to the overarching road charge program, were directed to Caltrans. The Program Administrator (Caltrans) served as the entity monitoring the overarching operation and success of the Demonstration and provided informative customer support on matters related to the overarching Demonstration.

**FIGURE 26.** Flow of Customer Support from Participants to Tier 1 and Tier 2 Support



Participants were able to access Demonstration customer support through three major channels:

- ▶ **Toll-Free Customer Support Hotline** - A toll-free customer support hotline was established with one telephone number for the entire duration of the Demonstration, consistent across all four phases of the project. The number was tied to a Voice over Internet Protocol (VoIP) system with calls being automatically routed to Demonstration Technical Team member phones to provide service. The toll-free hotline operated from 8:30 a.m. to 5:30 p.m. Pacific Time, Monday through Friday, for the duration of the Demonstration. At least two Technical Team members were available during hotline operating hours. If no Technical Team member was able to take an incoming call, or if calls were received outside of operating hours, the call was routed to voicemail. The Technical Team responded to all voicemails within one business day.
- ▶ **Dedicated Email Address / Inbox** - A dedicated Demonstration customer support email address was created under the California road charge website domain: [info@caroadcharge.com](mailto:info@caroadcharge.com). The Demonstration Technical Team monitored the dedicated inbox daily for incoming support requests and replied to open inquiries. Incoming support requests/emails were responded to within one business day.
- ▶ **Participant Portal** - The Participant Portal was established as a component of the California road charge website and featured a support request form for participants to submit questions or requests. Support request form submissions were forwarded as emails to the Demonstration Technical Team's dedicated inbox, [info@caroadcharge.com](mailto:info@caroadcharge.com). The Demonstration Technical Team monitored the dedicated this inbox daily for incoming support requests from the Participant Portal support request form. Incoming support requests will be responded to within one business day.

Service level requirements for the Technical Team, Business Partners, and Program Administrator for Tier 1 and Tier 2 customer service are summarized in **Table 23**.

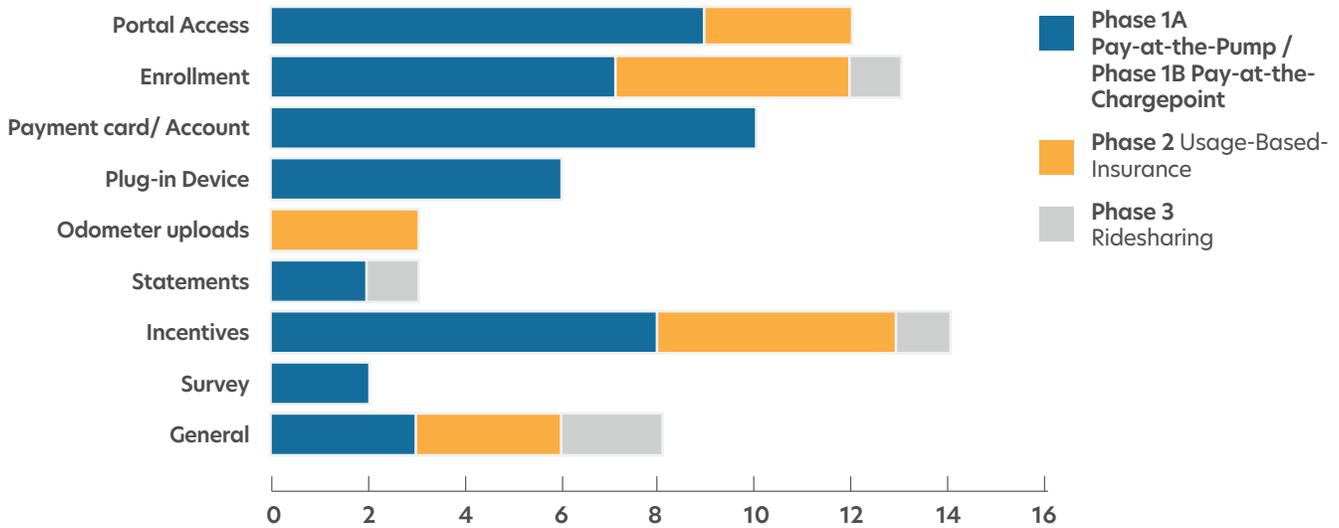
**TABLE 23. Customer Service Level Requirements**

CUSTOMER SERVICE TIER	REQUIREMENT
Tier 1	95 percent of incoming hotline calls answered before routed to voicemail
	Voicemails responded to within one business day
	Participant Portal support request form submission responded to (via email or phone) within one business day
	Resolution (or escalation to Tier 2) of customer support issues and inquiries within three business days
Tier 2	95 percent of incoming Tier 2 phone calls answered within five minutes
	95 percent of emails/online inquiries acknowledged within one business day
	Resolution of customer issues and inquiries within three business days

The Demonstration Technical Team managed customer support tracking and reporting. Upon receipt of a request for customer service through the hotline, Participant Portal, or email, the Demonstration Technical Team documented the interaction as a record in the customer support tracking system. Records included a unique case identifier to each request, information on the relevant phase of the Demonstration, the nature of the request made, and resolution or ongoing support and communications to resolve the issue. Each week, logged customer support items were analyzed by the Program Administrator and members of the Demonstration Technical Team. Resolution times, root causes, and other considerations were compared against the established metrics in the

Service Level Agreement. Unresolved issues were discussed with root causes and remediation actions presented to Caltrans for approval as Demonstration enhancements. The types of inquiries submitted for each phase of the demonstration are shown in **Figure 27**.

**FIGURE 27.** Tier 1 Customer Support Inquiries by Type, by Phase



**Table 24** summarizes Tier 1 customer inquiries received over the course of the Demonstration.

**TABLE 24.** Tier 1 Customer Inquiries and Resolution

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	POST-DEMONSTRATION	TOTAL
<b>(#) Total Tier 1 Customer Inquiries:</b>	12	12	14	7	7	10	9	<b>71</b>
<b>(#) Inquiries escalated (to Business Partner or Caltrans):</b>	2	0	1	1	0	2	0	<b>6</b>
<b>(#) Inquiries resolved within three business days:</b>	12	12	14	7	7	10	9	<b>71</b>
<b>(#) Inquiries NOT resolved within 3 business days:</b>	0	0	0	0	0	0	0	<b>0</b>

As the table shows, there were several items escalated from Tier 1 to Tier 2 over the course of the Demonstration:

- ▶ **January:** An “HTTP404” error from a Business Partner prevented a participant from completing enrollment. The Business Partner resolved the issues and responded within same day. Another participant encountered difficulty during enrollment when linking an existing Business Partner account with their participant account. The issue was resolved by the Business Partner the next day.
- ▶ **March:** A participant encountered difficulty completing the enrollment process. The Business Partner coordinated with the participant to ensure successful enrollment.
- ▶ **April:** One escalation to the Usage-Based Insurance Business Partner for participant whose enrollment email bounced back, email was triggered manually, and the participant completed the signup the following day.
- ▶ **June:** Two escalations to the Usage-Based Insurance Business Partner for participants that were unable to access their vehicle during the end-of-month odometer upload period. The Usage-Based Insurance Business Partner coordinated with the two participants to collect their final monthly odometer readings in alternative ways.

**Table 25** summarizes the calls received to the Demonstration customer service hotline, while **Table 26** summarizes emails and online inquiries received. As Table 26 shows, there have been instances over the course of the Demonstration where phone calls were not immediately answered. However, in all cases, the call was returned within one business day. In several cases a call was not answered because the caller hung-up. All e-mails were responded to within one business day.

**TABLE 25. Summary of Tier 1 Customer Service Phone Calls**

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	POST-DEMONSTRATION	TOTAL
<b>(#) Total Tier 1 phone calls:</b>	1	5	7	4	1	1	2	<b>21</b>
<b>(#) Tier 1 phone calls answered (not sent to voicemail):</b>	1	2	4	3	1	1	2	<b>14</b>
<b>(%) of Tier 1 phone calls answered (not sent to voicemail):</b>	100%	40%	57%	75%	100%	100%	100%	<b>67%</b>

**TABLE 26. Summary of Tier 1 Customer Service Emails and Online Inquiries**

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	POST-DEMONSTRATION	TOTAL
<b>(#) Total Tier 1 emails/online inquiries:</b>	11	26	40	11	21	19	25	<b>153</b>
<b>(#) Emails/online inquiries responded to within one business day:</b>	11	26	40	11	21	19	25	<b>153</b>
<b>(%) of emails/online inquiries responded to within one business day:</b>	100%	100%	100%	100%	100%	100%	100%	<b>100%</b>

### 4.3.3 Participant Surveys

Surveys of participants at various points during the Demonstration provided the Demonstration Technical Team with insight into how participants experienced the program, where the challenges were, and how perceptions of the Demonstration changed over time. The Demonstration Technical Team conducted quantitative style surveys with Demonstration participants at three phases of their participation in the Demonstration: at the beginning of their participation (a pre-test), during their participation (a mid-test), and at the conclusion of their participation (a post-test).

The topics covered by the participant surveys included satisfaction with various aspects of the Demonstration, questions about their understanding of the operational concept of the Demonstration, any challenges they faced in their participation, and effectiveness of information provided on the

Demonstration. Surveys informed understanding of key attitudes, such as support for road charge, satisfaction with participation, and perceptions of items like data security, accuracy, and fairness.

Participant surveys were conducted almost entirely online. Participants received e-mails from the Demonstration Technical Team inviting them to take the survey. The Demonstration Technical Team's participant management platform notified team members when it was time for a particular participant to receive a survey notice. Survey data collection was monitored daily, with reminder emails sent as needed to increase response rates. Following the conclusion of each wave of data collection, the data was cleaned, coded, and analyzed in preparation for reporting.

The results of the analysis are discussed in Section 5: Demonstration Results and Observations. Information and insights gathered through these participant surveys will not only aid in evaluating the performance

of the Demonstration but will also inform communications planning for subsequent road charge program development and implementation. The state will be more aware of how perceptions about the program are likely to change as awareness becomes more widespread. Furthermore, survey results may be used to inform refinements to road charge operations and administration as related to participation experience.

## 4.4 Participant Incentives

For all participants from the general public, Caltrans offered incentives of up to \$100 per participant to compensate them for their time. Incentives were offered to participants based on completion of certain activities. **Table 27** provides an overview of incentive-eligible to be paid out to participants for their involvement in the Demonstration and the associated milestones for payment. Incentive payments for milestone activity completion were paid at the end of the entire Demonstration, via mailed check or electronic Visa gift card (based on selection made by the participant).

**TABLE 27. Participant Incentive Activity and Amount Breakdown**

DEMONSTRATION ACTIVITIES	PHASE 1A AND 1B: PATP/PATCP	PHASE 2: UBI	PHASE 3: RS	PHASE 4: AV
Fuel up your car using your GasBuddy payment card / charge your electric vehicle using your ChargePoint account at least five times <i>\$10 each, up to \$50 total</i>	\$10 each = \$50 possible			N/A - No participants
Upload your odometer picture and validate your odometer reading through the UBI odometer upload portal once each month during the 5-month Demonstration <i>\$10 each, up to \$50 total</i>		\$10 each = \$50 possible		N/A - No participants
Schedule and take at least five trips with Via over the course of the 4-month Demonstration period using the Via app and your established account in their West Sacramento service area <i>\$10 each, up to \$50 total</i>			\$10 each = \$50 possible	N/A - No participants
Complete Participant Survey #1	\$15	\$15	\$15	N/A - No participants
Complete Participant Survey #2	\$15	\$15	\$15	N/A - No participants
Complete Participant Survey #3	\$15	\$15	\$15	N/A - No participants
Account closeout (Note that no incentives will be paid until account is successfully closed out) (Phase 1A and 1B must also return device)	\$5	\$5	\$5	N/A - No participants
<b>Total Available</b>	<b>\$100</b>	<b>\$100</b>	<b>\$100</b>	<b>N/A</b>

Key: Pay-at-the-Pump (PATP); Pay-at-the-Chargepoint (PATCP); Usage-Based Insurance (UBI); Ridesharing (RS); Autonomous Vehicles (AV)

The Demonstration Team tracked each incentive-eligible activity that a participant completed during the Demonstration. Participants were able to view their incentive-eligible activities and which they completed on the Participant Portal (example shown in **Figure 28**). Participants were presented the option to self-identify as an employee of CalSTA or its subsidiary departments. If a participant selected “yes,” their incentives tracking table disappeared.



**FIGURE 28.** Participant Portal Incentives Tracking Page - Example from Phase 2 Usage-Based Insurance

English Español

[About Road Charge](#)
[Our Partners](#)
[Road Charge Projects](#)
[Engage](#)

# Incentive Tracker

### Track Your Incentives

There may be a delay in when you have completed an incentive-eligible activity and when it is displayed on this site. If you have questions on whether a completed activity is being correctly logged, please contact us at [info@caroadcharge.com](mailto:info@caroadcharge.com)

**NOTE:** Employees of the California State Transportation Agency (CalSTA) or their subsidiary departments are not eligible to receive any demonstration incentives. CalSTA departments are listed here: <https://calsta.ca.gov/departments>

Are you an employee of the California State Transportation Agency (CalSTA) or their subsidiary departments?

 Yes

Submit

### Participant Portal

- [Portal Home](#)
- [Incentive Tracker](#)
- [Participant FAQs](#)
- [Change Password](#)
- [Logout](#)

**Odometer Upload**  
Upload your odometer picture and validate your odometer reading through the UBI odometer upload portal.

✓ Odometer Upload 1	\$10
✓ Odometer Upload 2	\$10
✓ Odometer Upload 3	\$10
Odometer Upload 4	\$10
Odometer Upload 5	\$10

**Surveys**  
Complete participant surveys.

✓ Pre-Demo Survey	\$15
✓ Mid-Demo Survey	\$15
Post-Demo Survey	\$15

**Complete Account Closeout Activities**  
At the end of the demonstration, complete account closeout activities.

Account Closeout	\$5
------------------	-----

**Current Total:** \$60  
(out of \$100 in possible incentives)

### Participant Questions

Submit your questions or comments to the project team during any phase of the Road Charge Demonstration.

Comment:

Submit

Or you can call us at (833) 651-1281  
*Hours of Operation: Monday thru Friday  
8:30 am – 5:30 pm Pacific Time*

**TABLE 28. Incentive-Eligible Participant Counts & Payout Amounts for All Phases**

PHASE	PARTICIPANTS	INCENTIVE AMOUNTS
Phase 1A: PATP	21	\$1,245
Phase 1B: PATCP	8	\$780
Phase 2: UBI	21	\$2,005
Phase 3: RS	6	\$370
Ineligible Participants	27	\$2,700 not paid
Uncompleted Incentives	(varies)	\$1,200 not paid
<b>TOTALS</b>	<b>83</b>	<b>\$8,300</b>

Key: Pay-at-the-Pump (PATP); Pay-at-the-Chargepoint (PATCP); Usage-Based Insurance (UBI); Ridesharing (RS)

**FIGURE 29. Incentives by Phase**

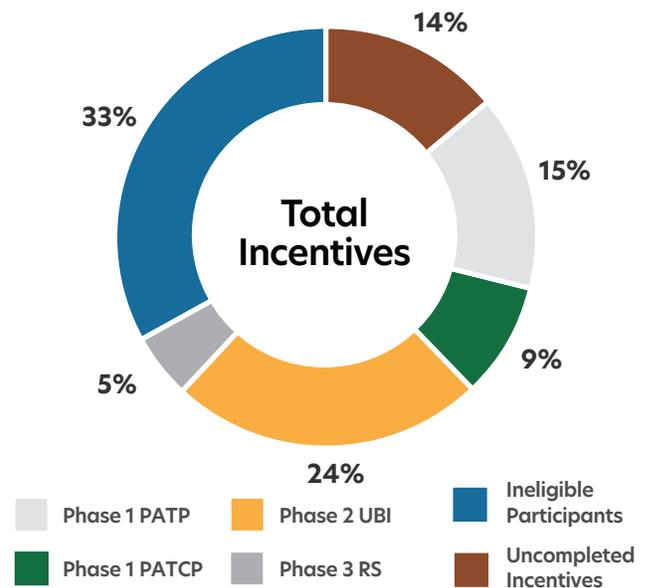


Figure 29 shows the breakdown of incentives by phase, as well as incentives not paid out due to ineligibility or incentive activities not completed by incentive-eligible participants.

Fifty-one participants received incentive payouts for completing incentive-eligible activities. Five participants (all in Phase 1A: Pay-at-the-Pump) did not complete any incentive-eligible activities and did not receive any incentive payout. Twenty-seven participants were considered ineligible to receive incentive payouts, either because they self-declared as an employee of CalSTA or its subsidiary departments or were flagged by the Caltrans Project Team as ineligible to receive incentives due to affiliation with the project.

## 4.5 Website Administration

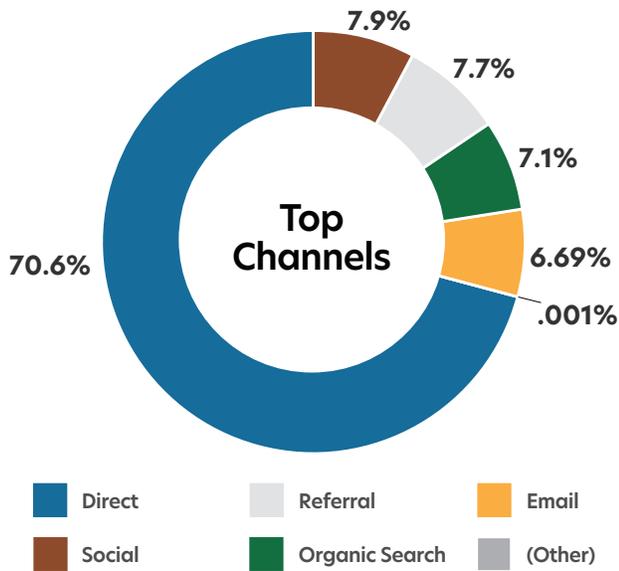
Dedicated to the communications and information dissemination of the California Road Charge Program, the California Road Charge Program website relaunched in 2020. The website included a contact form for members of the public to submit questions and comments, for interested parties to provide an expression of interest in receiving periodic communications about the Road Charge program, or for those interested in participating in the Demonstration. Table 29 summarizes visits to the website, public comments submitted on the website, and the number of interested parties added through the intake page summary.

**TABLE 29. Website Hits and Form Submissions**

	WEBSITE HITS	PUBLIC COMMENTS	INTERESTED PARTIES
<b>Before Demonstration Launch October to December 2020</b>	12,326	1,578	1,406
<b>After Demonstration Launch</b>			
<b>January 2021</b>	810	29	22
<b>February 2021</b>	1,443	65	44
<b>March 2021</b>	1,378	11	8
<b>April 2021</b>	1,062	8	11
<b>May 2021</b>	803	73	31
<b>June 2021</b>	611	4	3
<b>Total to Date</b>	<b>18,433</b>	<b>1,768</b>	<b>1,525</b>

**Figure 30** summarizes the channels through which website visitors found and accessed the Demonstration website. As the figure shows, the largest number of visitors accessed the page through a direct link provided by a newsletter, email, or press release.

**FIGURE 30.** Channels Directing Visitors to the Website - September 2020 through June 2021



## 4.6 PRIME Administrative Portal and Analytics Dashboards

### 4.6.1 PRIME Administrative Portal

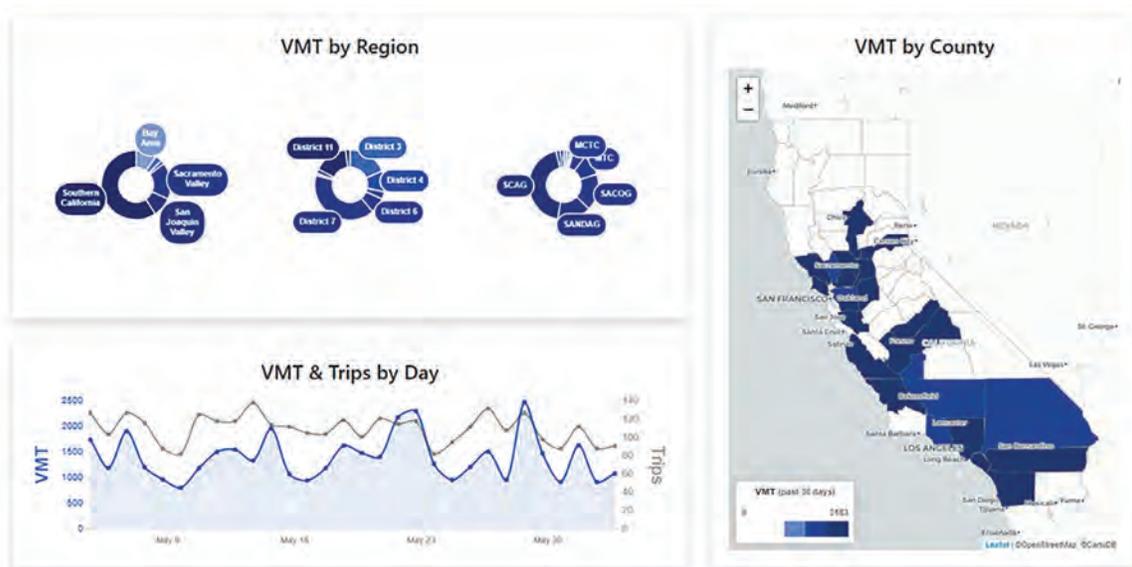
The PRIME administrative portal (**Figure 31**) provided access to Demonstration Administrators about the status of Demonstration operations. The web portal provided information about participants, their enrollment status, and associated vehicles, as well as locations to monitor device health and interactions with the Business Partners (**Figure 32**).

The web portal included administrative functionality for Demonstration Administrators to manage Demonstration operations, including:

► **Dashboards:**

- VMT Summary: VMT by region, by county, and trips by day - dashboard level snapshots.
- Admin: Report generation page - Ability to pull summary reports for each Business Partner, for any reporting period, formatted in a JSON or CSV export.

**FIGURE 31.** PRIME Administrative Portal VMT Summary Dashboard





- ▶ **Participants:** Add new participants, update existing participants, associate vehicles and devices, associate to a Business Partner, review general travel information).
- ▶ **Business Partners:** Add new Business Partners, update existing Business Partners, associate participants to a Business Partner, update existing participant associations, review summary reports.
- ▶ **Vehicles:** List of vehicles associated to participants in Phase 1A and 1B and Phase 2 (no vehicles for Phase 3, only one vehicle for Phase 4 that is not managed by Administrators).
- ▶ **MROs:** List of MROs, also referred to as devices, assigned to Phase 1A and 1B participants and their current activity status.

**FIGURE 32.** PRIME Administrative Portal - Participant Page (Example)

California Road Charge

**Kent, Clark**  
cfb447ee-3609-4a21-a857-02e17a1895a8

Phone: 0 -  
Email: [clark.kent@dailyplanet.com](mailto:clark.kent@dailyplanet.com)  
Address: 517 Market St, Metropolis, IL 62960 (map)  
Enrollment Date: 2021-01-14  
Enrollment Type:  
Active:

Notes:

Participant Statistics

[Vehicles and Mileage Recording Devices](#)

[New Vehicle](#) [Edit Vehicle](#) [Edit MRO \(Device\)](#)

	VIN	MRO	Year	Make	Model	License Plate	Fuel Use Method	EPA MPG Rating	Notes
<input type="checkbox"/>	SUPERMAN	245362	1979	LEX	LUTHER	-	1	24	-

[Business Partner Relationship](#)

[Participant Trips \(last 30 days\)](#)

### 4.6.2 PRIME Analytics Dashboards

The PRIME system included functionality to perform analytics on Demonstration data to assist in managing Demonstration operations as well as provide transportation-related metrics and dashboards. While not all Californians may choose to share their location information in a road charge system, for those that do, the Demonstration Team wished to explore potential applications of that data to improve the safety and efficiency of the State’s transportation network.

PRIME dashboarding included operational and financial summaries (as reported monthly during the Demonstration) with dynamic parameters to change date ranges and reporting period types to see snapshots of Demonstration data at various intervals to simulate revenue flows (**Figure 33**).

**FIGURE 33.** PRIME Dashboard - Monthly Reporting Snapshot

## Monthly Report

Select a reporting period:

Month  Quarter  Year

Filter by month or date range:

January February March April May June

01/01/2021 → 06/30/2021

### Operational & Financial Summary

#### Phase 1: Pay-at-the-Pump (GasBuddy) Simulated Revenues

Month	Vehicles Reporting	Total Miles	California Miles	Out-of-State Miles	Other Miles	Fuel Purchased (gal)	Gross Road Charge (\$0.022/mi)	Fuel Tax Credit (\$0.505/gal)	Net Road Charge
January 2021	3	522.3	522.3	0.0	0.0	0.0	\$11.49	\$0.00	\$11.49
February 2021	13	6,016.2	6,016.2	0.0	0.0	234.8	\$132.36	-\$118.59	\$13.77
March 2021	24	14,600.2	14,444.0	156.2	0.0	454.6	\$100.70	-\$228.07	\$72.63

Another dashboard developed in PRIME provided information on trips captured from Phase 1A- and 1B-participating devices that indicated whether participants could have used available transit. The Transit Accessible Trips dashboard (**Figure 34**) allows users to select individual trips (sanitized of PII) by a participant to see how that trip may have occurred using transit in the area.

The dashboard provided directions for taking the trip via transit, which may highlight whether the trip would have been more efficient using transit, or if there were potential reasons not to take transit to complete the trip (such as the next available bus on the route would not have arrived at the stop for 2 hours).

**FIGURE 34.** PRIME Dashboard - Transit Accessible Trips Snapshot

### Transit Accessible Trips

#### Potential Transit Trip

Transit Travel Time: 4 minutes  
 This transit trip is 8 minutes faster than driving  
 Directions for Trip:

- Board Route 171-JIBE Southwest at DUCKHORN DR & ARENA BLVD (SB)(7308) at 17:41:00 -> Arrive at DUCKHORN DR & SAN JUAN BLVD (SB)(7309) at 17:45:00

- Approximate Drive Trip Origin
- Approximate Drive Trip Destination

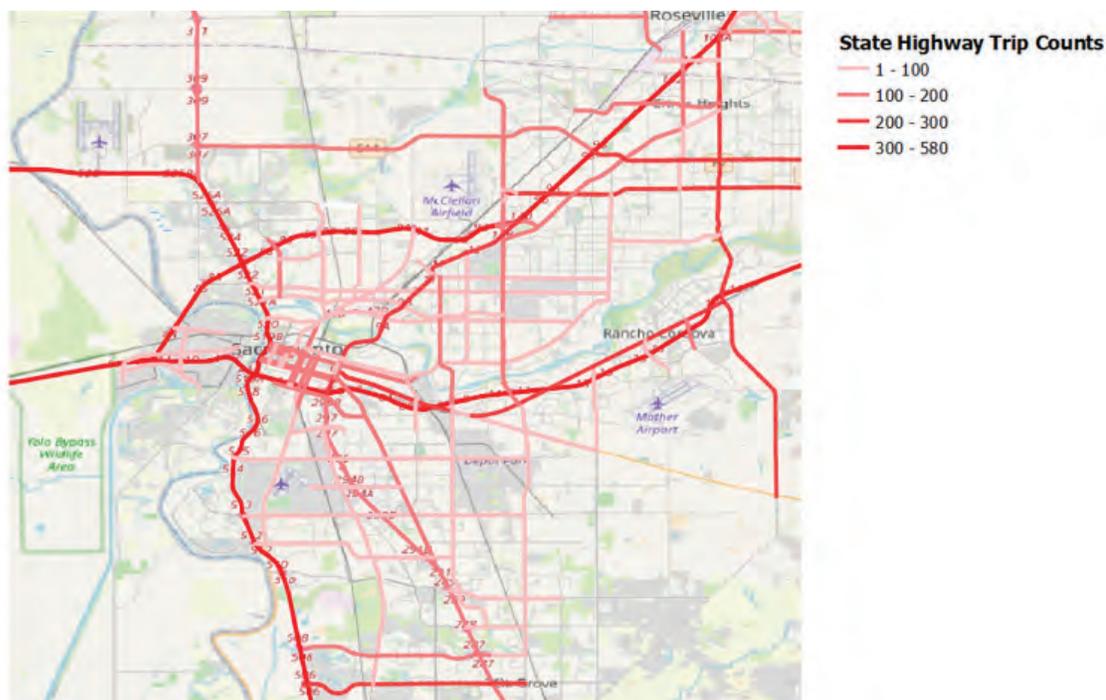


Showing 1 to 10 of 123 rows 10 rows per page

Device ID	Start Time	End Time	VMT	Auto Travel Time	From Station	To Station	Transit Travel Time
0110986006	Mon, March 8, 2021, 5:40 PM PST	Mon, March 8, 2021, 5:52 PM PST	2.5 miles	12 min	7308	7309	4 min



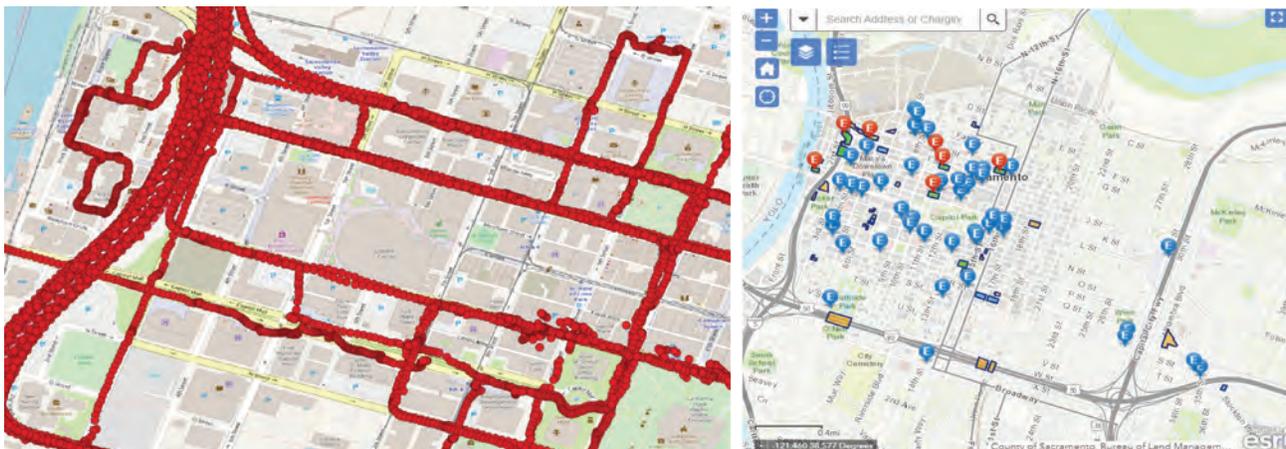
**FIGURE 35.** PRIME Snapshot Dashboard - Highway Trip Concentrations



PRIME snapshot dashboards were also created to identify potential use cases for analysis to inform data-driven decisions. Some of the snapshot dashboards created in PRIME included:

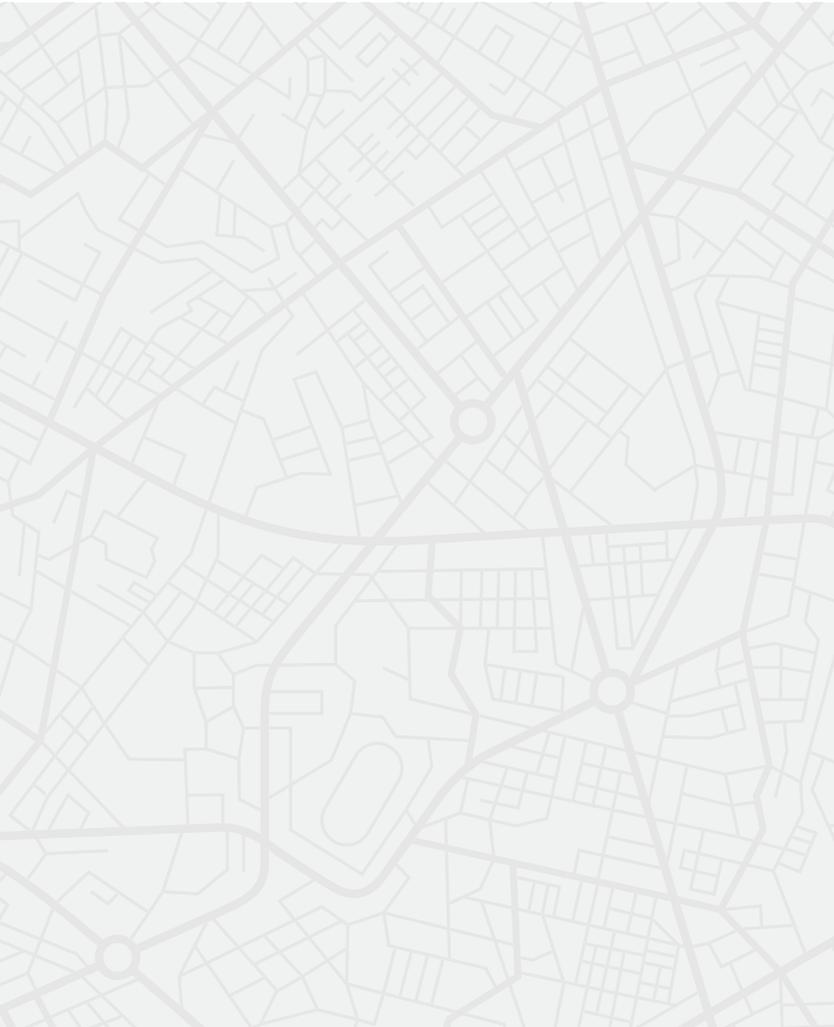
- ▶ **Highway Trip Concentrations (Figure 35):** Identified real-time congestion and which corridors were operating most efficiently; Could lead to identifying how to better fund roadway maintenance.
- ▶ **Electrical Grid Impacts (Figure 37):** Determine the optimal locations for installing charging stations based on electric vehicle travel concentrations, as well as identified potential electrical grid surges due to electric vehicle charging activity.
- ▶ **Complete Streets Considerations (Figure 36):** Identified trips less than two miles and analyzed the traveled roadways to determine why the road user may have chosen to drive rather than take alternative modes (bicycle, walking), such as a roadway that had no sidewalks or was auto-oriented and not safe for a pedestrian.

**FIGURE 36.** PRIME Snapshot Dashboard - Electrical Grid Impacts





**FIGURE 37.** PRIME Snapshot Dashboard - Complete Streets Considerations



## 4.7 Systems Management

Throughout all phases of the Demonstration live operations, the systems and networks used to support the Demonstration were actively managed through automated and manual activities performed by the Demonstration Technical Team. Automated resource management included fail-safes where needed (e.g., to prevent data loss, data was retained until confirmation from the receiving system that the data had been received), backup and recovery processes (including time travel—the ability to access deleted historical data for a preconfigured period of time without having to recover the entire backup), and redundant systems for business-critical functions (such as running scheduled jobs to process data). Manual resource monitoring included the Demonstration Technical Team performing validation checks on automated processes and systems, random data validation checks, and monitoring the access to, use, and processing of data in the clearinghouse.

Additionally, the monthly progress reports showed historical data of system performance across the following categories:

- ▶ **System Uptime:** The percent of time the system was operational during the month based on the total time in the month the system could have been available along with justifications for any downtime less than 99.9 percent.
- ▶ **System Maintenance:** Maintenance activities performed on the system and the corresponding downtime statistics.
- ▶ **Change and Configuration Management:** Changes made to the system during the month along with the status of the change, which resolutions were applicable, and a list of affected requirements.
- ▶ **PRIME Database Summary:** Statistics summarizing PRIME activity including interfaces in and out of PRIME, the amount of database storage in gigabytes, Snowflake “Credits” (the number of raw cloud data-processing hours), and the number of GPS events captured (GPS events include second-by-second GPS latitude/longitude pings during active trips, connect and heartbeat events, and trip events (parameters for trip start/end)).

A summary of these statistics via the monthly progress reports is shown in the **Tables 30, 31, and 32**.

**TABLE 30. Summary of Monthly System Uptime**

METRIC	MONTH						
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Average
System Uptime (%)	99.96%	99.963%	100%	100%	100%	100%	99.98%
(%) of System Downtime (%)	0.04%	0.057%	0%	0%	0%	0%	0.02%
Explanation of Downtime	GasBuddy HTTP404 error for new enrollments	<a href="http://caroadcharge.com">caroadcharge.com</a> website crash on February 2, 2021	N/A	N/A	N/A	N/A	--

**TABLE 31. Summary of Monthly System Change and Configuration Management**

CHANGE DATE	DESCRIPTION	STATUS	RESOLUTIONS	AFFECTED REQUIREMENTS
January 2021	No changes	N/A	N/A	N/A
February 2021	No changes	N/A	N/A	N/A
March 19, 2021	GasBuddy transactions missing for Dry Run testers	Completed	GasBuddy generated transactions and summary emails for Dry Run participants 3/19/2021	BP.BLL.1; AM.BLL.1; AM.BLL.2
March 21, 2021	GasBuddy displaying incorrect road charge rate in summary email	Completed	Road charge summary email template updated	AM.BLL.4
March 22, 2021	Mile Auto using incorrect road charge rate for February invoices	Completed	Mile Auto changed rate (from 2.3 cents to 2.2 cents) in system, regenerated invoices, and reissued invoices to participants for February 2021 travel	BP.REP.3; BP.REP.4; TP.MRT.1

**TABLE 32. Summary of Monthly PRIME Activity**

METRIC	MONTH					
	Jan.	Feb.	Mar.	Apr.	May	Jun.
# of Active Interfaces in/out (Business Partners)	4	4	5	6	6	6
Database Storage (Gigabytes)	4.628	17.22	28.33	68.4	155.37	195.07
Snowflake Credits (Hours)	36.21	193.28	265.54	421.87	1,287.9	423.99





## Section 5

# DEMONSTRATION RESULTS AND OBSERVATIONS

The operational Demonstration included a number of data gathering activities in terms of collecting and processing road usage data, collecting input from participants on their experience, collecting and analyzing public opinion data, and conducting business case research in support of future road charge program development and administration. This section summarizes the results and observations from the Demonstration's various data gathering activities as follows:

- ▶ Operational and financial summary
- ▶ Participant perceptions
- ▶ General public perceptions
- ▶ Business model analysis
- ▶ Observations
- ▶ Demonstration accomplishments
- ▶ Independent evaluation

## 5.1 Operational and Financial Summary

The Demonstration tested road charge administration in conjunction with emerging mobility services as a potential transportation funding replacement for the state's fuel excise taxes. Two of these phases (Phase 1A: Pay-at-the-Pump and 1B: Pay-at-the-Chargepoint and Phase 2: Usage-Based Insurance) were conducted at a statewide level. This section summarizes the estimated revenues collected over the course of the Demonstration and the travel volumes for the statewide phases.

### 5.1.1 Simulated Road Charge Revenues

The rate applied in the Demonstration was intended to be revenue neutral from the perspective of the user. In other words, it was set so that average drivers would pay the same amount in road charge as they typically would in fuel taxes. **Table 33** summarizes total simulated revenues generated in each phase of the Demonstration under this rate structure.

**TABLE 33. Demonstration Simulated Revenue Summary**

	TOTAL MILES	GALLONS OF FUEL PURCHASED	GROSS ROAD CHARGE	FUEL TAX CREDITS	NET ROAD CHARGE
<b>Phase 1A: Pay-at-the-Pump</b>	80,675	2,246	\$1,766.05	\$1,134.33	\$631.72
<b>Phase 1B: Pay-at-the-Chargepoint</b>	21,763	N/A	\$478.82	N/A	\$478.82
<b>Phase 2: Usage-Based Insurance</b>	72,116	2,371	\$1,586.55	\$1,197.35	\$389.20
<b>Phase 3: Ridesharing</b>	175	7	\$3.86	\$3.53	\$0.33
<b>Phase 4: Autonomous Vehicles</b>	295	N/A	\$6.49	N/A	\$6.49

As the table shows, each of the phases generated net revenue over the course of the Demonstration. Phase 1B: Pay-at-the-Chargepoint and Phase 4: Autonomous Vehicles involved electric vehicles that would not receive fuel tax credits and would therefore be expected to generate net revenue, regardless of the rate. The subsequent sections provide additional detail on the simulated revenues generated under each of the phases.

#### **Phase 1A: Pay-at-the-Pump Simulated Revenues (GasBuddy)**

**Table 34** summarizes monthly travel trends and associated simulated revenues collected under the pay-at-the-pump account option in Phase 1A. As the table shows, the six months of operation generated net simulated revenues from participants with April being the only month where fuel tax credits exceeded gross assessed road charge. Miles traveled outside California were limited, accounting for only about 0.5 percent of the total 80,675 miles assessed under the pay-at-the-pump account option.

**TABLE 34. Phase 1A: Pay-at-the-Pump - Simulated Road Charge Revenues**

REPORTING MONTH	VEHICLES REPORTING	TOTAL MILES*	CALIFORNIA MILES*	OUT-OF-STATE MILES*	FUEL (GALLONS) PURCHASED**	GROSS ROAD CHARGE \$0.022/MILE	FUEL TAX CREDIT \$0.505/GALLON	NET ROAD CHARGE
<b>January</b>	4	522.3	522.3	0.0	0.0	\$11.49	\$0.00	\$11.49
<b>February</b>	14	6,016.3	6,016.3	0.0	234.8	\$132.38	-\$118.58	\$13.80
<b>March</b>	21	14,609.3	14,441.1	168.2	154.6	\$317.73	-\$78.06	\$239.67
<b>April</b>	25	16,678.6	16,678.6	0.0	796.16	\$366.91	-\$402.05	-\$35.14
<b>May</b>	24	21,618.8	21,618.8	0.0	523.4	\$475.61	-\$264.31	\$211.30
<b>June</b>	25	21,229.9	20,997.9	232.0	537.5	\$461.93	-\$271.33	\$190.60
<b>Cumulative</b>	N/A	80,675.2	80,275.0	400.2	2,246.46	\$1,766.05	-\$1,134.33	\$631.72

\* Miles traveled reported from plug-in devices.

\*\* Fuel (gallons) reported are based on fuel purchases reported by GasBuddy.

Miles traveled increased each month of the Demonstration until the final month. This was because more vehicles and devices were enrolled and reporting, and there was a general uptick in travel because pandemic restrictions were slowly lifted. Furthermore, the Participant Portal incentives tracking page was launched in May, allowing participants to view what incentives they were eligible for and what incentives they had completed to date.

Phase 1A: Pay-at-the-Pump participants were eligible for a \$10 incentive for up to five GasBuddy fuel purchases. The month of May saw an uptick in fuel purchases using the GasBuddy card, which may indicate participants intentionally fueling with the GasBuddy card after viewing their incentives completion status. A total of seven enrolled vehicles never reported miles and it is likely that devices were received but never plugged in. These participants were ineligible to receive incentives.

The average mpg for all participating vehicles under the Phase 1A: Pay-at-the-Pump option was 35.9 when calculated by dividing total miles by fuel purchases reported. This observed fuel efficiency was higher than the average EPA mpg rating for pay-at-the-pump phase vehicles of 27.8, likely due to underreporting of fuel purchases. Many participants, for example, found that the fuel card used in the Demonstration was not accepted everywhere in California and made fuel purchases using other forms of payment that were subsequently not reported to PRIME.

### **Phase 1B: Pay-at-the-Chargepoint Simulated Revenues (ChargePoint)**

**Table 35** summarizes the simulated revenues collected under the chargepoint account option. Simulated net revenue was much higher under the chargepoint option due to the lack of fuel tax credits.

**TABLE 35. Phase 1B: Pay-at-the-Chargepoint - Simulated Road Charge Revenues**

REPORTING MONTH	VEHICLES REPORTING	TOTAL MILES*	FUEL (GALLONS) PURCHASED**	GROSS ROAD CHARGE \$0.022/MILE	FUEL TAX CREDIT \$0.505/GALLON	NET ROAD CHARGE
January	3	152.4	N/A	\$3.35	N/A	\$3.35
February	7	2,514.2	N/A	\$55.31	N/A	\$55.31
March	9	4,834.5	N/A	\$106.37	N/A	\$106.37
April	9	4,911.9	N/A	\$108.07	N/A	\$108.07
May	9	5,162.3	N/A	\$113.58	N/A	\$113.58
June	9	4,188.1	N/A	\$92.14	N/A	\$92.14
<b>Cumulative</b>	<b>N/A</b>	<b>21,763.4</b>	<b>N/A</b>	<b>\$478.82</b>	<b>N/A</b>	<b>\$478.82</b>

\* Miles traveled reported from plug-in devices

\*\* No fuel is reported for electric vehicles in the chargepoint phase. This field remains in the summary to be consistent with other phases

Upon full enrollment in March, all nine participants in the Phase 1B: Pay-at-the-Chargepoint account option actively reported miles traveled through the plug-in devices during their participation. Miles traveled by Pay-at-the-Chargepoint participants were generally consistent across months, possibly indicating that electric vehicle owners (or at least those participating in the Demonstration) did not significantly shift their driving behavior in response to pandemic restrictions. An alternative explanation is that electric vehicles are more likely to be secondary vehicles used only for short, local trips and therefore correlate less with broader travel trends.

Some Phase 1B: Pay-at-the-Chargepoint participants provided feedback to the customer support system about charging their vehicles using the ChargePoint charging stations as a prerequisite to complete their incentive activities (participants were required to charge using a ChargePoint station at least five times during the Demonstration). General feedback from these participants was that the requirement was a constraint and they were concerned about the limited range of their electric vehicle precluding their ability to only charge at ChargePoint stations. However, this condition was specific to the Demonstration and the Project Team

and ChargePoint confirmed that a participant or future road user should never feel range-anxiety or become stranded because they are constrained to a particular electric vehicle charging station company. Subsequent Demonstration or implementation activities related to road charge and electric vehicles should consider these challenges when integrating charging station technology and account management options with road charge assessment.

### Phase 2: Usage-based Insurance Simulated Revenues (Mile Auto)

**Table 36** summarizes the simulated revenues collected under Phase 2 of the Demonstration. As the table shows, Phase 2 generated net revenue (after accounting for fuel tax credits) in all phases of the Demonstration. Location data was not collected, so there was no differentiation between miles accrued within California relative to other states. The average fuel efficiency of Phase 2 vehicles, as calculated using aggregate mileage and estimated fuel consumption, was 30.41 miles per gallon. This relatively high rating is likely due to the inclusion of three all-electric vehicles and four hybrid vehicles with higher mpg ratings. The general variety of vehicles in Phase 2 can perhaps serve a base sample set for projecting larger volumes of vehicles in a road charge program.

**TABLE 36. Phase 2: Usage-Based Insurance - Simulated Road Charge Revenues (Mile Auto)**

REPORTING MONTH	VEHICLES REPORTING	TOTAL MILES*	ESTIMATED FUEL (GALLONS) CONSUMED**	GROSS ROAD CHARGE \$0.022/MILE	FUEL TAX CREDIT \$0.505/GALLON	NET ROAD CHARGE
January	N/A	N/A	N/A	N/A	N/A	N/A
February	11	5,166	163.92	\$113.65	-\$82.78	\$30.87
March	24	11,751	365.97	\$258.52	-\$184.81	\$73.71
April	28	15,683	532.5	\$345.03	-\$268.91	\$76.11
May	25	16,690	534.0	\$367.18	-\$269.67	\$97.51
June	27	22,826	774.6	\$502.17	-\$391.17	\$111.00
Cumulative	N/A	72,116	2,370.99	\$1,586.55	-\$1,197.35	\$389.20

\* Miles traveled reported from changes in uploaded odometer values.

\*\* Estimated fuel gallons consumed calculated using EPA miles per gallon (mpg) rating: miles traveled / mpg = estimated fuel consumed.

Miles traveled increased each month of the Demonstration with the final month, June, seeing the highest levels of travel. This month-by-month increase was observed despite fluctuations in the number of vehicles reporting each month, possibly indicating an increase in travel because of pandemic restrictions lifting in the state. These fluctuations occurred for a number of different reasons. Some participants indicated difficulty with being required to report odometer readings only at the end of the month, as sometimes they were not able to easily access their vehicle at that time. For example, one participant went on vacation and left their vehicle at home, not returning until after the reporting window had closed. In all cases, participants were able to contact the Tier 1 customer support service to have their monthly odometer reading entered. This highlights the need for "off-schedule" odometer readings or mileage reporting options that allow participants to successfully report their mileage and remain in compliance with the program, without being overburdened.

### Phase 3: Ridesharing Simulated Revenues (Via)

**Table 37** summarizes the simulated revenues collected under Phase 3: Ridesharing of the Demonstration. As the table shows, Phase 3: Ridesharing resulted in the generation of net revenue, but it was less than \$1 (\$0.33). This is due to the very low levels of mileage reported for this phase, with a total of about 175 miles being traveled by Phase 3 participants compared to 102,438 miles by Phase 1A and 1B participants and 72,116 miles by Phase 2 participants.

**TABLE 37. Phase 3: Ridesharing - Simulated Road Charge Revenues**

REPORTING MONTH	PARTICIPANTS REPORTING	TOTAL MILES*	ESTIMATED FUEL (GALLONS) CONSUMED**	GROSS ROAD CHARGE \$0.022/MILE	FUEL TAX CREDIT \$0.505/GALLON	NET ROAD CHARGE
January	N/A	N/A	N/A	N/A	N/A	N/A
February	N/A	N/A	N/A	N/A	N/A	N/A
March	4	20.9	0.83	\$0.46	-\$0.42	\$0.04
April	4	33.0	1.32	\$0.72	-\$0.67	\$0.05
May	8	55.9	2.2	\$1.24	-\$1.13	\$0.11
June	6	64.9	2.6	\$1.44	-\$1.31	\$0.13
<b>Cumulative</b>	<b>N/A</b>	<b>174.7</b>	<b>6.95</b>	<b>\$3.86</b>	<b>-\$3.53</b>	<b>\$0.33</b>

\* Miles traveled reported from calculated miles traveled for participant rides in Via's West Sacramento ridesharing program

\*\* Estimated fuel gallons consumed calculated using EPA miles per gallon (mpg) rating: miles traveled / mpg = estimated fuel consumed

A total of 12 participants fully enrolled in the Ridesharing Phase. However, two of those participants never completed a ride with Via in its West Sacramento service area. Due to Via's limited service area in West Sacramento, most rides were between 1 and 3 miles, thus representing a true "first/last mile" solution but resulting in generally low miles traveled throughout the Demonstration. Some of the rides reported were for 'shared' rides, where more than one Via rider was traveling in the ridesharing vehicle at the same time. Such rides tended to have different pick-up and/or drop-off locations, which created the potential for double charging for miles traveled, as more than one rider is traveling the same mile but each is paying for the ride separately.

### Phase 4: Autonomous Vehicles Simulated Revenues (EasyMile)

**Table 38** summarizes mileage and associated road charge revenues. A single automated vehicle participated in Phase 4 and operated as a shuttle along a 1-mile fixed route. The AV travels this route multiple times per day, two days per week. This short, specific route resulted in a generally low number of miles traveled during the month and associated low revenues. The AV shuttle was offline for maintenance on 3.5 operating days in June 2021. The AV used in the Demonstration was an EV, so no fuel tax credits were generated.

**TABLE 38. Phase 4: Autonomous Vehicles – Simulated Road Charge Revenues**

REPORTING MONTH	VEHICLES REPORTING	TOTAL MILES*	ESTIMATED FUEL (GALLONS) CONSUMED**	GROSS ROAD CHARGE \$0.022/MILE	FUEL TAX CREDIT \$0.505/GALLON	NET ROAD CHARGE
January	N/A	N/A	N/A	N/A	N/A	N/A
February	N/A	N/A	N/A	N/A	N/A	N/A
March	N/A	N/A	N/A	N/A	N/A	N/A
April	1	86.0	N/A	\$1.89	N/A	\$1.89
May	1	138.0	N/A	\$3.04	N/A	\$3.04
June	1	71.0	N/A	\$1.56	N/A	\$1.56
<b>Cumulative</b>	<b>N/A</b>	<b>295.0</b>	<b>N/A</b>	<b>\$6.49</b>	<b>N/A</b>	<b>\$6.49</b>

### 5.1.2 Phase 1A and 1B Mileage Summary and Breakdown

The devices used by Phase 1A and 1B participants collected location data that allowed travel to be differentiated by geographical region. **Figure 38** shows how the state was divided into broad geographic regions and **Table 39** summarizes travel by Phase 1A and 1B devices within those regions. As the table shows, the largest share of mileage accrued during the Demonstration (41 percent) was not collected using a location-based device. When looking at mileage where the location of the device was known, almost half (47 percent) of that mileage was accrued in the southern region of the state, with the Northern (26 percent) and Central (28 percent) accounting for just over half. This breakdown in mileage roughly corresponds with the geographic distribution of participants in Phase 1A and 1B, indicating that travel patterns were generally consistent across the three areas of the state in terms of overall travel.

**FIGURE 38.** The Demonstration Project-defined Geographic California Regions**TABLE 39. Travel by Defined Geographic Region**

REGION	JAN.	FEB.	MAR.	APR.	MAY	JUN.	TOTAL
Northern	0.0	987.4	3,937.6	5,045.0	6,568.9	5,061.9	21,600.8
Central	464.7	2,239.4	4,414.3	5,046.4	5,213.5	5,735.1	23,113.4
Southern	210.0	4,700.5	9,453.6	7,541	9,551.2	7,686.0	39,142.3
Insufficient GPS data*	0.0	603.2	1,659.2	4,077.2	6,644.5	6,839.0	19,823.1
No Location**	0.0	5,166.0	11,751.0	15,683.0	16,690.0	22,896.0	72,186.0
<b>Total</b>	<b>674.7</b>	<b>13,696.5</b>	<b>31,215.80</b>	<b>37,392.6</b>	<b>44,668.1</b>	<b>48,218.0</b>	<b>175,865.6</b>

\* GPS data not detailed/granular enough to determine geographic region.

\*\* No Location: Mileage reporting option does not capture location (e.g., odometer readings).



## 5.2 Participant Perceptions

As discussed earlier in this report, three surveys were administered to participants over the course of the Demonstration: a pre-survey, a mid-survey, and a closing survey. The first survey was administered to participants before they began active participation in the Demonstration (the pre-test), the second was administered in the middle of their participation (the mid-test), and the last was administered immediately following the end of participation (the post-test). Each survey included specific questions about the perceptions of the Demonstration phase a participant was in participating under (Pay-at-the-Pump/Pay-at-the-Chargepoint, User-Based Insurance, Ridesharing).

The surveys asked participants questions on the following topics:

- ▶ Satisfaction with experience.
- ▶ Perceptions about key aspects of road charge, particularly around data security, accuracy, equity, and fairness.
- ▶ Understanding the implementation details of their phase.
- ▶ Perceptions about the phase in which they are participating.
- ▶ Challenges faced in specific steps taken (onboarding, technical setup, recording miles, etc.).
- ▶ Satisfaction with communications about program and their participation.
- ▶ Likelihood to recommend road charge to others upon statewide implementation.

While included for informational purposes, it must be stressed that given the small number of participants these results cannot be extrapolated to the state as a whole.

### 5.2.1 Phase 1 Participant Surveys

The following section outlines the key takeaways observed through the pre, mid, and post-tests. Participants were asked to rank their experience on a scale from 1 to 7, where 1 is very unsatisfied and 7 is very satisfied. It should be noted that due to the smaller sample sizes of these surveys mean that the results cannot be generalized to a larger population and are of a more qualitative character.

#### **Phase 1: Pre-Survey**

In total, 27 participants completed the pre-test survey for Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint between January 28 and April 26, 2021. The survey completion rate for the pre-test survey in Phase 1A and 1B was 64 percent. Heading into the Demonstration, participants rated their overall satisfaction with process as a 5.4, indicating that they were generally satisfied with their experience. All aspects of the Demonstration that were tested received a mean satisfaction rating of 5.0 or higher, indicating general satisfaction. The survey areas with the highest levels of satisfaction are listed below:

▶ Device setup.....	<b>6.1</b>
▶ Getting questions answered.....	<b>6.0</b>
▶ Communications and instructions.....	<b>5.7</b>
▶ Number and quality of opportunities to provide feedback .....	<b>5.7</b>
▶ Data security.....	<b>5.5</b>
▶ Privacy protection.....	<b>5.4</b>
▶ Ability to cheat the reporting system.....	<b>4.8</b>

Respondents generally agreed that they had the information they needed to successfully participate in the Demonstration, but half (48 percent) were less intense in their sentiment, only “somewhat” agreeing. Some (41 percent) said they did not know where to get answers to any questions they had. Most (89 percent) said that email was a communication method that would be helpful to them. Over one-quarter (30 percent) had contacted customer support, with only one respondent saying an issue was not resolved at the time of the survey.



**Phase 1: Mid-Survey**

In total, 26 participants completed the mid-test survey for Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint between April 1 and May 10, 2021. The survey completion rate for the mid-test survey in Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint was 62 percent. Approximately midway into the Demonstration, participants on average rated their overall satisfaction with the process as a 5.3, indicating that they were generally satisfied with the experience. This is similar to the mean overall satisfaction score seen in the pre-test survey among these groups (5.4). The survey areas with the highest levels of satisfaction are listed below:

- ▶ Reporting mileage.....**6.2**
- ▶ Time spent on participation.....**5.9**
- ▶ Protection of personal data.....**5.9**
- ▶ Ease of reporting .....**5.7**
- ▶ Understanding the calculation of road usage charge fee .....**5.7**

**Phase 1: Post-Survey**

In total, 24 participants completed the post-test survey for Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint between July 9 and August 2, 2021. The survey completion rate for the post-test survey in Phase 1A and 1B was 57 percent. Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint participants rated their satisfaction with their overall road charge experience as a 5.7 on average, indicating that they were generally satisfied with the experience. This represents a slight increase over the mean overall satisfaction score seen in the pre-test (5.4) and mid-test (5.3) among this phase.

This phase of respondents gave every aspect of the Demonstration that was tested a mean satisfaction rating of 5.3 or higher. This is in contrast to the mid-test, where every aspect scored at least a 5.0, with half scoring a 5.3 or lower. A plurality of Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint

respondents were “very satisfied” (rating the aspect as a 7) with each aspect in the post-test except two—the overall experience and the mileage reporting method itself. The survey areas with the highest levels of satisfaction are listed below:

- ▶ Time spent on participation.....**6.0**
- ▶ Getting questions answered.....**6.0**
- ▶ Communications and instructions.....**5.9**

Two of the three highest-scoring aspects are related to communication. Nearly two-thirds (63 percent) of respondents strongly agreed that they had all the information they needed to successfully participate in the Demonstration and another quarter (25 percent) said they somewhat agreed (88 percent total). When asked if they knew how to get answers to their questions, 88 percent of respondents said yes. This is an improvement from the mid-test, which saw less than half (46 percent) of respondents strongly agree that they had the information they needed, and 73 percent say they knew how to get their questions answered.

By the end of the Demonstration, Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint participants’ views on whether a road charge would be more fair than a gas tax had declined slightly, with 78 percent of respondents initially thinking it more fair in the pre-test, and 71 percent of respondents thinking it more fair in the post-test. Perceptions of how much they would have to pay under a road charge system versus a gas tax system remained steady through all three surveys, with a majority thinking they would pay about the same each time. Support for exploring a per-mile road charge as a replacement for the gas tax was near-unanimous in all three surveys as well. Phase 1A: Pay-at-the-Pump and Phase 1B: Pay-at-the-Chargepoint respondents reflected on their experience participating in the Demonstration through a series of open-ended questions. They were very positive about the program, with almost every participant saying either that they enjoyed being part

of a possible solution or describing the Demonstration as easy and hassle-free. Respondents largely said that the experience made them more open to replacing the gas tax or taught them about new, fairer ways to fund infrastructure investments.

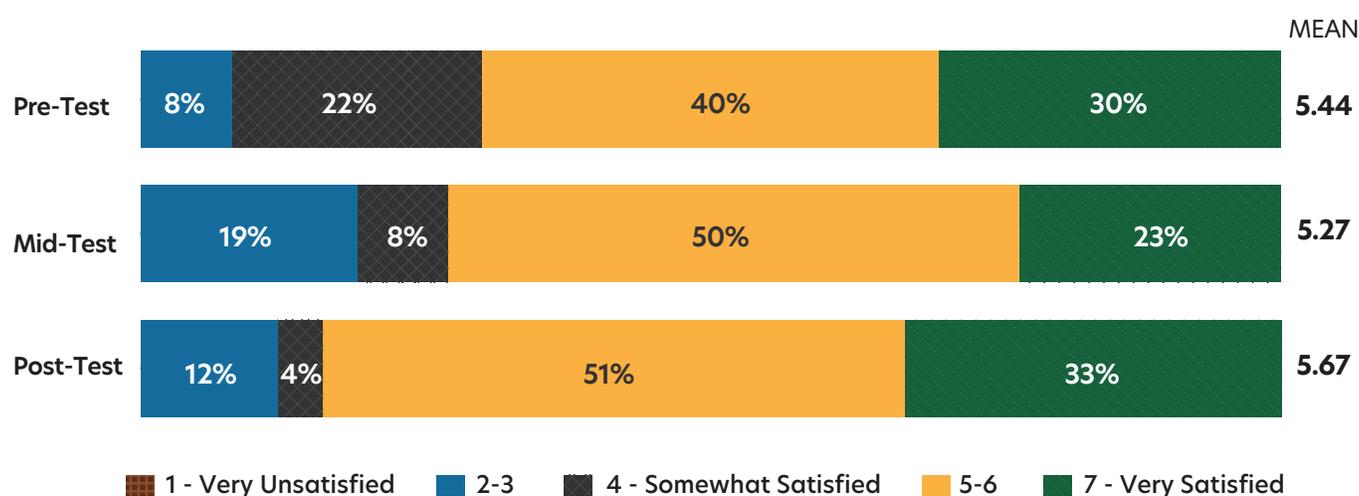
## 5.2.2 Participant Perceptions in the Phase 1 Demonstration

The following section outlines the changes in attitudes over the course of the demonstration. As assessed by the pre, mid, and post-tests. The changes in participant attitudes over the course of the demonstration is examined through five key areas: general satisfaction, reporting, privacy and security, fairness, and acceptance.

### Phase 1: General Satisfaction

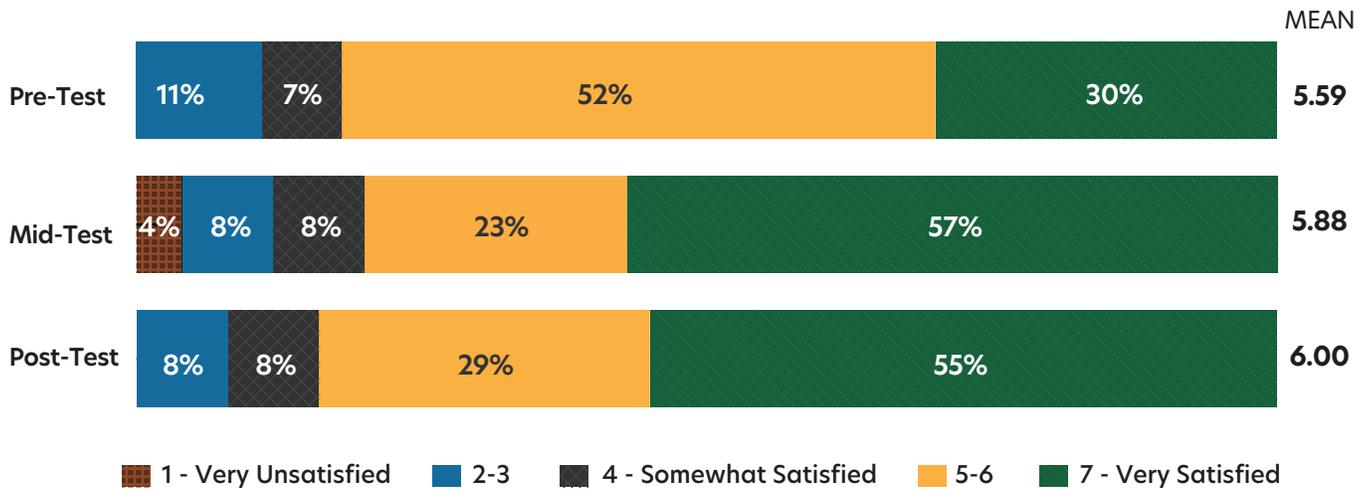
The two measures used to determine changes in participant attitudes pertaining to general satisfaction were their overall program experience and the amount of time they spent participating in the demonstration. As shown in **Figure 39** - Overall Program Experience, those participants who described their overall program experience as either satisfied or very satisfied increased over the course of the demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (70%) to the Post-Test (84%) by 14%. Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (8%) to the Mid-Test (19%) but declined from the Mid-Test (19%) to the Post-Test (8%).

**FIGURE 39.** Phase 1 Perceptions - Overall Program Experience



The amount of time a participant was spending on their participation in the demonstration was the second measure to indicate their general satisfaction. As shown in **Figure 40** - General Satisfaction: Amount of Time, those participants who described their overall program experience as either satisfied or very satisfied increased over the course of the demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (82%) to the Post-Test (84%) by 2%. More specifically, those who rated their experience as very satisfied increased from the Pre-Test (30%) to the Post-Test (55%). Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (8%) to the Mid-Test (12%) but declined from the Mid-Test (12%) to the Post-Test (8%).

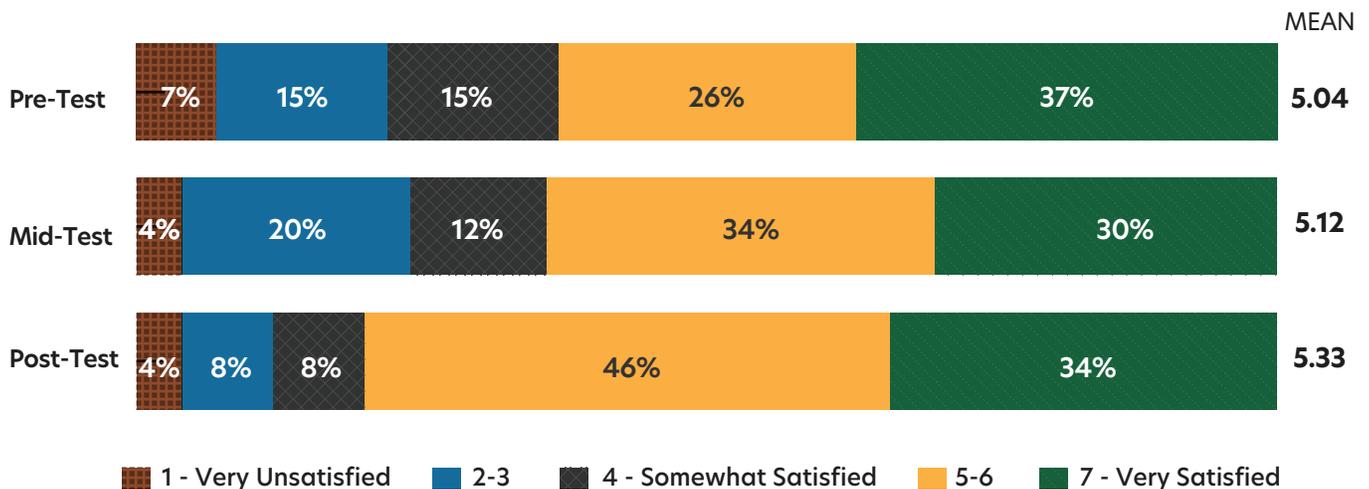
**FIGURE 40.** Phase 1 Perceptions - Amount of Time Reporting



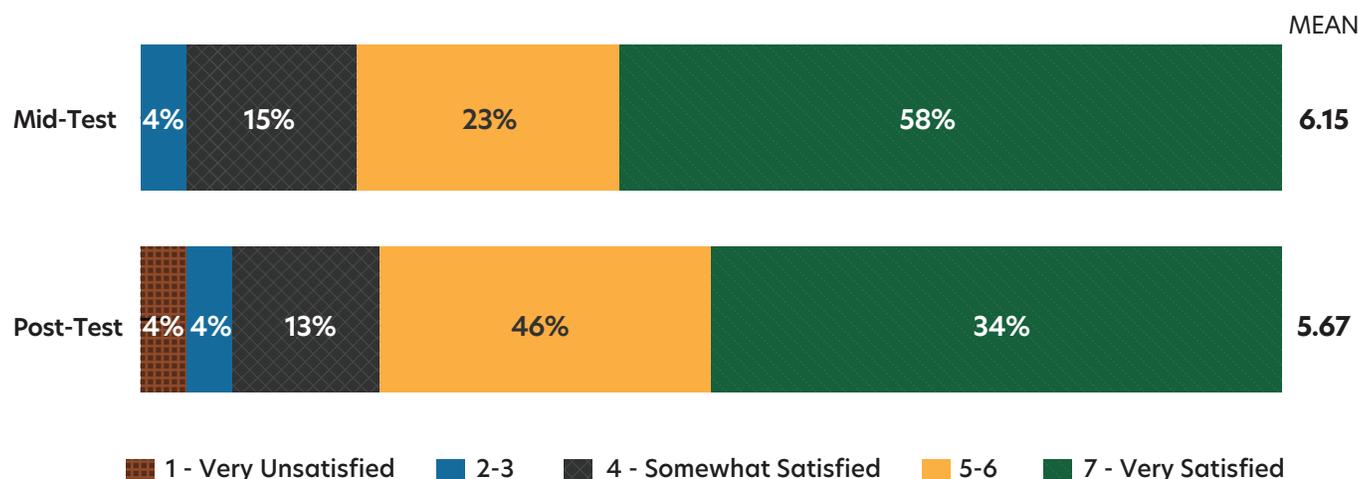
**Phase 1: Reporting**

The two measures used to determine changes in participant attitudes pertaining to reporting were the mileage reporting method used and the process of reporting mileage. As shown in **Figure 41** - Mileage Reporting Method, those participants who described their mileage reporting method experience as either satisfied or very satisfied increased over the course of the Phase 1A and 1B demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (63%) to the Post-Test (80%) by 17%. Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (22%) to the Mid-Test (24%) but declined from the Mid-Test (24%) to the Post-Test (12%).

**FIGURE 41.** Phase 1 Perceptions - Mileage Reporting Method

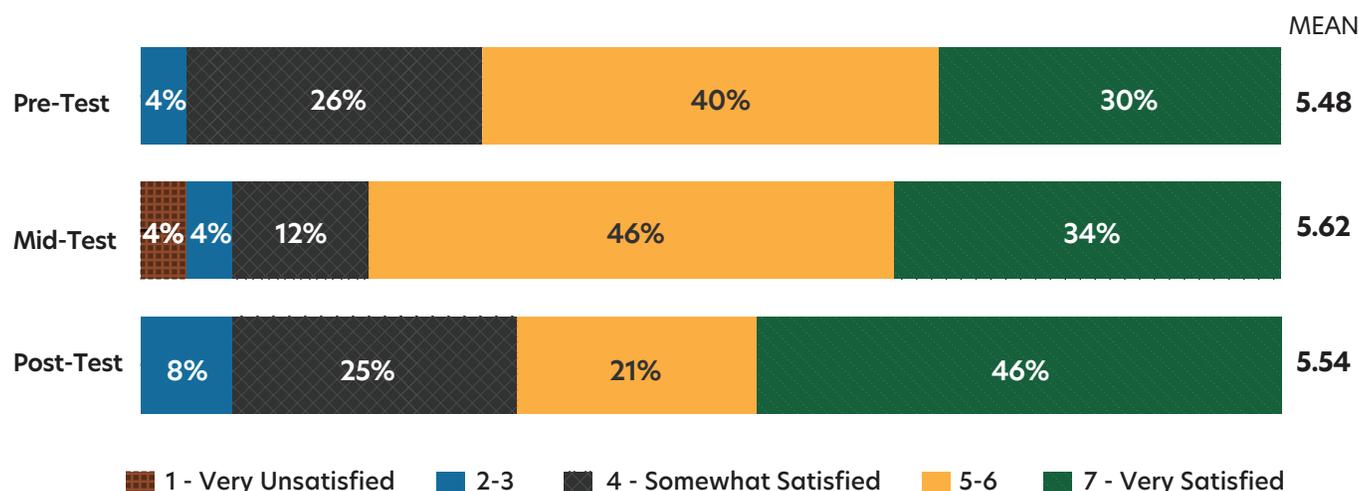


The process of reporting mileage during participation in the demonstration was the second measure to determine attitude change over the course of the Phase 1A and 1B demonstration. As shown in **Figure 42** - Process of Reporting, those participants who described their process of reporting experience as either satisfied or very satisfied decreased from the Pre-Test (81%) to the Post-Test (79%) by 2%. Conversely, those participants that were unsatisfied or very unsatisfied increased from the Mid-Test (19%) to the Post-Test (21%).


**FIGURE 42.** Phase 1 Perceptions - Process of Reporting


### Phase 1: Privacy and Security

The two measures used to determine changes in participant attitudes pertaining to privacy and security were the security of the data being collected and the protection of participants personal data. As shown in **Figure 43** - Security of the Data Being Collected, those participants who described their privacy and security experience as either satisfied or very satisfied increased over the course of the Phase 1A and 1B demonstration. This grouping of participants level of satisfaction decreased from the Pre-Test (70%) to the Post-Test (67%) by 3%. Conversely, those participants that were unsatisfied or very unsatisfied increased over the course of the demonstration. This grouping of participants increased from the Pre-Test (4%) to the Post-Test (8%) by 4%.

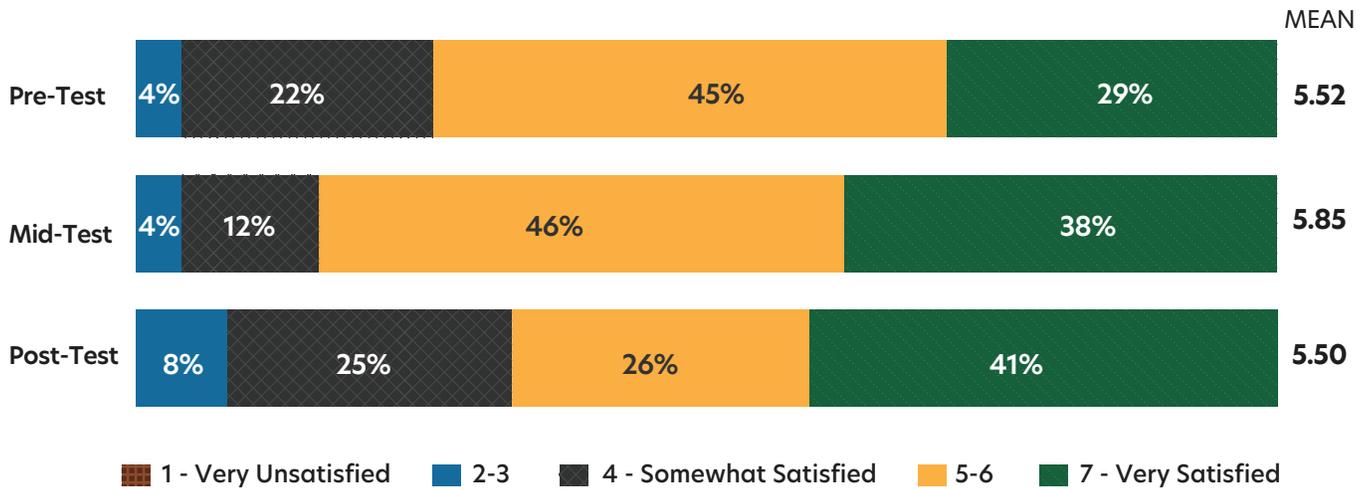
**FIGURE 43.** Phase 1 Perceptions - Security of the Data Being Collected


The protection of participants personal data in the demonstration was the second measure to determine attitude change with privacy and security over the course of the Phase 1A and 1B demonstration. As shown in **Figure 44** - Protection of Participant Personal Data, those participants who described their experience as either satisfied or very satisfied decreased over the course of the Phase 1A and 1B demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (74%) to the Mid-Test (84%), but declined from the Mid-Test (84%) to the Post-Test (67%). More specifically, those who rated their experience as very satisfied increased from



the Pre-Test (30%) to the Post-Test (55%). Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (8%) to the Mid-Test (12%) but declined from the Mid-Test (12%) to the Post-Test (8%).

**FIGURE 44.** Phase 1 Perceptions - Protection of Participant Personal Data

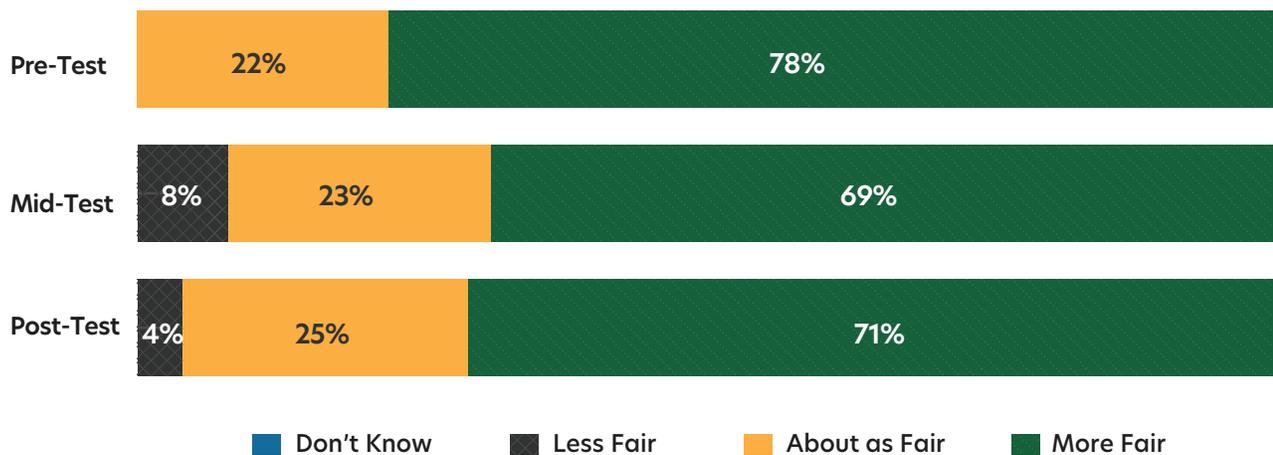


**Phase 1: Fairness**

The two questions used to determine changes in participant attitudes pertaining to fairness were a comparison between the road charge and fuel tax to fund highway maintenance and if participants believed they would pay more or less under a road charge program. When asked, *“Would you say that paying for road and freeway maintenance and repair based on the miles you drive is more fair or less fair than paying based on the amount of gas you buy?”*

Those participants who described road charge as more fair decreased from the Pre-Test (78%) to the Post-Test (71%) by 7%, as shown in **Figure 45** - Road Charge v. Fuel Tax to Fund Maintenance. Conversely, those participants that described road charge as less fair increased from the Pre-Test (0%) to the Post-Test (4%).

**FIGURE 45.** Phase 1 Perceptions - Road Charge v. Fuel Tax to Fund Maintenance

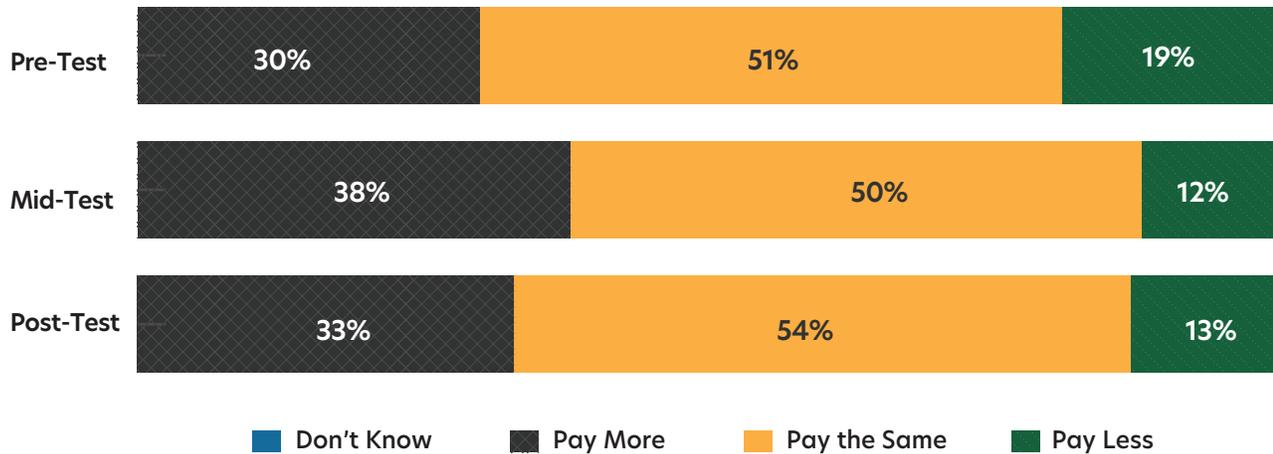


The second question used to determine changes in participant attitudes pertaining to fairness was if participants believed they would pay more or less under a road charge program. When asked, *“Do you think that you would pay more or less with a road charge than you currently do in gas tax?”*, those participants who stated they would



pay about the same or less under a road charge program decreased from the Pre-Test (70%) to the Post-Test (67%) by 3%, as shown in **Figure 46** - Pay More or Less with Road Charge. Conversely, those participants that stated they would pay more increased from the Pre-Test (30%) to the Post-Test (33%).

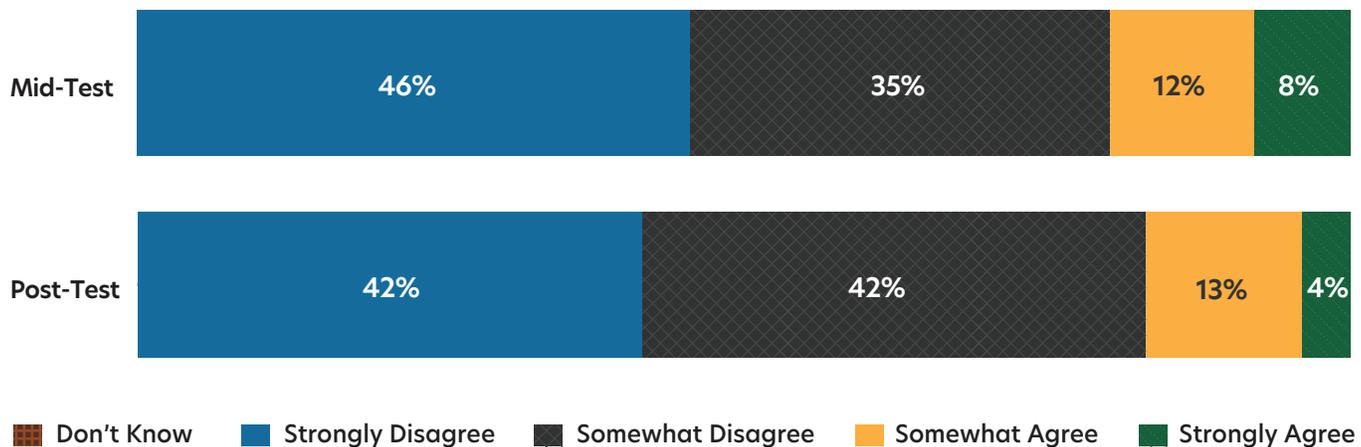
**FIGURE 46.** Phase 1 Perceptions - Pay More or Less with Road Charge



**Phase 1: Acceptance**

The two questions used to determine changes in participant attitudes pertaining to acceptance were should Californians continue to use the fuel tax to fund highway maintenance and if the State of California should continue exploring road charge. When asked to agree or disagree with, *“the state should stick with the gas tax to fund road and highway maintenance in California.”*; those participants who responded with somewhat agree or strongly agree decreased from the Mid-Test (20%) to the Post-Test (17%) by 3%, as shown in **Figure 47** - Continue to use Fuel Tax. Conversely, those participants who responded with somewhat disagree or strongly disagree increased from the Mid-Test (81%) to the Post-Test (84%).

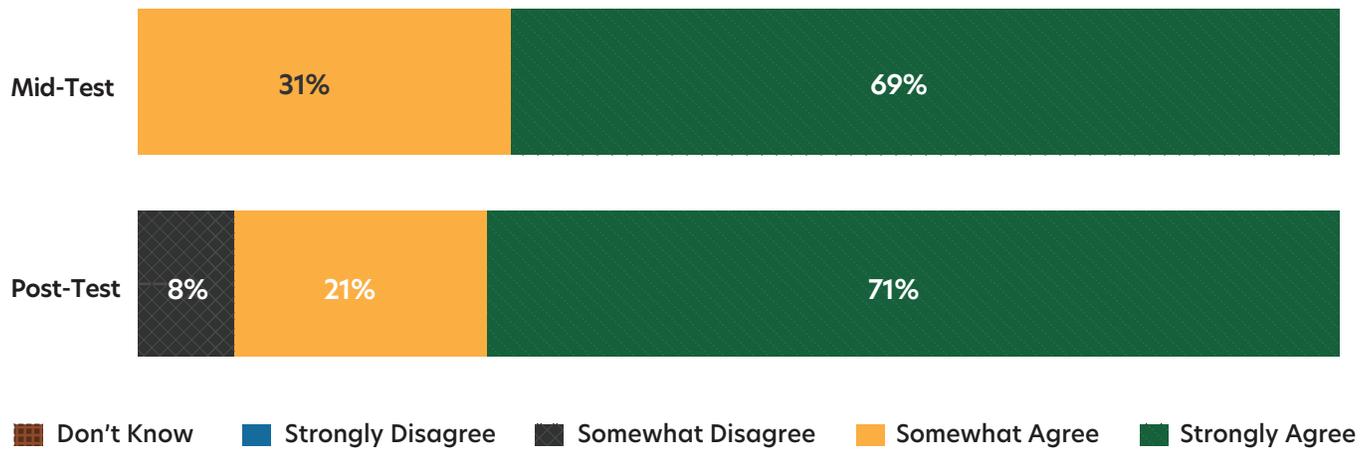
**FIGURE 47.** Phase 1 Perceptions - Continue to use Fuel Tax



The second question used to determine changes in participant attitudes pertaining to acceptance was if participants believed if the State of California should continue exploring road charge. When asked to agree or disagree with, *“the state should continue to explore replacing the gas tax with a per mile road charge to fund road and highway maintenance in California.”*; those participants who responded with somewhat agree or strongly agree decreased from the Mid-Test (100%) to the Post-Test (92%) by 8%, as shown in **Figure 48** - Continue Exploring Road Charge.



**FIGURE 48.** Phase 1 Perceptions - Continue Exploring Road Charge



### 5.2.3 Phase 2 Participant Surveys

The following section outlines the key takeaways observed through the pre, mid, and post-tests. Participant were asked to rank their experience on a scale from 1 to 7, where 1 is very unsatisfied and 7 is very satisfied. It should be noted that due to the smaller sample sizes of these surveys mean that the results cannot be generalized to a larger population and are of a more qualitative character.

#### Phase 2: Pre-Survey

In total, 25 participants completed the pre-test survey for Phase 2: Usage-Based Insurance between January 28th and April 26th, 2021. The survey completion rate for this phase was 86 percent. At this point in the Demonstration, participants rated their overall satisfaction with process as a 6.0, indicating that they were generally satisfied with the experience. All aspects of the program that were tested received a mean satisfaction rating of 5.8 or higher, indicating general satisfaction. The survey areas with the highest levels of satisfaction are listed below:

- ▶ Mileage reporting method (Mile Auto)..... **6.6**
- ▶ Communications and instructions..... **6.5**
- ▶ Account setup..... **6.1**
- ▶ Data security..... **5.9**
- ▶ Privacy protection..... **5.7**

Respondents generally agreed that they had the information they needed to successfully participate in the Demonstration, with nearly three-fourths (72 percent) saying that they “strongly agreed.” However, a few (12 percent) “strongly disagreed.” A few (12 percent) said they did not know where to get answers to any questions they had. Nearly all (92 percent) said that email was a communication method that would be helpful to them. Nearly half (44 percent) of respondents’ views were mixed about whether others could cheat the reporting system using the Usage-Based Insurance method, scoring a mean of 4.5.

#### Phase 2: Mid-Survey

In total, 23 participants completed the pre-test survey for Phase 2: Usage-Based Insurance between April 1 and May 10, 2021. The survey completion rate for this phase was 79 percent. Approximately midway into the Demonstration, participants on average rated their overall satisfaction with the process as a 6.6, indicating that they were quite satisfied with the experience. This is an increase from the mean overall satisfaction score seen in the pre-test among this group (6.0). All aspects of the program that were tested received a mean satisfaction rating of 6.2 or higher, indicating general satisfaction. The survey



areas with the highest levels of satisfaction are listed below:

- ▶ Getting questions answered..... **6.7**
- ▶ Process of mileage reporting..... **6.7**
- ▶ Mileage reporting method (Mile Auto)..... **6.7**

Usage-Based Insurance phase respondents generally thought that their mileage was being reported accurately and that their road charge invoice was being calculated accurately, giving a mean score of 6.8, and they also noted their confidence in the accuracy of the mileage reporting (mean response score of 6.4). Respondents were asked about their confidence with the Demonstration's privacy protections and data security. The mean confidence ratings were similar, with privacy receiving a 6.1 mean response and data security receiving a 6.0 mean response. These numbers were up slightly from those in the pre-test (5.7 for privacy and 5.9 for security).

Usage-Based Insurance phase respondents generally agreed that they had the information they needed to successfully participate in the Demonstration, with many (83 percent) strongly agreeing that they had the information needed, and an additional 9 percent somewhat agreeing. A third (35 percent) reported that they needed to contact customer support at some point during the Demonstration. Most of those who had to contact customer service (88 percent) said that their issue was resolved and that their reasons for contacting customer service included signing up for an account with Mile Auto and finding issues with the Participant Portal.

### **Phase 2: Post-Survey**

In total, 26 participants completed the post-test survey for Phase 2 Usage-Based Insurance between July 9 and August 2, 2021. The survey completion rate for this phase was 90 percent. Phase 2 Usage-Based Insurance participants on average rated their overall satisfaction with the road charge experience as a 6.4, indicating that they were quite satisfied with the experience. This is similar to the mean score from the mid-test (6.6).

All aspects of the program that were tested received a mean satisfaction rating of 6.1 or higher, indicating high general satisfaction, with "the mileage reporting method you are using, Mile Auto" (6.7) receiving the

highest score. Satisfaction with the Mile Auto reporting method continued to be high, as it was rated a 6.6 in the pre-test and 6.7 in the mid-test. A majority of respondents said they were "extremely satisfied" with each aspect of the program, giving aspects a score of 7. During the mid-test, all aspects of the Demonstration received at least a 6.2 mean satisfaction rating. By the end of the Demonstration, Phase 2: Usage-Based Insurance participants' views on whether a road charge would be fairer than a gas tax had held relatively steady, with 80 percent of re-test respondents initially thinking it was fairer and 73 percent of post-test participants thinking it was fairer. Throughout the Demonstration, Phase 2: Usage-Based Insurance respondents had different views on whether they would pay less under a road charge, with one-quarter (24 percent) saying they would in the pre-test, nearly half (48 percent) saying they would in the mid-test, and one-third (35 percent) saying they would in the post-test. Support for exploring a per-mile road charge as a replacement for the gas tax was very high in all three surveys as well; in the post-test, 88 percent of participants said the state should continue exploring it as an option.

Phase 2: Usage-Based Insurance respondents reflected on their experience participating in the Demonstration through a series of open-ended questions. They were positive about the program, with almost every participant saying either that they enjoyed being part of a possible solution or describing the Demonstration as straightforward and easy to understand. Respondents largely said that the experience made them more open to replacing the gas tax and said that replacing the gas tax would introduce equity into infrastructure funding.

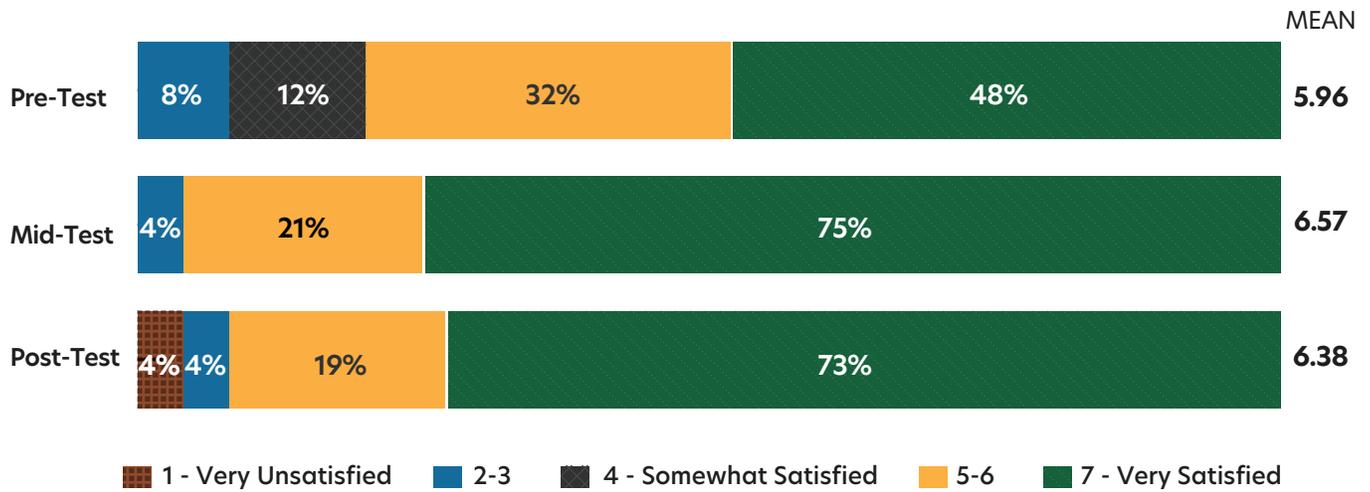
### **5.2.4 Participant Perceptions in the Phase 2 Demonstration**

The following section outlines the changes in attitudes over the course of the demonstration. As assessed by the pre, mid and post-tests. The changes in participant attitudes over the course of the demonstration is examined through five key areas: general satisfaction, reporting, privacy and security, fairness, and acceptance.

**Phase 2: General Satisfaction**

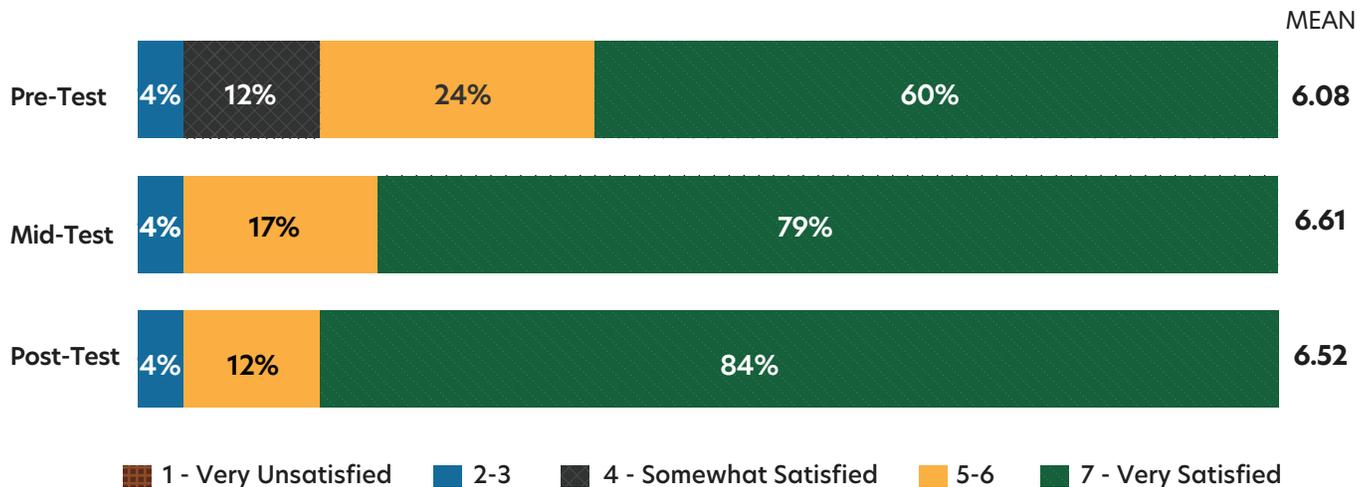
The two measures used to determine changes in participant attitudes pertaining to general satisfaction were their overall program experience and the amount of time they spent participating in the demonstration. As shown in **Figure 49** - Overall Program Experience, those participants who described their overall program experience as either satisfied or very satisfied increased over the course of the demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (80%) to the Post-Test (92%) by 12%. Conversely, those participants that were unsatisfied or very unsatisfied remained the same from the Pre-Test (8%) to the Post-Test (8%).

**FIGURE 49.** Phase 2 Perceptions - Overall Program Experience



The amount of time a participant was spending on their participation in the demonstration was the second measure to indicate their general satisfaction. As shown in **Figure 50**- Amount of Time, those participants who described their overall program experience as either satisfied or very satisfied increased over the course of the demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (84%) to the Post-Test (96%) by 22%. Conversely, those participants that were unsatisfied or very unsatisfied remained the same from the Pre-Test (8%) to the Post-Test (8%).

**FIGURE 50.** Phase 2 Perceptions - Amount of Time

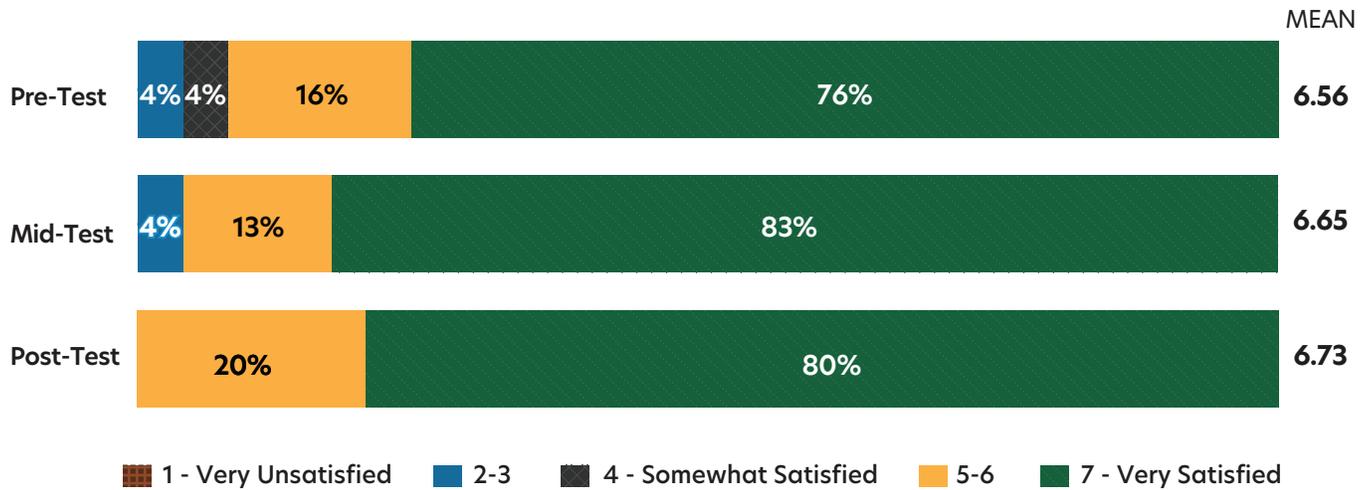




**Phase 2: Reporting**

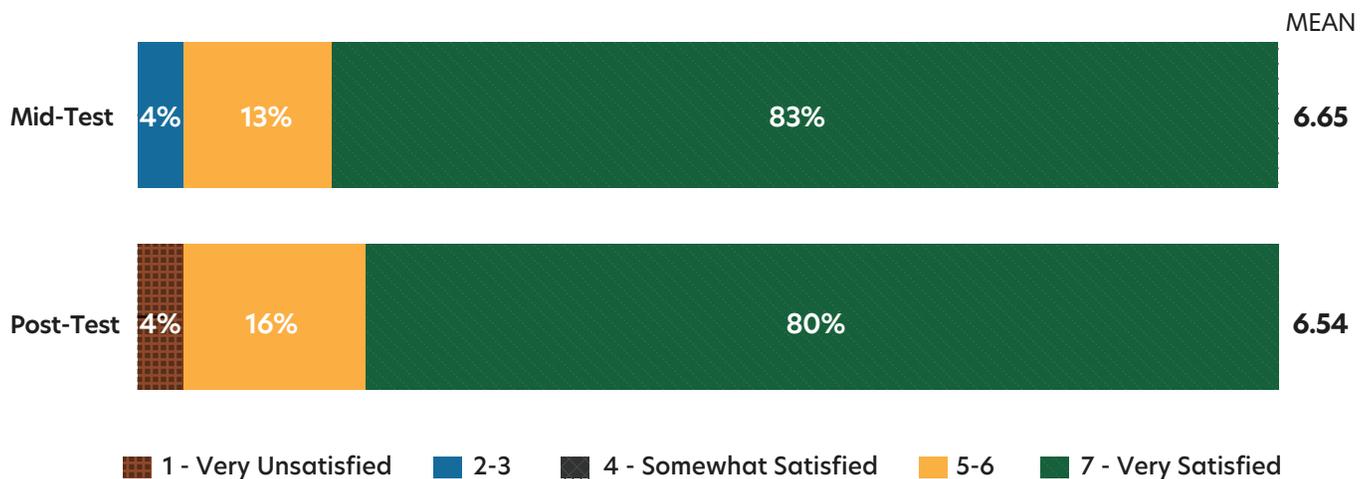
The two measures used to determine changes in participant attitudes pertaining to reporting were the mileage reporting method used and the process of reporting mileage. As shown in **Figure 51** - Mileage Reporting Method, those participants who described their mileage reporting method experience as either satisfied or very satisfied increased over the course of the Phase 2 demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (92%) to the Post-Test (100%) by 8%. Conversely, those participants that were unsatisfied or very unsatisfied decreased from the Pre-Test (4%) to the Post-Test (0%).

**FIGURE 51.** Phase 2 Perceptions - Mileage Reporting Method



The process of reporting mileage during participation in the demonstration was the second measure to determine attitude change over the course of the Phase 2 demonstration. As shown in **Figure 52** - Process of Reporting, those participants who described their process of reporting experience as either satisfied or very satisfied remained the same from the Mid-Test (96%) to the Post-Test (96%). Similarly, those participants that were unsatisfied or very unsatisfied remained the same from the Mid-Test (4%) to the Post-Test (4%).

**FIGURE 52.** Phase 2 Perceptions - Process of Reporting

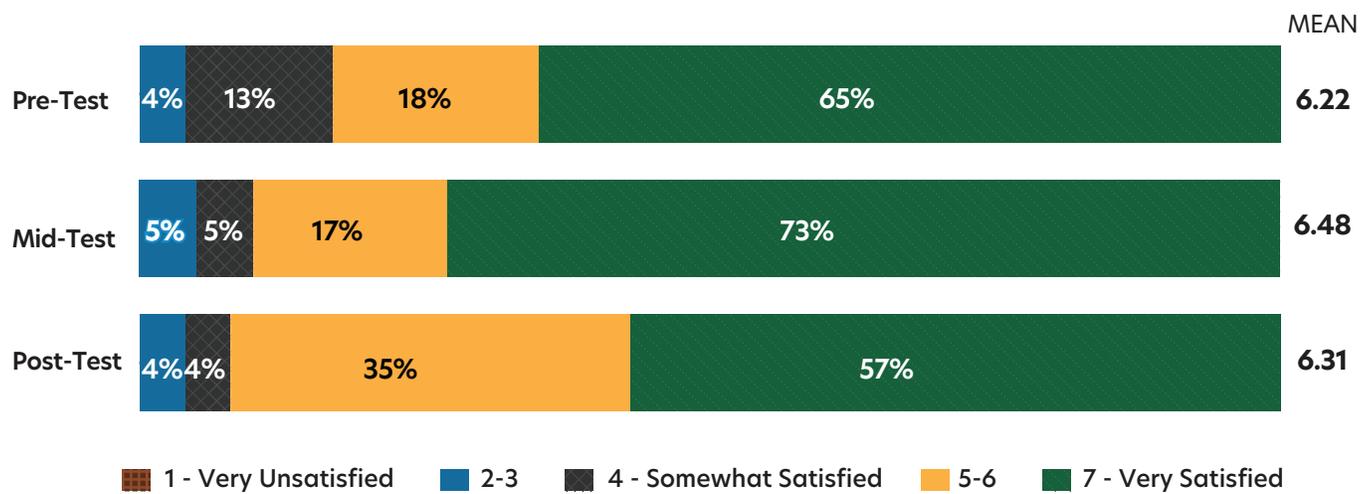




### Phase 2: Privacy and Security

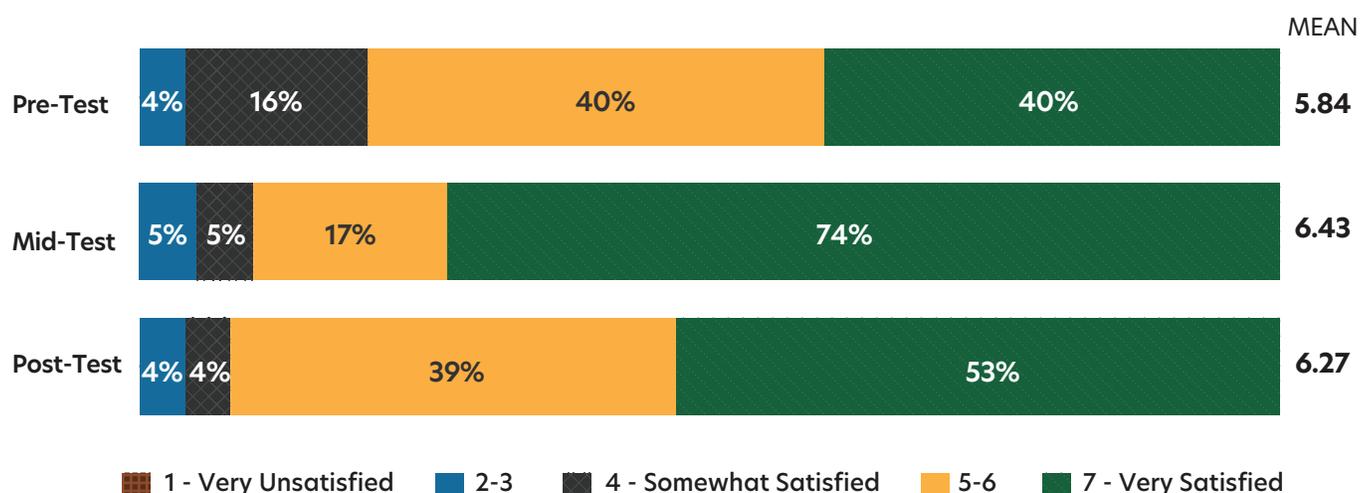
The two measures used to determine changes in participant attitudes pertaining to privacy and security were the security of the data being collected and the protection of participant's personal data. As shown in **Figure 53** - Security of the Data Being Collected, those participants who described their privacy and security experience as either satisfied or very satisfied increased over the course of the Phase 2 demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (83%) to the Post-Test (92%) by 9%. Conversely, those participants that were unsatisfied or very unsatisfied remained the same over the course of the demonstration from the Pre-Test (4%) to the Post-Test (4%).

**FIGURE 53.** Phase 2 Perceptions - Security of the Data Being Collected



The protection of participant's personal data in the demonstration was the second measure to determine attitude change with privacy and security over the course of the Phase 2 demonstration. As shown in **Figure 54** - Protection of Participant Personal Data, those participants who described their experience as either satisfied or very satisfied decreased over the course of the demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (80%) to the Post-Test (92%) by 12%. Conversely, those participants that were unsatisfied or very unsatisfied remained the same over the course of the demonstration from the Pre-Test (4%) to the Post-Test (4%).

**FIGURE 54.** Phase 2 Perceptions - Protection of Participant Personal Data



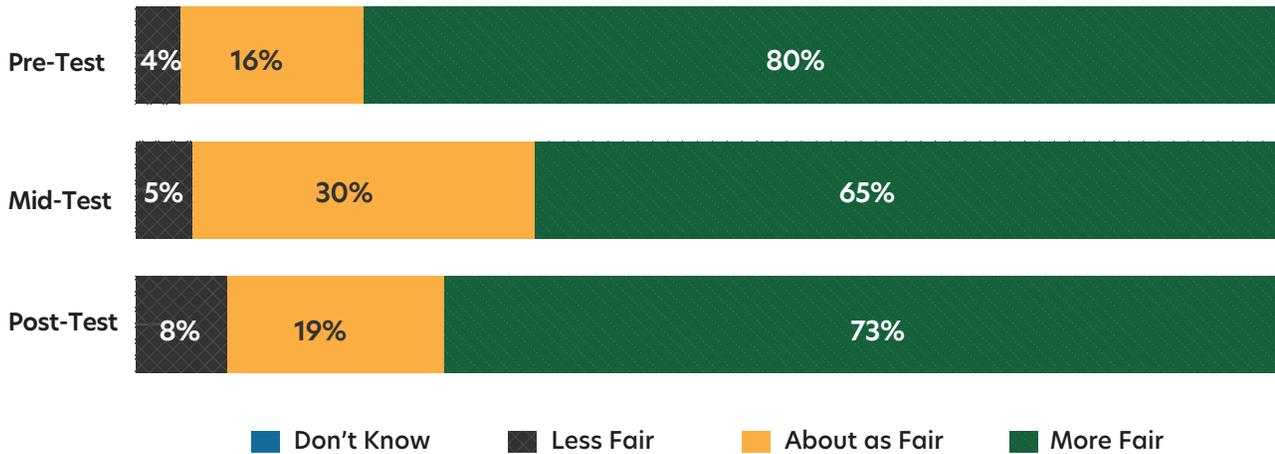


**Phase 2: Fairness**

The two questions used to determine changes in participant attitudes pertaining to fairness were, a comparison between the road charge, and fuel tax to fund highway maintenance and if participants believed they would pay more or less under a road charge program. When asked, *“Would you say that paying for road and freeway maintenance and repair based on the miles you drive is more fair or less fair than paying based on the amount of gas you buy?”*

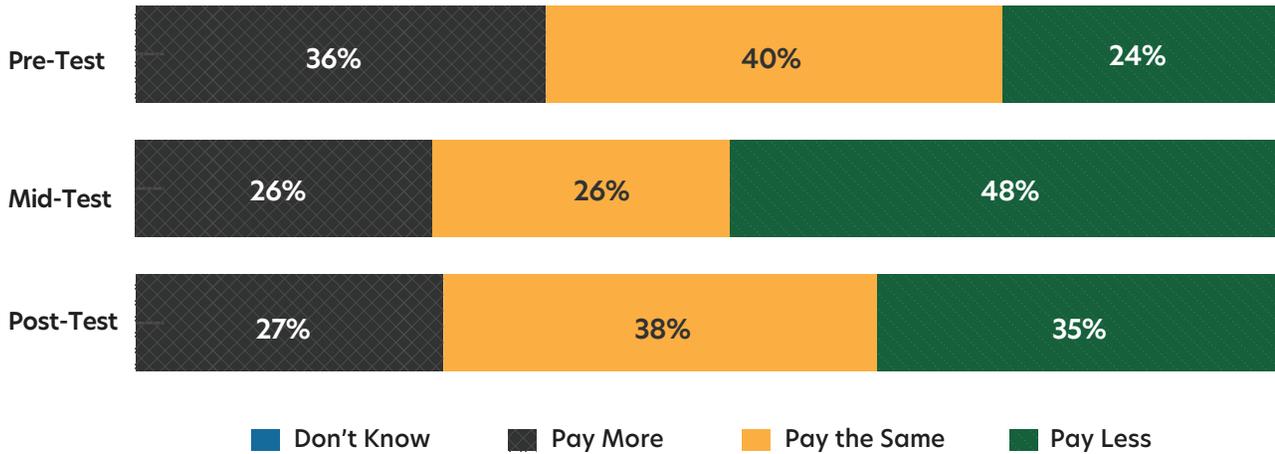
Those participants who described road charge as more fair decreased from the Pre-Test (80%) to the Post-Test (73%) by 7%, as shown in **Figure 55** - Road Charge v. Fuel Tax to Fund Maintenance. Conversely, those participants that described road charge as less fair increased from the Pre-Test (4%) to the Post-Test (8%).

**FIGURE 55.** Phase 2 Perceptions - Road Charge v. Fuel Tax to Fund Maintenance



The second question used to determine changes in participant attitudes pertaining to fairness was if participants believed they would pay more or less under a road charge program. When asked, *“Do you think that you would pay more or less with a road charge than you currently do in gas tax?”*, those participants who stated they would pay about the same or less under a road charge program increased from the Pre-Test (64%) to the Post-Test (73%) by 9%, as shown in **Figure 56** - Pay More or Less with Road Charge. Conversely, those participants that stated they would pay more decreased from the Pre-Test (36%) to the Post-Test (27%).

**FIGURE 56.** Phase 2 Perceptions - Pay More or Less with Road Charge

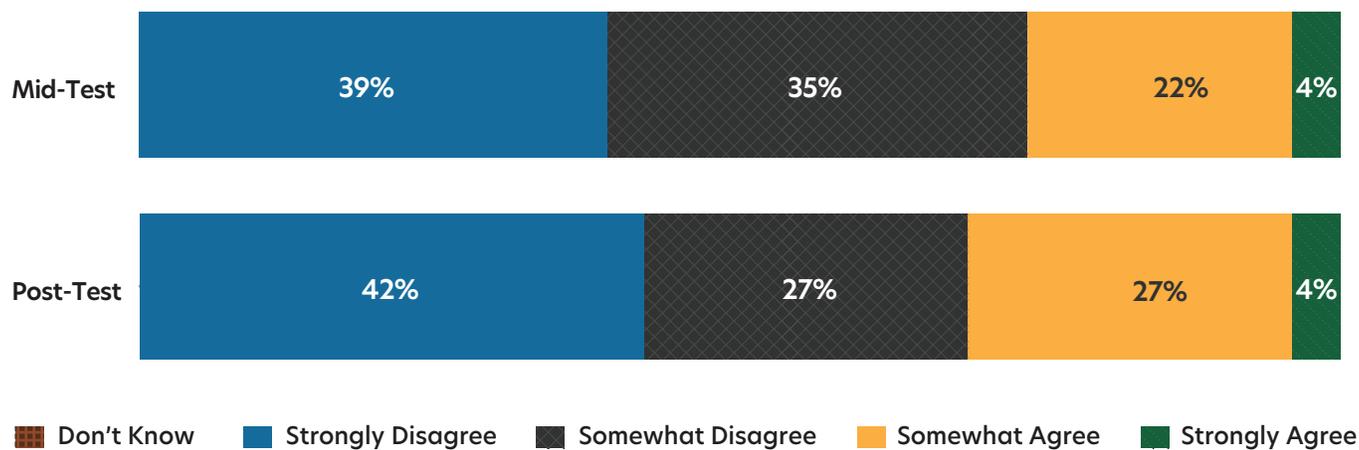




### Phase 2: Acceptance

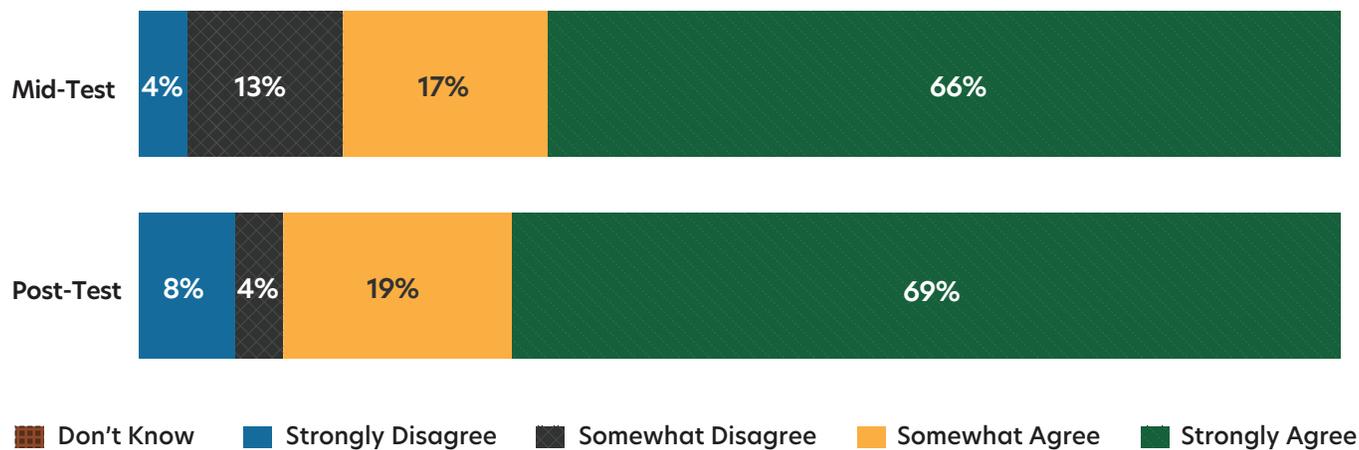
The two questions used to determine changes in participant attitudes pertaining to acceptance were should Californians continue to use the fuel tax to fund highway maintenance and if the State of California should continue exploring road charge. When asked to agree or disagree with, *“the state should stick with the gas tax to fund road and highway maintenance in California.”*, those participants who responded with somewhat agree or strongly agree decreased from the Mid-Test (26%) to the Post-Test (31%) by 5%, as shown in **Figure 57** - Continue to use Fuel Tax. Conversely, those participants who responded with somewhat disagree or strongly disagree decreased from the Mid-Test (74%) to the Post-Test (69%).

**FIGURE 57.** Phase 2 Perceptions - Continue to use Fuel Tax



The second question used to determine changes in participant attitudes pertaining to acceptance was if participants believed if the State of California should continue exploring road charge. When asked to agree or disagree with, *“the state should continue to explore replacing the gas tax with a per mile road charge to fund road and highway maintenance in California.”*, those participants who responded with somewhat agree or strongly agree increased from the Mid-Test (83%) to the Post-Test (88%) by 5%, as shown in **Figure 58** - Continue Exploring Road Charge. Conversely, those participants who responded with somewhat disagree or strongly disagree decreased from the Mid-Test (17%) to the Post-Test (12%).

**FIGURE 58.** Phase 2 Perceptions - Continue Exploring Road Charge





### 5.2.5 Phase 3 Participant Surveys

The following section outlines the key takeaways that were observed through the pre, mid, and post-tests. Participant were asked to rank their experience on a scale from 1 to 7, where 1 is very unsatisfied and 7 is very satisfied. It should be noted that due to the smaller sample sizes of these surveys mean that the results cannot be generalized to a larger population and are of a more qualitative character.

#### **Phase 3: Pre-Survey**

In total, three participants completed the survey for Phase 3: Ridesharing between January 28 and April 26, 2021. The survey completion rate for this phase was 50 percent. Due to the small sample size, it is impossible to look at the results with statistical confidence, but generally respondents were satisfied with their participation in the program. One respondent had to download the application to participate in the program. Respondents generally were confident in the privacy and security of the Demonstration, but only one reported seeing information about this topic. All somewhat agreed that they had the information they needed to successfully participate in the program. All reported a neutral or concerned response regarding people's ability to cheat if a road charge were implemented.

#### **Phase 3: Mid-Survey**

In total, three participants completed the survey for Phase 3: Ridesharing between April 1 and April 28, 2021. The survey completion rate for this phase was 33 percent. Due to the small sample size, it is impossible to look at the results with statistical confidence. One respondent was very unsatisfied with their experience, but the others were generally very satisfied. All respondents reported that it was easy to report their mileage and were confident that it was being reported and calculated accurately. Only one respondent said they received an email regarding their simulated road charge fee. One respondent was not confident at all about the Demonstration privacy protections, while the two others were very confident. Respondents were more confident regarding the data security of the Demonstration. All respondents at least somewhat agreed with the statement "under the

method I am using in this demonstration, it is possible to report my mileage inaccurately."

#### **Phase 3: Post-Survey**

In total, five participants completed the survey for Phase 3: Ridesharing between July 9th and August 2nd, 2021. The survey completion rate for this phase was 42 percent. This analysis reflects only four of the responses, as one participant was a Caltrans employee. This employee was removed from analysis. Due to the small sample size, it is impossible to look at the results with statistical confidence. The four participants said that the overall experience was generally satisfying. They were confident that their mileage and invoice were calculated accurately and unanimously said that it was easy to report their mileage. Three participants were confident in the Demonstration's privacy and data security protections, with one responding neutrally to each question.

Respondents gave mixed reviews on the effects of a road charge: two of them said California should stick with a gas tax while two disagreed. One participant said that the state should not continue to explore a road charge. One respondent thought they would pay more with a road charge, two said it would be about the same as a gas tax, and one thought a road charge would be cheaper. They all agreed that people will likely find ways to report their mileage inaccurately but diverged on whether it was possible to report mileage inaccuracy using Via.

### 5.2.6 Participant Perceptions in the Phase 3 Demonstration

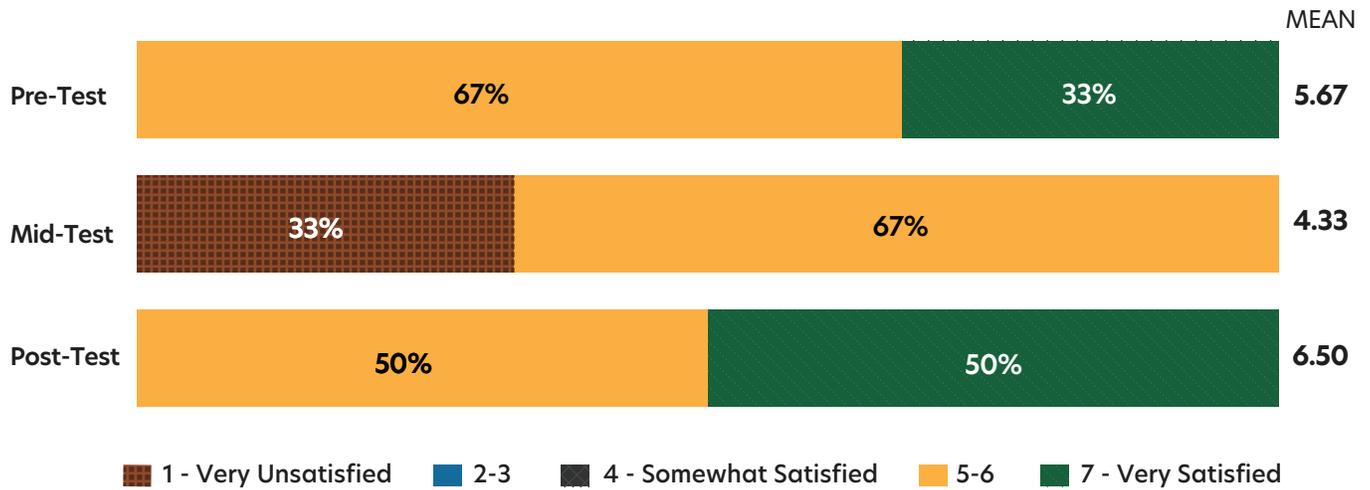
The following section outlines the changes in attitudes over the course of the demonstration. As assessed by the pre, mid, and post-tests. The changes in participant attitudes over the course of the demonstration is examined through five key areas: general satisfaction, reporting, privacy and security, fairness, and acceptance.

#### **Phase 3: General Satisfaction**

The two measures used to determine changes in participant attitudes pertaining to general satisfaction were their overall program experience

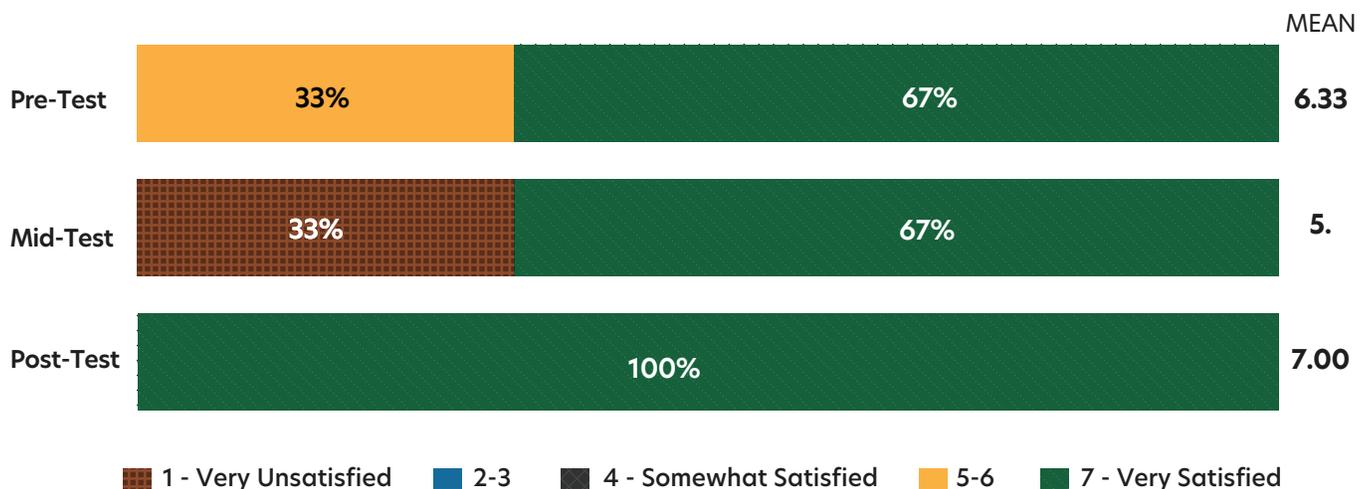
and the amount of time they spent participating in the demonstration. As shown in **Figure 59** - Overall Program Experience, those participants who described their overall program experience as either satisfied or very satisfied fluctuated over the course of the demonstration. This grouping of participants level of satisfaction decreased from the Pre-Test (100%) to the Mid-Test (67%) by 33%, but increased from the Mid-Test (67%) to the Post-Test (100%). Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (0%) to the Mid-Test (33%) but declined from the Mid-Test (33%) to the Post-Test (0%).

**FIGURE 59.** Phase 3 Perceptions - Overall Program Experience



The amount of time a participant was spending on their participation in the demonstration was the second measure to indicate their general satisfaction. As shown in **Figure 60** - Amount of Time, those participants who described their overall program experience as either satisfied or very satisfied fluctuated over the course of the demonstration. This grouping of participants level of satisfaction decreased from the Pre-Test (100%) to the Mid-Test (67%) by 33%, but increased from the Mid-Test (67%) to the Post-Test (100%). Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (0%) to the Mid-Test (33%) but declined from the Mid-Test (33%) to the Post-Test (0%).

**FIGURE 60.** Phase 3 Perceptions - Amount of Time

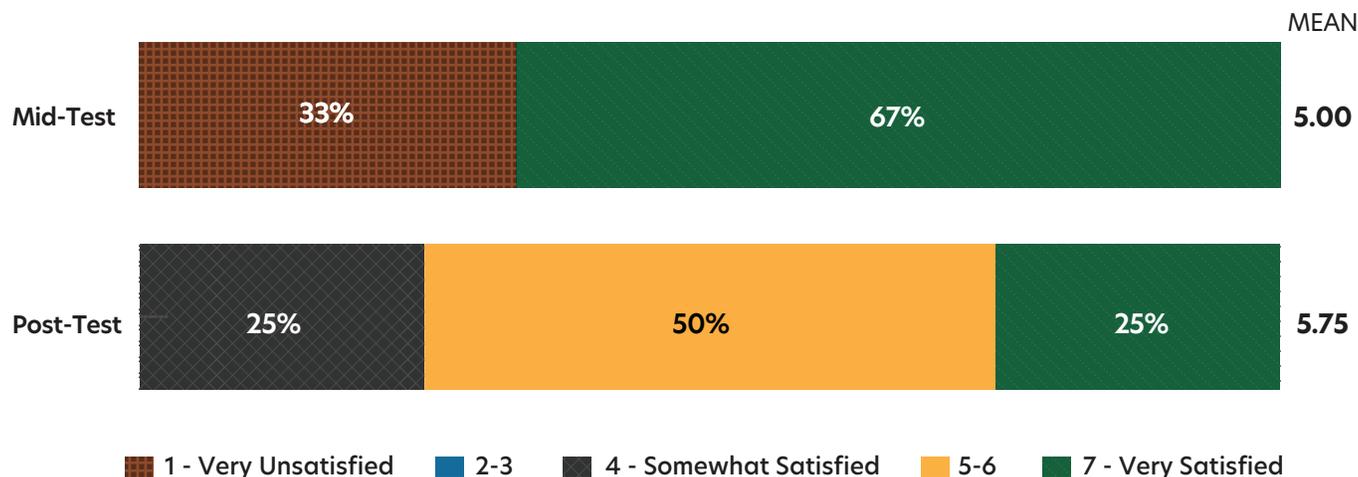




### Phase 3: Reporting

The measure used to determine changes in participant attitudes pertaining to reporting was the process of reporting mileage. As shown in **Figure 61** - Process of Reporting, those participants who described their process of reporting experience as either satisfied or very satisfied increased from the Mid-Test (67%) to the Post-Test (75%) by 8%. Conversely, those participants that were unsatisfied or very unsatisfied decreased from the Mid-Test (33%) to the Post-Test (0%).

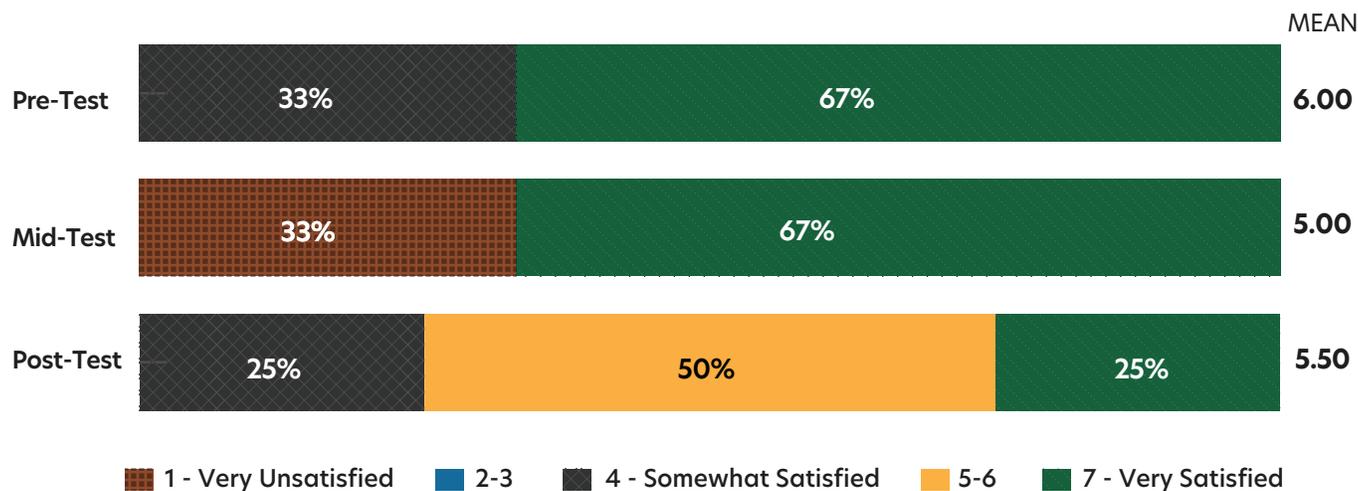
**FIGURE 61.** Phase 3 Perceptions - Process of Reporting



### Phase 3: Privacy and Security

The two measures used to determine changes in participant attitudes pertaining to privacy and security were the security of the data being collected and the protection of participants personal data. As shown in **Figure 62** - Security of the Data Being Collected, those participants who described their privacy and security experience as either satisfied or very satisfied increased over the course of the Phase 3 demonstration. This grouping of participants level of satisfaction increased from the Pre-Test (67%) to the Post-Test (75%) by 8%. Conversely, those participants that were unsatisfied or very unsatisfied increased over the course of the demonstration. This grouping of participants increased from the Pre-Test (0%) to the Mid-Test (33%), but decreased from the Mid-Test (33%) to the Post-Test (0%).

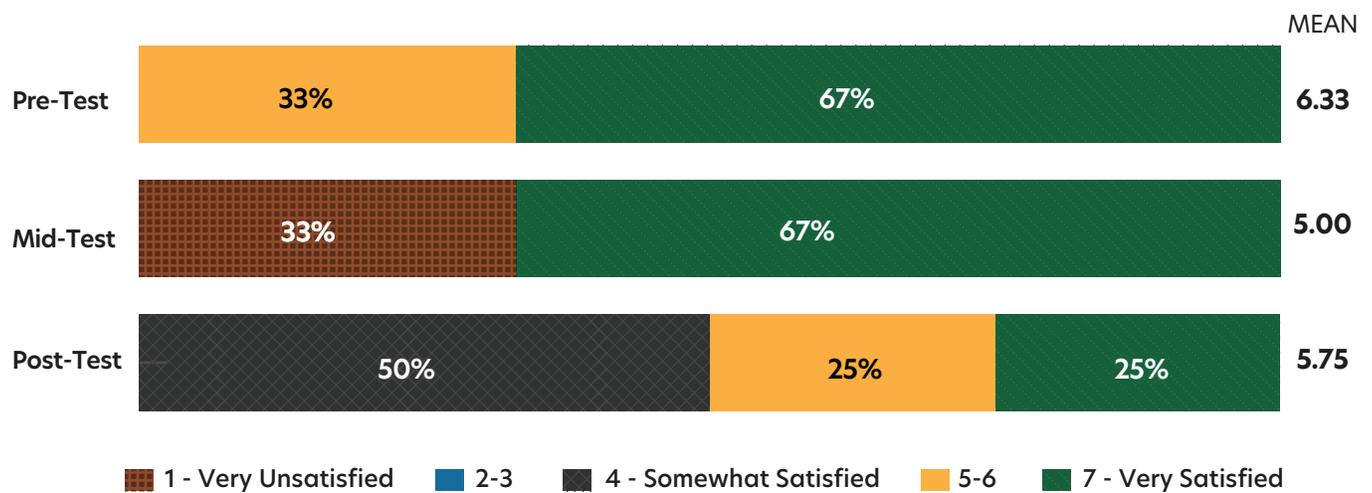
**FIGURE 62.** Phase 3 Perceptions - Security of the Data Being Collected





The protection of participant's personal data in the demonstration was the second measure to determine attitude change with privacy and security over the course of the Phase 3 demonstration. As shown in **Figure 63** - Protection of Participant Personal Data, those participants who described their experience as either satisfied or very satisfied decreased over the course of the demonstration. This grouping of participants level of satisfaction decreased from the Pre-Test (100%) to the Mid-Test (67%) and further declined from the Mid-Test (67%) to the Post-Test (50%). More specifically, those who rated their experience as very satisfied decreased from the Pre-Test (67%) to the Post-Test (25%). Conversely, those participants that were unsatisfied or very unsatisfied increased from the Pre-Test (0%) to the Mid-Test (33%) but declined from the Mid-Test (33%) to the Post-Test (0%).

**FIGURE 63.** Phase 3 Perceptions - Protection of Participant Personal Data

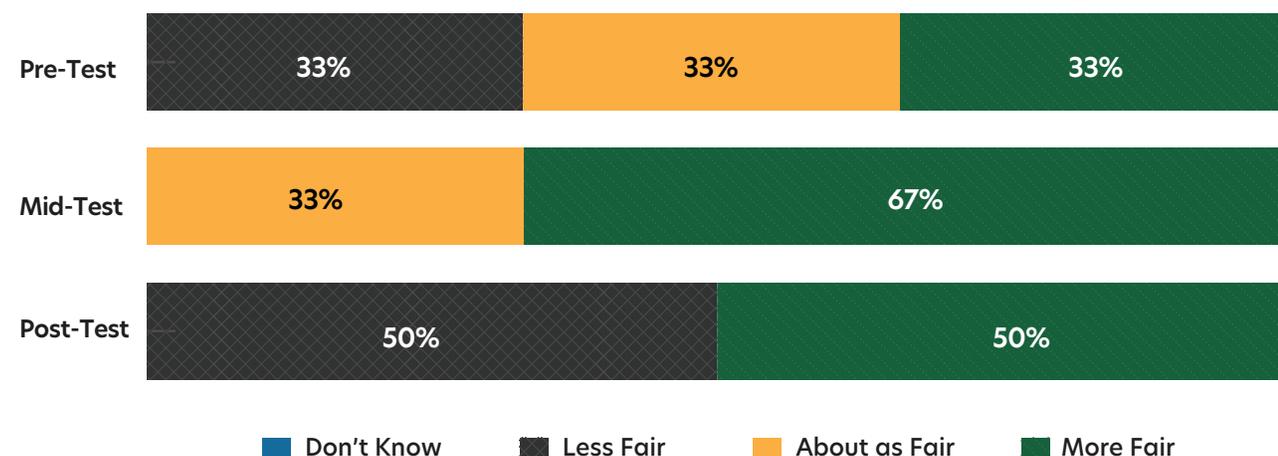


**Phase 3: Fairness**

The two questions used to determine changes in participant attitudes pertaining to fairness were, a comparison between the road charge, and fuel tax to fund highway maintenance and if participants believed they would pay more or less under a road charge program. When asked, *“Would you say that paying for road and freeway maintenance and repair based on the miles you drive is more fair or less fair than paying based on the amount of gas you buy?”*

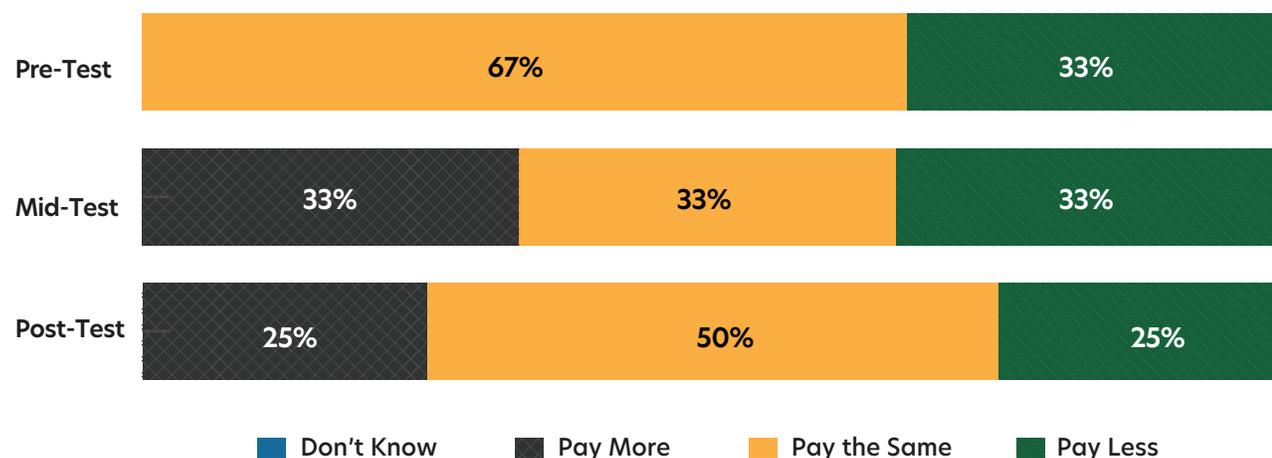
Those participants who described road charge as more fair decreased from the Pre-Test (33%) to the Post-Test (50%) by 7%, as shown in **Figure 64** - Road Charge v. Fuel Tax to Fund Maintenance. Conversely, those participants that described road charge as less fair increased from the Pre-Test (33%) to the Post-Test (50%).

**FIGURE 64.** Phase 3 Perceptions - Road Charge v. Fuel Tax to Fund Maintenance



The second question used to determine changes in participant attitudes pertaining to fairness was if participants believed they would pay more or less under a road charge program. When asked, *“Do you think that you would pay more or less with a road charge than you currently do in gas tax?”*, those participants who stated they would pay about the same or less under a road charge program decreased from the Pre-Test (100%) to the Post-Test (75%) by 25%, as shown in **Figure 65** - Pay More or Less with Road Charge. Conversely, those participants that stated they would pay more increased from the Pre-Test (0%) to the Post-Test (25%).

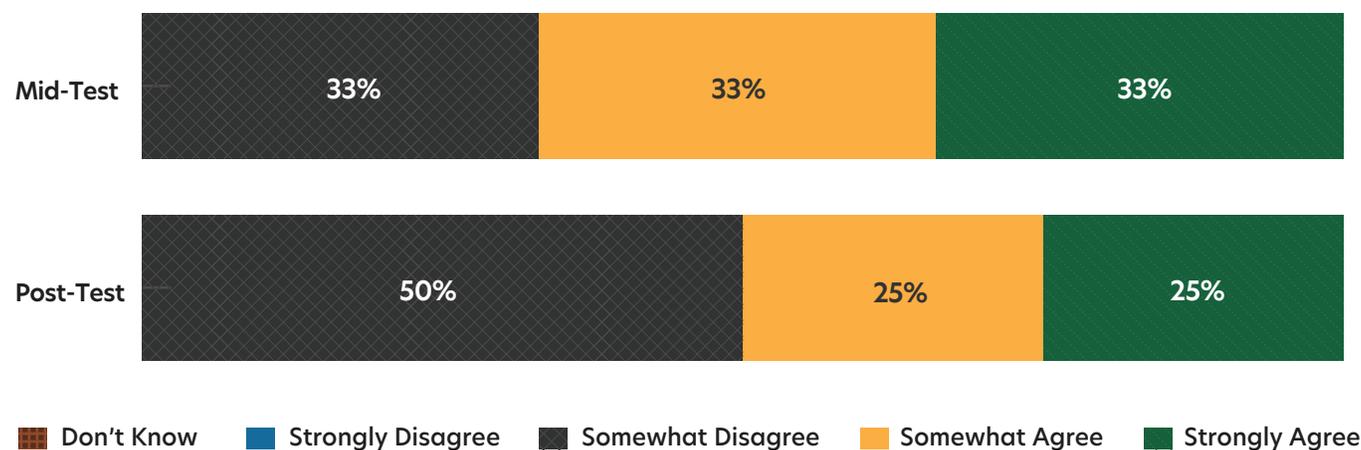
**FIGURE 65.** Phase 3 Perceptions - Pay More or Less with Road Charge



### Phase 3: Acceptance

The two questions used to determine changes in participant attitudes pertaining to acceptance were, should Californians continue to use the fuel tax to fund highway maintenance, and if the State of California should continue exploring road charge. When asked to agree or disagree with, *“the state should stick with the gas tax to fund road and highway maintenance in California.”*, those participants who responded with somewhat agree or strongly agree decreased from the Mid-Test (66%) to the Post-Test (50%) by 16%, as shown in **Figure 66** - Continue to use Fuel Tax. Conversely, those participants who responded with somewhat disagree or strongly disagree increased from the Mid-Test (33%) to the Post-Test (50%).

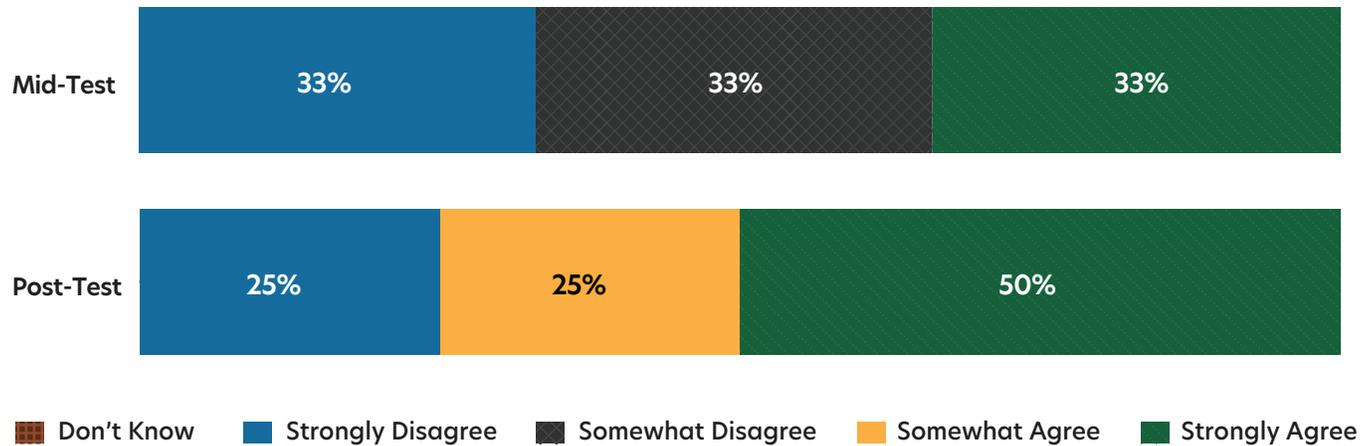
**FIGURE 66.** Phase 3 Perceptions - Continue to use Fuel Tax





The second question used to determine changes in participant attitudes pertaining to acceptance was if participants believed if the State of California should continue exploring road charge. When asked to agree or disagree with, *“the state should continue to explore replacing the gas tax with a per mile road charge to fund road and highway maintenance in California.”*; those participants who responded with somewhat agree or strongly agree decreased from the Mid-Test (33%) to the Post-Test (75%) by 42%, as shown in **Figure 67** - Continue Exploring Road Charge. Conversely, those participants who responded with somewhat disagree or strongly disagree decreased from the Mid-Test (33%) to the Post-Test (25%).

**FIGURE 67.** Phase 3 Perceptions - Continue Exploring Road Charge



### 5.3 General Public Perceptions

In order to inform communications about road charge in California and how it can work with the technology platforms being tested through the Demonstration, the Demonstration Technical Team engaged a series of public research activities including:

- ▶ Three public opinion polls with adults in California.
- ▶ Twelve focus groups with adults in California.

These results of these research efforts are summarized in this section. For more extensive results, please see Appendix O General Public Polling Results and Appendix P Focus Group Results.

#### 5.3.1 Focus Groups

Focus groups with California adults allow for in-depth exploration of perspectives on road charge in California. As a qualitative research tool, focus groups provide the opportunity to steer conversation and address concerns and questions in a group discussion without the constraints presented by quantitative research methods like surveys. This component of the work helped develop an understanding about how the public views the program. It allowed the Demonstration Technical Team to dig deep into concerns and questions people may have and probe the topics mentioned, such as equity concerns, fairness of the program, and implementation details.

The Demonstration Technical Team conducted 12 focus groups with California drivers over the course of the Demonstration, as summarized in **Table 40**. Ten of these groups were conducted in English, one in Spanish, and one in Chinese (Mandarin), across five different locations. Twelve participants were recruited from the general public (not the Demonstration participant pool) for each focus group, for an estimated 8 to 10 participants in each session. Each focus group lasted approximately two hours and participants were paid an incentive of \$125 for their participation in the group.

**TABLE 40. Focus Group Schedule**

DATE	SESSION TOPIC / FOCUS	LOCATION
2/18/21	General road charge perspectives	Bay Area
2/18/21	General road charge perspectives	Central Valley
2/23/21	General road charge perspectives	Northern California
2/23/21	General road charge perspectives	Los Angeles
2/24/21	General road charge perspectives	Orange County / San Diego
4/6/21	Long-distance commuters	Statewide
4/7/21	Rural issues and concerns	Central Valley
4/7/21	Rural issues and concerns	Northern California
4/13/21	Electric Vehicle Drivers	Statewide
4/14/21	Ride Hailing Drivers	Statewide
4/15/21	Spanish Speakers	Statewide
4/15/21	Chinese (Mandarin) Speakers	Statewide

The first round included five focus groups conducted among Bay Area, Central Valley, Northern California, the Los Angeles area, and San Diego/Orange County area drivers in February 2021. The second round included seven focus groups and was conducted among electric vehicle drivers, ridesharing service drivers, long-distance commuters, rural drivers in Northern California and the Central Valley, and Spanish- and Chinese-speaking drivers in April 2021. All 12 focus groups were conducted online. At the conclusion of the two rounds of focus group testing, several key themes emerged. These themes are organized into the categories of common issues identified, reactions to road charge, and technical implementation concerns.

### **Common Issues**

While most participants generally were aware that taxes fund road and highway maintenance in California, and some were aware of the gas tax as one of those sources, there was little depth of knowledge about the way the funding works or the adequacy of funding levels. Many thought that since there generally is a lot of construction in their area, the state has enough money to fund roads. Additionally, perceptions of discrepancies in road conditions across communities lead to assumptions that road maintenance funding is not always distributed equitably.

Most participants knew they were paying a gas tax as part of their fuel costs but did not think or know how much of that cost is taxes. Many believed that the gas tax in California was high, simply because they think that taxes are generally higher in the state compared to others. They appreciated the pay-as-you-go nature of the gas tax and had strategies for budgeting for fuel costs that incorporated the total amount they anticipated paying for gas (including taxes) and how much they could drive on that budget.





In discussions about road maintenance funding, most participants felt that everyone should share the burden of paying to maintain them, including individual Californians and the corporations using public resources for profit. There was a general perception that companies likely had a way to avoid paying their share, even though the trucks they use to transport goods contribute significantly to wear and tear. However, those who had to drive long distances because of their place of residence or nature of their work were likely to comment on the unfairness it placed on people who had no other options than driving long distances.

### **Reactions to Road Charge**

The initial interest in the concept of a road charge was limited, largely due to concerns about implementation and fairness. When participants were introduced to the idea, they raised concerns about the ability of the state to implement the program correctly given the complexity of tracking and reporting, the fairness of shifting to a miles-based system, and the perception of impact on the cost of driving for all Californians. While drivers were not rejecting the notion that they should contribute to road maintenance, they were not convinced that abandoning the gas tax mechanism completely, which they perceived as working fine for most drivers, is the right approach. Above and beyond, the point that increasing fuel efficiency was a main cause of the problem was lost on many; participants thought it was caused by electric and hybrid cars and were doubtful that gas car drivers should be asked to help solve a problem that they didn't create.

When presenting road charge as a necessary change due to adoption of different types of vehicles, participants had questions about the broadness of the proposed solution. The framing of the funding gap as a result of the shift to hybrid vehicles and electric vehicles led many to ask why the state is not just considering a smaller solution aimed just at drivers of those vehicles, rather than forcing everyone to change to a new, complicated system. Many thought setting up a parallel road charge system for electric and hybrid vehicles, while keeping gasoline-powered vehicles under the gas tax, would be preferable.

Most participants felt a road charge was just a way to generate more revenue from residents by shifting more of the burden to individuals and away from corporations, as opposed to a way to rebalance the existing burden. This was reinforced by general feelings of distrust about government and transparency overall, and a perception that anything they were not being told was probably bad for them. Many feared that the gas tax would not actually go away, and they would never really know because of the lack of transparency around the amount of the gas tax and the gradual way it is paid.

When participants were provided with road charge cost information, many questioned whether the road charge would be implemented at the rates presented in the focus group materials. Many suspected that even if a road charge started off at the two-cent rate shown in the materials during the implementation stage, it would inevitably increase with time. They were also skeptical about statements that said that the road charge would be a replacement for the gas tax; they did not think the state would really give up a tax they were already charging.

A shift to a per-mile charge led to concerns about people who have to drive many miles, be that because they have a job that requires a lot of driving that is not reimbursed or paid for by their employer, a long commute due to an inability to afford to live closer to their workplace, lack of public transit outside urban areas, or multiple jobs to make ends meet. Most concluded that for a road charge to be made fair, it should consider other factors than the number of miles driven, such as the weight of the vehicle. Participants also pointed out that the concept of equity also needs to include companies and other entities who use California highways to profit with heavy, damaging delivery trucks.



For many, the idea of creating a new system to impose a fee specifically on electric vehicle drivers felt misplaced. The perception was that electric vehicle drivers purchased their vehicles with the understanding that the vehicle might cost more but they were saving on the gas tax and doing something positive for the environment. Many worried that a road charge would slow the rate of electric vehicle adoption. One group suggested that fuel efficiency could be a factor determining the rate at which the road charge is paid, to ensure all vehicles are contributing to road maintenance while still incentivizing lower levels of carbon emissions.

### **Technical Implementation Concerns**

Many participants felt it would be impossible to implement a road charge accurately and fairly. Some of their concerns included data recording and reporting accuracy, data privacy and tracking issues, people finding ways to underreport miles, how to charge out-of-state drivers, whether Californian drivers would still pay this tax when they travel out of the state, and the timing and frequency of road charge payments. Many wondered if it was just too risky to throw away a system that mostly works fine for one that they were not confident could even be implemented.



Most participants knew they paid a gas tax every time they filled up their tank and that was part of how they planned how far they could afford to drive. Without knowing the frequency of payments under a road charge, many feared it would be a significant monthly or annual bill, and even if it was the same amount they had paid under the gas tax, they could struggle to anticipate larger amounts under this type of system. They also worried that with a road charge you had to pay after you drove the miles, and there was a greater risk of overspending without realizing until it was too late. Many expressed a preference for small, frequent payments, since this is how they pay the gas tax now and they are used to budgeting in that way.

For many participants, the notion of tracking the miles driven brought to mind the idea of “being tracked by the government,” which undermined the receptiveness toward a road charge. Having to install a device in one’s car for this purpose elicits privacy and cost concerns. That said, most drivers are familiar with the mileage-based insurance and smog checks, and many participants thought the mileage reporting would be similar to those mechanisms, which they are more comfortable with.

While some were concerned about the privacy implications of automatic mileage reporting, concern that people would misreport and underpay (whether on purpose or accidentally) generally outweighed those concerns. Many felt their location information was already being gathered by technology companies, insurance companies, and others, so providing that information to a state program as well was not a big concern. While some initially liked the idea of using other systems where mileage is already collected, such as insurance records, annual vehicle registration fees, or smog check data, these tools all raised concerns about the risks of large and infrequent payments as opposed to frequent, small payments.

### 5.3.2 Public Polling

As part of the Demonstration, three random, representative sample polls of California adults were conducted to understand how the public perceives the road charge concept and to assess the impact of additional information on those perceptions. All three public polls contained consistent questions regarding basic attitudes about road charge, issue environment, and demographics that allowed for comparisons across the three polls and assess potential changes over time. Each poll also had a specific focus area:



- ▶ This first poll included questions about how a road charge interacts with other road funding mechanisms and tested messaging regarding the program.
- ▶ The second poll focused on the technical details regarding the implementation of a road charge program, including how residents view the logistics of the program.
- ▶ The third poll focused on asking specific questions to help envision the future of road charge and position it as the next generation transportation vision for California.

Results and observations from each poll are discussed in the following subsections. Polling results, particularly from the first poll, informed subsequent focus groups of California residents and surveys of road charge Demonstration participants. The results of these research efforts are discussed in subsequent sections of this report. Full results can be found in Appendix P Focus Group Results.

#### **First Public Poll**

The first poll was conducted in 2020 from July 24 through July 30. It was a mixed-mode survey comprised of a representative sample of California adult residents with respondents being contacted for phone interviews (via landline and cell phone) or through an email invitation to complete a web version of the survey. A total of 603 interviews were administered with overall margin of error  $\pm 3.9$  percentage points. Telephone interviews were conducted in English and Spanish by trained, professional interviewers.

The survey was administered in the fourth month of the COVID-19 pandemic while much of California continued to be under a shelter-in-place order. During that time, driving and transit riding had decreased sharply but were slowly beginning to return. However, driving and transit usage remained significantly below pre-pandemic levels in most parts of the state.

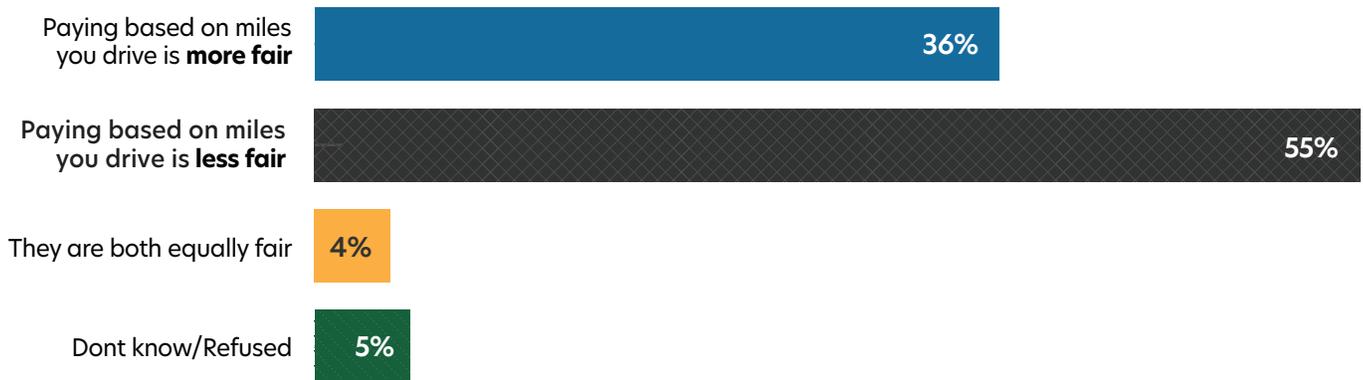
The survey found that more than half of respondents feel their local freeways and roads are in fair or poor condition. Freeways and highways tended to be rated somewhat higher than local streets and roads, but a majority of respondents still rated these facilities as being in poor or fair condition. A majority of respondents (67 percent) indicated that there is at least some need for more money to maintain those facilities, with nearly a third (29 percent) saying there is a great need. However, 61 percent responded that costs of road and freeway maintenance should be shared equally as a service because everyone benefits, while only 15 percent believed that those who drive more should pay more, as a road charge would do.

As might be expected based on public funding preferences, Californians were not enthusiastic about the idea of a road charge, either as an independent idea or as a replacement for the gas tax as a source of transportation funding. Two-thirds of respondents had a negative reaction to the concept of replacing the gas tax with a road

charge (defined in the survey as “a per-mile charge for driving on public roads”). A majority (55 percent) felt that paying for road and freeway maintenance based on miles driven is less fair than paying based on the amount of fuel purchased (**Figure 68**).

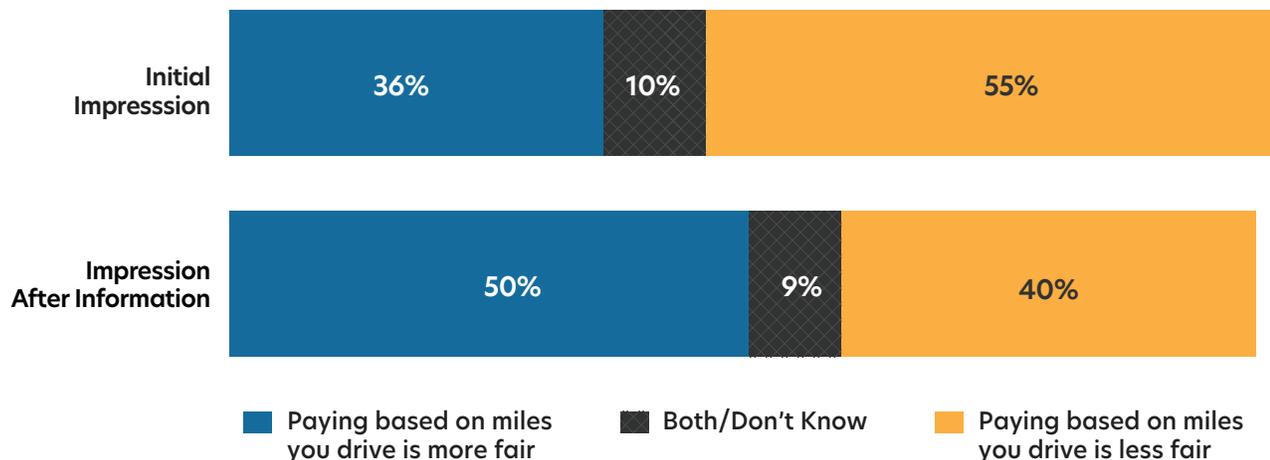
**FIGURE 68.** Survey 1 Responded on the Fairness of Road Charge

**Would you say that paying for road and freeway maintenance and repair based on the miles you drive is more fair or less fair than paying based on the amount of gas you buy?**



Providing additional information on the concept helps the idea of road charge as a replacement to the gas tax gain traction and support. Nearly half of respondents had a positive reaction to the concept after learning more, and half felt that paying based on miles driven is more fair than a gas tax (**Figure 69**). The initial survey showed that clearly explaining the deficiencies of the gas tax in comparison to road charge is likely the most effective way to gain support for the road charge concept. This includes communicating that the fuel tax is an outdated model, that it creates inequities in distribution of costs, and that it is leading to declining revenues for road and freeway maintenance.

**FIGURE 69.** Perceptions of Fairness After Receiving More Information on Road Charge



**Second Public Poll**

The second public poll was conducted in 2021 from April 6 through April 12 and took the same form as the initial poll. It was a mixed-mode survey comprised of a representative sample of California adult residents with respondents being contacted for phone interviews (via landline and cell phone) or through an email invitation to complete a web survey. A total of 615 interviews were administered with an overall margin of error ±3.9 percentage points. Telephone interviews were conducted in English and Spanish by trained, professional interviewers.



The poll was administered during the COVID-19 pandemic while much of California continued to experience restrictions on gathering and traveling, and most were not following their typical travel and commute habits. During that time, driving and transit riding had decreased sharply but were slowly beginning to return. However, driving and transit usage remained significantly below pre-pandemic levels in most parts of the state.

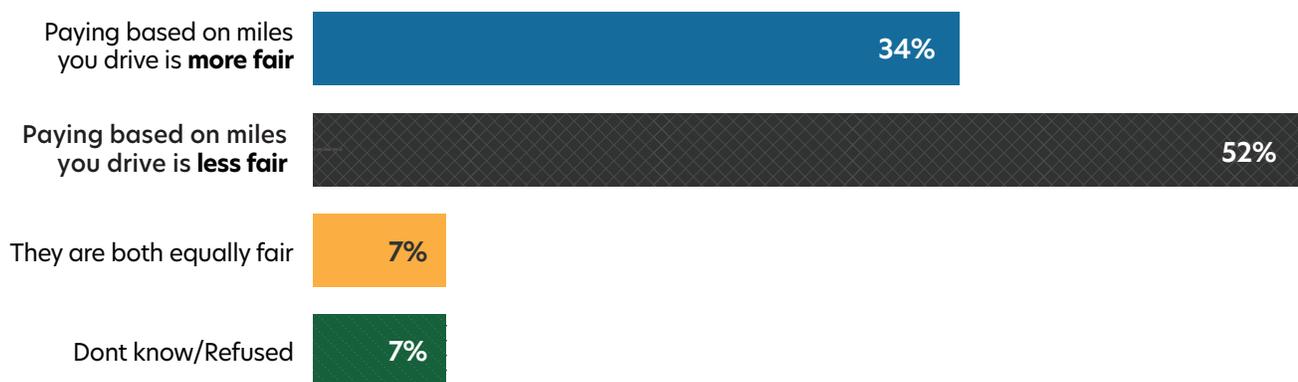
The poll found that more than half of Californians felt that their local freeways and roads are in only fair or poor condition. Local streets and roads tended to be rated somewhat higher (55 percent) than freeways and highways (56 percent), but a majority of respondents still rated these facilities as being in poor or fair condition. This data represents a shift from the July 2020 poll, where freeways and highways were rated slightly higher.

A majority of respondents (70 percent) indicated that there is at least some need for more money to maintain those facilities, a two percent increase from the July 2020 poll. However, 59 percent responded that costs of road and freeway maintenance should be shared equally as a service because everyone benefits, while only 17 percent believed that those who drive more should pay more, as a road charge would do, a two percent increase from the July 2020 poll.

As might be expected based on public funding preferences, Californians were not enthusiastic about the idea of a road charge, either as an independent idea or as a replacement for the gas tax as a source of transportation funding. Two-thirds of respondents had a negative reaction to the concept of replacing the gas tax with a road charge (defined in the survey as “a per-mile charge for driving on public roads”). However, between July 2020 and April 2021, the percentage of respondents with a negative overall impression of the road charge concept fell from 82 percent to 77 percent. A majority (52 percent), a 3 percent increase from the July 2020 poll, felt that paying for road and freeway maintenance based on miles driven is less fair than paying based on the amount of fuel purchased (**Figure 70**).

**FIGURE 70.** Survey 2 Responded on the Fairness of Road Charge

**Would you say that paying for road and freeway maintenance and repair based on the miles you drive is more fair or less fair than paying based on the amount of gas you buy?**



**Third Public Poll**

The third public poll was conducted in 2022 from January 18 to January 24 and took the same form as the two preceding polls. It was a mixed mode survey comprised of a representative sample of California adult residents with respondents being contacted for phone interviews (via landline and cell phone) or through an e-mail invitation to complete a web version of the survey. A total of 800 interviews were administered with an overall margin of error ±3.5 percentage points. Interviews in all modes were conducted in English and Spanish.

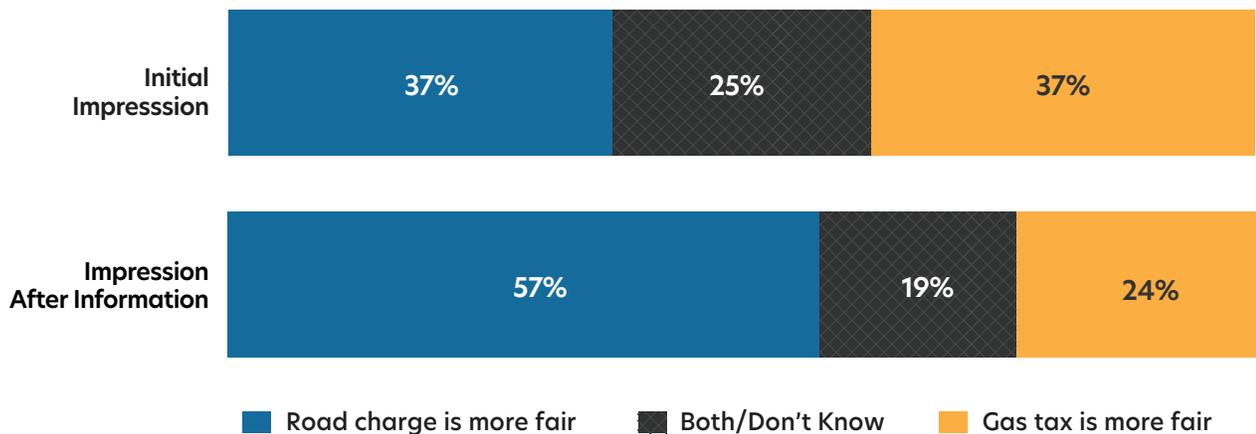
The poll was administered at the end of the second year of the Coronavirus pandemic, when much of California continued to experience restrictions on gathering and traveling, and many were still likely not following typical travel and commute habits.

The third public poll found that more than half of Californians feel their local freeways and roads are in only fair or poor condition, consistent with the two previous surveys. The condition of local streets and roads was rated at the same level as freeways and highways (59 and 58 percent, respectively).

A majority of respondents (66 percent) indicated that there is at least some need for more money to maintain those facilities, and one-fourth indicated that there is great need. However, 63 percent responded that costs of road and freeway maintenance should be shared equally as a service because everyone benefits, while only 17 percent believed that those who drive more should pay more, as a road charge would do, and the idea that those who drive more should pay more remained a minority view (15 percent), consistent with the earlier polls.

In contrast to the first two public polls, the third poll led with establishing the problem presented by the gas tax prior to asking opinions about a road charge. With this shift in framing of the issue, three-fourths of Californians felt that replacing the gas tax with a more stable revenue stream for the state's road and freeway maintenance is important. Then, when the idea of road charge was introduced following that, more Californians reacted positively to it (41% positive) compared to earlier polling, and perceptions of fairness between road charge and gas tax was split, with 37 percent of residents saying road charge is more fair and 37 percent saying gas tax is more fair (also a change from the earlier polling). Many of the informational statements resonated strongly with residents, and information effectively improved both the positive impression of the road charge (63 percent) and perception of fairness (57 percent saying road charge is more fair; **Figure 71**).

**FIGURE 71.** Public Poll 3 - Responses on Fairness after More Information on Road Charge



## 5.4 Security Audit and Evaluation

At the end of testing, an independent data security assessment was conducted to ensure that personally identifiable information would be protected, data encrypted and secured both in transit and at rest, and that the integrity of data would be upheld through the entire process. An independent data security audit was conducted on the Demonstration system that is based on criteria for actual operational systems. The Demonstration Technical Team compiled a list of audit criteria, validated the security processes and protocols in place, and conducted penetration testing where appropriate, results of which documented in the Data Security Audit Report. The findings in this report do not denote that the Demonstration system has issues; rather, some aspects will need to be remediated should this system ever go live.

The Data Security Audit Report established the processes, findings, and recommendations related to the protection of data at rest and in motion. The Data Security Audit Report focused on ensuring that PII is protected, encrypted, and integrity confirmed through the entire process. Within the Data Security Audit Report, the Demonstration Technical Team concluded that the Demonstration was a moderate impact system in accordance with the starting impact rating of Energy, Installation and Environment Risk Management Framework Master List and Federal Information Process Standard 199, Standards for Security Categorization of Federal Information and Information Systems. **Table 41** details the audit report’s recommendations for cybersecurity of a future road charge system, which of the recommendations are already being met through the Demonstration’s design, and information on how each recommendation is being met by current design or will be met in future initiatives.

**TABLE 41. Independent Data Security Assessment Recommendations and Recommended Resolutions**

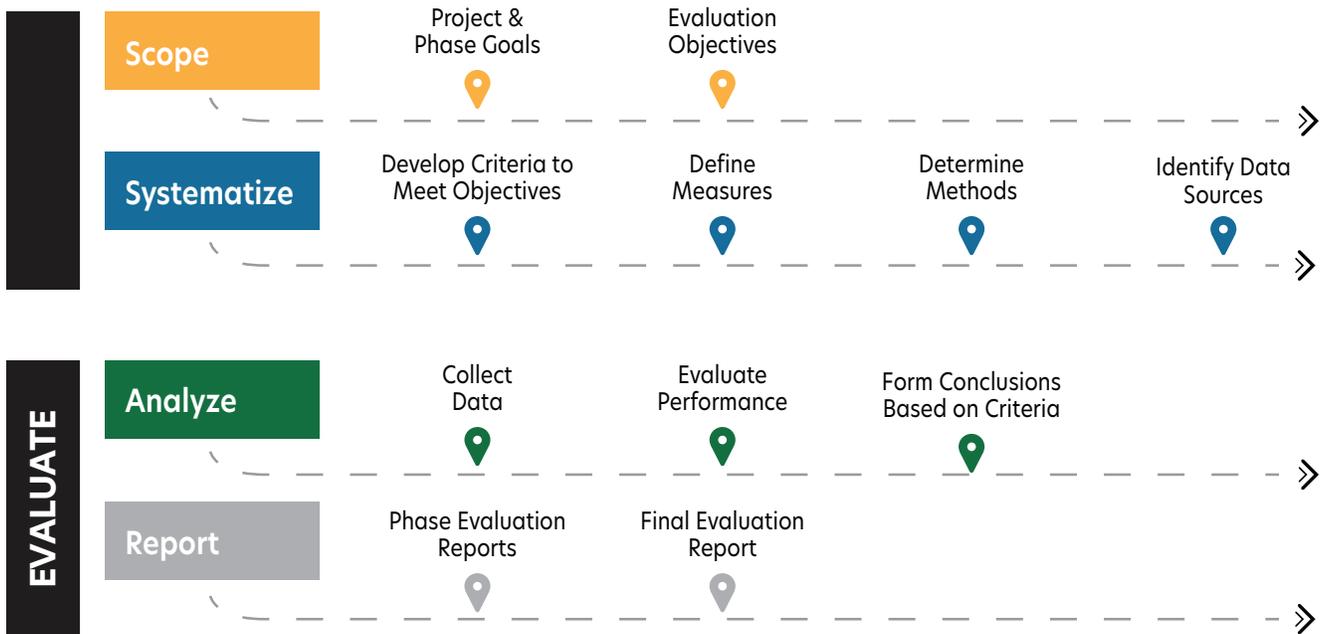
AUDIT RECOMMENDATION	IN DEMO DESIGN	HOW THE RECOMMENDATION IS BEING / WILL BE MET
Apply the three fundamentals of security being confidentiality, integrity, and availability.	☑	NIST Cybersecurity Framework and ISO 27001 standard, including their principles of confidentiality, integrity, and availability of data was used as the basis to develop system design and specifications.
Include Cybersecurity in the software process migrating from Development and Operations (DevOps) to Development, Security, and Operations (DevSecOps).	☑	Cybersecurity is included in system design, architecture, requirements, and testing. See SRS requirements SYS.XXX.##
Hardening of all physical devices including the exclusive use of Accredited Vendor List (AVL) and Accredited Product List (APL) equipment.	N/A for demo	California AVL/APL will be consulted for potential vendors to provide technology and/or services for a future program, if and when it is explored.
Creation of device guidelines centered on cybersecurity during deployment and operations.	☑	Operational and performance-based requirements developed that support security and cybersecurity principles and national best practices that will support device guidelines.
User and credential access management.	☑	Access management included in system requirements. See SRS requirements SYS.SEC.xx and SYS.DPP.4.
Data protection at rest and in transit, including approved protocols and certificate authorities.	☑	Access management included in system requirements. See SRS requirements SYS.SEC.xx.
Application Programmer Interface security.	☑	Access management included in system requirements. See SRS requirements SYS.SEC.xx.
PII sanitization, protection, and retention.	☑	Access management included in system requirements. See SRS requirements SYS.DPP.xx.
Payment Card Industry Data Security Standard (PCI-DSS) requirements.	☑	Access management included in system requirements. See SRS requirements SYS.SEC.11 and SYS.SEC.12.

## 5.5 Independent Evaluation

The previous section of this report qualitatively assessed how the Demonstration performed relative to goals and objectives established by the Demonstration Technical Team, Caltrans, the TAC, and the STSFA funding program. A formal, more quantitative independent evaluation was also conducted by project partner Highlands Consulting Group, which was not involved in implementing or operating the Demonstration. The evaluation does not express judgments or make recommendations; rather, it is a compilation of data and analysis related to the performance of the Demonstration, designed to illustrate efforts and achievements directed at the Demonstration’s objectives and goals. That evaluation is provided in Appendix A.

This evaluation was guided by the Demonstration Evaluation Strategy Plan, using the objectives discussed in Section 5.6 and detailed criteria designed to assess how well the project met its objectives. Those criteria, with their associated measures and analytical methods were incorporated into an Evaluation Criteria Matrix which is included as an attachment to the Final Evaluation. The evaluation followed a rigorous process to plan for and then conduct the evaluation as shown in **Figure 72**.

**FIGURE 72.** Road Charge Demonstration Evaluation Process



As shown in the figure, the two primary activities associated with the evaluation included:

- ▶ **Planning:** This step involved understanding the scope of the evaluation in terms of reviewing the goals and objectives established by Caltrans for the entire Demonstration and each phase. To make these goals and objectives actionable and measurable, the evaluation team created a systematic structure for the evaluation: creating evaluation criteria for each objective, defining measures for each criterion, determining the analytical methods to develop each measure, and identifying data sources.
- ▶ **Evaluating:** The active evaluation began with analyzing data and documentation collected and reported by the project delivery team and collected from interviews, surveys, polls, and other sources. With the collected data, the team evaluated performance to determine whether the project was meeting the criteria established in the Demonstration Evaluation Strategy Plan. The Project Team then made conclusions that form the basis of this and other evaluation reports.

This evaluation was based on the following information gathering and analysis methods:

- ▶ **Data Analysis:** Review of quantitative and qualitative data from periodic operational reports, surveys, polls, focus groups, and ad hoc data provided by the operational team.
- ▶ **Documentation Review:** Review of foundational project documents, including authorizing legislation, grant applications, contracts, operational and communications plans, participant instructions, email and other communications to participants, and other descriptive documents created during the Demonstration.

- ▶ **Business Partner Compliance Testing:** Detailed documentation of how each Business Partner met standards required by Caltrans and the project delivery team.
- ▶ **Independent Security Audit:** An independent review of Business Partners' compliance with detailed standards for data and system security and reliability.
- ▶ **Interviews:** Structured interviews with Business Partners, consultants, and Caltrans staff to probe questions about the Demonstration's performance, successes, and challenges.
- ▶ **Focus Groups:** A series of 12 focus groups with drivers from various regions of the state, drivers of electric vehicles, ridesharing drivers, rural drivers, long-distance commuters, and drivers fluent in Spanish and Mandarin.
- ▶ **Participant Surveys:** A series of surveys for the three Demonstration phases that involve participants (excluding AVs), conducted before starting, at the mid-point, and at the conclusion of their participation.
- ▶ **Public Opinion Polls:** A series of three polls, conducted in 2020 and 2021, gauging California residents' opinions on road charge concepts and other related transportation issues.

The independent evaluation established a total of 87 objectives and concluded that the Demonstration successfully satisfied 66 of those objectives and partially satisfied the remaining 21. The evaluation concluded that most of the partially achieved outcomes were the result of participant user errors during the small number of participants responding to surveys.





Section 6

# FOUR-PHASE DEMONSTRATION LESSONS LEARNED

Why did California conduct this Demonstration? Like other states, California's gas tax is increasingly less effective at funding our system's maintenance, reconstruction, and operational needs. California successfully demonstrated the general feasibility of the road charge concept as a potential replacement for the gas tax with its 2017 Road Charge Pilot. This Demonstration was conducted to further test, inform, and shape an implementable alternative tax structure for potential use in the state, as well as offering insight for other states that are or will be studying a road charge as a potential replacement for the gas tax. Specifically, the California Four-Phase Demonstration explored principles for an easy user experience in a road charge system, as well as the technical feasibility of pairing road charge with several emerging technologies and business models, and has offered many useful insights. This section details the accomplishments, key findings, and lessons learned through this Demonstration for California and other policy makers.





## 6.1 Overall Demonstration Findings and Principles

The overall Demonstration resulted in the identification of several basic principles for supporting ease of road user and business partner experience. These findings, while encountered during the demonstration, can certainly be applied to future large-scale road charge efforts.

### **Building on existing business models is a win-win-win.**

Building on existing business models, systems, and processes is key to a successful road charge program. To the motorist/taxpayer, leveraging familiar processes and systems from tried and trusted sources promotes comfort in the reporting, confidence in payment, and may aid in understanding how a road charge program could operate.



For business partners, leveraging existing systems and processes means they can expand their market access without the need to incorporate sweeping changes to accommodate road charge. Additional costs and risks associated for systems administration, collections, and enforcement can be minimized if business partners can use their existing operations. The business partners involved in the Demonstration expressed preference for using existing systems, processes, and methods for reporting and assessing a road charge. Leveraging existing processes also promotes easier entry into the road charge market. This can help promote market competition and ultimately lower the cost to the State as well as provide better services to the motorist/taxpayers.

To the State, leveraging existing systems equates to considerably reduced administrative costs, both those levied by the business partners, and those internal costs needed to administer the road charge program. Less time is needed to ramp up staff, train on new policies or systems, and less risk for lost revenue due to mistakes from new systems.

### **All of the business partners expressed interest in a market share under an operational program.**

Each of the five business partners that participated in the Demonstration expressed that a market share in an operational road charge program was a motivator for their interest in participating. This was true even for businesses that already had access to their customers' mileage data and therefore could not be incentivized to join based on data access. Road charge continues to gain popularity across the country and each of the business partners see the strategic advantage in becoming an early adopter of the road charge concept. By doing so, several expressed they could help shape the messaging around road charge, gain valuable insight, promote their existing services as part of a new initiative, and be able to proactively engage decision makers as to how road charge should be deployed as opposed to reacting to policies.



## Existing business providers can be integrated securely and reliably with a road charge system.

One of the major focuses of the Demonstration was to determine how easily, securely, and reliably road charge could be introduced into existing systems from well-established markets that are not built around road charge. Prior to Demonstration launch, the entire Demonstration system, to include third-party systems, was successfully tested to determine how reliably, securely, and effectively the system could support Demonstration operations. All testing passed with no issues or remediation efforts needed. The entire system was also audited against the National Institute of Standards and Technology (NIST) 800-series publications which relate to the security and privacy of information and information systems. This comprehensive audit evaluated the systems architecture, data retrieval and storage methods, use of encryption, and the sanitization of data to include removal of all Personally Identifiable Information (PII). This audit resulted in no major findings, further supporting that the Demonstration, including third party systems, could capture information and safeguard it against unauthorized dissemination. Looking to the future, the potential of integrating a road charge system with businesses that already have a national market of their own supports easy scalability.

**Simple, transparent approaches will be more positively accepted than complex solutions.** Transparency is key as participants want to see how their road charge is calculated, how secure and safeguarded the systems are that collect and process their road charge payments, and a direct correlation between the road charges paid and the improvement to California's highways.

## Privacy concerns and complexity are perceived challenges.

Two key challenges identified by participants were privacy and complexity. Some participants noted potential privacy concerns regarding their reporting methods and the exchange of data between multiple parties. Some participants also noted the complexity of enrolling in certain phases was a challenge. Participants in phases with minimal steps to enroll and participate showed higher satisfaction.

## Technology-based reporting methods can pose accessibility issues.

While technology options like those explored in the Demonstration can provide a simple, cost-effective way to participate a road charge system, an overdependence of high technology solutions can result in accessibility challenges and inequities with economically underserved and older populations. Smartphones are not ubiquitous among California residents, and reliance on smartphone technology for participation presents a potential barrier for some economically underserved and vulnerable populations who may choose to not use technology to report their road charge. Some instances were reported from participants in higher age brackets having difficulty downloading smartphone apps, taking odometer pictures, or summoning ridesharing services. This was a good reminder that low technology and no-technology options, while not the focus of this Demonstration, also need to be included in a road charge system to help assuage equity concerns over technology usage and access.

## Clear definition, communication, and proactive enforcement of business practices is critical.

Proactive enforcement of business partners' established business rules with tangible penalties for violations is critical to program success and participant satisfaction. For example, monthly invoices were not emailed to many participants using the GasBuddy account management options. Participants were still able to view their assessed road charges in the app, but most did not know intuitively that they needed to check their mobile app for the transaction, raising concerns over program transparency. Future state oversight agencies must establish, communicate, and audit customer service standards for commercial account managers.

## 6.2 Phase 1A Pay-at-the-Pump Lessons Learned

Phase 1A illustrated the true complexity of assessing a road charge at the fueling pump. The disparity of technologies and processes between fueling retailers presenting challenges in implementing a single technology or process for pay-at-the-pump road charge.



**While the technology is available, there is not an existing business model to support pay-at-the-pump road charge.**

Paying a road charge at the pump has garnered a high level of interest from policy makers. The idea of being able to exactly copy the existing taxpayer experience under the fuels tax is appealing. However, this raised challenges with a potential need for a technology retrofit at fueling pumps. That approach raises considerable problems for the statutory structure of a potential road charge system by inviting a third entity (fuel stations) into the taxpayer/commercial account manager relationship, creates questions about how to fund a technology upgrade for fueling pumps, and potentially puts the state in the uncomfortable position of choosing one technology solution over others.

The solution presented by technology partner GasBuddy was able to avoid these policy quagmires. The debit card-based solution did not require any changes to fueling pumps and opened the door to the idea of major credit card companies serving as road charge business partners. However, GasBuddy's current business model is transactional in nature and does not require mileage reporting. The connection between mileage collection and the financial transaction was not as reliable as it would need to be in a functioning road charge system.

That does not mean, however, that no potential exists for a credit card company to serve effectively as a road charge commercial account manager, offering a pay-as-you-go solution. The concept still has compelling possibilities, but more work needs to be done to bring the different aspects into a working whole. Part of the Demonstration's value has been learning that a road charge collection option does not have to exactly copy the fuels tax payment experience in order to copy its easiness.

**Integration with existing fueling infrastructure is possible but not the best path at this time.**

Integrating road charge with existing fueling infrastructure continues to face large hurdles at this point in time. While the pay-at-the-pump phase (Phase 1A) successfully demonstrated that road charge transactions can be integrated with fueling receipts, integration with the actual fueling pump technology proved to be such a challenge that Caltrans took a very different approach in the pilot's execution with the GasBuddy solution, which still did not prove fully feasible. Few pumps have a way to read mileage data directly from a vehicle, and vehicles do not readily provide that information without third-party telematics devices or as part of an embedded telematics infotainment solution. While the technology is available to support this information exchange, a full statewide road charge implementation would require integration with over 10,000 fueling stations which poses considerable costs, as well as complexities with engaging each fuel retailer.

California expects technologies and business models to constantly evolve in the future life of a potential road charge system, and intends to create a system structure that can adapt and absorb new approaches from third party commercial account managers. There will likely be a time that a potential commercial account manager will offer a pay-at-the-pump approach that will cost-effectively pass the state's certification requirements. At the present time, however, this is not an approach the state should spend more time on.



### Third-party smartphone apps may not accurately capture trip information needed to support a functioning road charge system.

During Phase 1A, a small study was conducted that compared the trip mileage and location data captured by the GasBuddy app against that captured by an onboard diagnostics plug-in device. The mileage collection aspect of GasBuddy app is a service, not a key part of their business model. It was determined that the app was not nearly as accurate, not turning on for the first two minutes of a trip, not accurately determining the location, or not being able to capture a trip because the phone was not in the vehicle. This confirms issues raised with smartphones as a point of mileage collection in other pilot efforts.

### Technologies and apps for fuel retailers may prove over complex for some motorists.

The processes to enroll in Phase 1A proved complicated for some participants. Participants were required to download a smartphone app, create an online account, and acquire a GasBuddy payment card, which was linked to the participant's checking account. All fuel purchased over the course of the Demonstration was then required to be paid for using the GasBuddy payment card. This may deter some participants from enrolling in this option, especially if they are tied to a single provider or a single, complicated solution.

### A Pay-at-the-Pump Road Charge Model can support accurate calculation of fuels tax credits.

The fuel consumption data collected from the vehicle as part of the road charge calculation can be coupled with the fueling information captured from a fueling session, to accurately calculate any fuel tax credits.

## 6.3 Phase 1B Pay-at-the-Chargepoint Lessons Learned

Phase 1B Pay-at-the-Chargepoint showed that although electric vehicle charging entails the exchange of information between the user and service provider, mileage is not part of that exchange. Furthermore, there are a wide range of options for electric vehicle owners and drivers to charge their vehicles outside of the retail charging environment. However, electric vehicles are also more likely to feature in-vehicle telematics that could provide accurate mileage collection outside a retail environment while being more challenging to tamper with relative to aftermarket devices.



### At this time, electric vehicles do not directly transfer mileage data through a charging station.

During the Demonstration design efforts, it was determined that no mileage or location information is transferred between the electric vehicle and the charging station through the charging plug or vehicle port. This required the project team to incorporate onboard diagnostics plug-in devices for Phase 1B to capture and report mileage and location information. While this data was accurately transferred and used in conjunction with ChargePoint's systems, it prevented the ability to conduct real-time transactions with a direct connection between the vehicle and the charging station.

### Many electric vehicles do not have an onboard diagnostics port, making plug-in devices obsolete.

A vehicle's onboard diagnostics port was originally introduced to support emissions testing. Over the years though, this port has evolved to serve multiple roles including vehicle diagnostics, firmware updates, and road charge mileage collection. As electric vehicles create zero emissions, many models are manufactured without an onboard diagnostics port. This poses a challenge in capturing vehicle mileage and other telematics data using



third-party devices and further supports the reliance of embedded telematics systems for direct data transfers. As vehicle manufacturers migrate towards all-electric production, the onboard diagnostics port, and plug-in devices that connect to this port, may become obsolete for new vehicles. This highlights the need for multiple technology options for mileage collection across the whole California fleet of vehicles.

### **A pay-at-the-chargepoint model may work well for electric vehicle drivers that regularly use a provider's electric vehicle charging station network or purchase their home-charging station.**

Phase 1B proved that a road charge could be assessed and paid through an electric vehicle charging station provider's account management system. Participants held an account with the electric vehicle charging station provider, and were able to receive and simulate payment of their road charges whether they used publicly available charging infrastructure or home charging stations supplied by the provider. While this may not be the right commercial account manager option for those who just charge at home, it may be a viable option for the subset of electric vehicle drivers who commercially charge.

## **6.4 Phase 2 Usage-Based Insurance Lessons Learned**

Phase 2 featured a simple assessment and payment approach where mileage collection could be directly connected to an existing bill.

### **The usage-based insurance business model aligns well with road charge as mileage data is already reported for the insurance policy.**

This approach of using reported miles to assess per-mile insurance is well-established and offered through multiple mediums including plug-in devices, smartphone apps, embedded telematics, and, as demonstrated, odometer photo uploads. Insurance companies are quickly launching these platforms such as the Progressive Snapshot, USAA's Noblr, or State Farm's Drive Safe & Save program. While this market is still in its infancy, it is quickly becoming a viable market and one that could fully and inexpensively support integration with road charge.



### **The usage-based insurance mileage collection method used (odometer photo upload) was widely supported by participant smartphones.**

Mile Auto's odometer photo upload method for reporting miles proved to be a reliable, and easy-to-use solution that was supported by all participants' smartphones. The Mile Auto system relied on text messaging instead of a third-party app. This removed any challenges with phone compatibility and allowed any smartphone that had a camera, a data plan, and the ability to send and receive text messages to participate in this phase.

### **Risk for fraudulent odometer photo uploads is minimal.**

Risk of fraud was one of the initial questions raised when considering the odometer photo capture method. Mile Auto's system contains over 250,000 unique photographs of odometers and vehicle dashboards. Each uploaded photo is compared against this database to validate the year, make, model, and trim package associated with the participating vehicle. The inability to defraud Mile Auto's system was also tested during the pre-deployment phases using different model dashboards, as well as dashboards from the same year, make, and model. Mile Auto had already invested in this anti-fraud infrastructure in support of its own business model, so it was not a cost incurred to administer a road charge. This potentially allows for a lower administration cost for the state.

**The odometer photo upload can be used to assess road charges without the need for location technology.** Mile Auto's odometer photo upload method is considered a more "low-tech" approach that only requires a smartphone to capture and upload odometer pictures over a Short Message Service (SMS) network. This option proves viable to participants who desire the convenience of a technology-based reporting solution, without the concern of location "tracking".

### Participants were extremely pleased with how the odometer photo upload protected their privacy over other methods.

The odometer photo upload option was the most acceptable option to participants. 81% of participants who participated in Phase 2 rated the Mile Auto solution as "Very Satisfied". This high-level satisfaction came from ease of use in reporting mileage (93%), confidence in the accuracy of the reported mileage (96%), and the confidence that personally identifiable information was protected (93%). While the size of this Demonstration was too small to broadly extrapolate results, this upload method was also highly rated during the 2017 California Road Charge Pilot.

## 6.5 Phase 3 Ridesharing Lessons Learned

Phase 3 demonstrated how a road charge could be assessed in a ridesharing operation. Ridesharing service providers, like Via, already collect mileage as part of their typical business operations, so integrating road charge capabilities proved operationally simple.



### The ridesharing business model aligns well with road charge.

As shown in Phase 3, a road charge program can be successfully integrated with a rideshare platform. During Phase 3, mileage and location information was collected from rideshare vehicles and used to assess a theoretical road charge. Participants only had to download the Via rideshare app to request their ride and complete their trip. Via's platform calculated the theoretical road charges and emailed participants a receipt showing the trip, the distance traveled, and the assessed road charge. Rideshare systems already collect and calculate mileage and location data. Their systems already collect payments, and they are highly secure and protect customer privacy.

**This phase most closely replicated the ease of the current gas tax experience, as there was nothing the participant had to do to pay the road charge. They simply called a ride as they would usually do, nothing more.**

### The ridesharing business model raises policy considerations about how to assess road charges during non-fare operations and how to assess charges for multiple riders.

While the rideshare business model can very effectively support integration operationally with road charge, there are some unique policy questions raised when considering how to assess road charge in a rideshare operating model.

- ▶ **Should the road charge be directly passed on to the rider, as they are ultimately the one “using” the road? At the present time, gas taxes are absorbed by the driver.**
- ▶ **How should the state charge for miles when there is no customer (i.e. “deadheading”)?**
- ▶ **How should the state accurately allocate trip charges amongst multiple riders during a shared ride who may be traveling to multiple destinations?**

These are important policy questions to be decided if ridesharing companies are to effectively serve as commercial account managers for their drivers, but the operational ease of this method makes these companies excellent candidates to be commercial account managers for this section of the California fleet. It gives ridesharing companies an opportunity to provide a benefit to their drivers at low cost and potentially facilitates tying the road use cost more directly to the user.

### **When a smartphone is required for the taxpayer to receive a service other than road charge, it can be a reliable collection method for a road charge system.**

Smartphones provide the technological foundation for ridesharing services. For the rideshare model to work effectively, the smartphones and the apps installed on those phones must be working properly and accurately reporting location and mileage. The success of a rideshare session hinges on accurate and reliable smartphone reporting between the rider requesting the ride at a specific location, the driver acknowledging the customer pickup location, and the overall distance and location of the trip itself. Inaccuracies or issues with either one of these smartphone-based mechanisms invalidates the rideshare session and causes both lost fare revenues and frustrated customers. Ridesharing companies know this, and invest in their infrastructure and technologies accordingly to support their business model. The state can benefit from piggybacking off of this business investment.

Phase 1A findings note the concerns with accuracy when smartphones are used for mileage collection in a road charge system. But with ridesharing, these issues can be overcome. First, the businesses themselves have developed highly accurate technology to support their business model. But more importantly, for an individual to receive the service the smartphone must be present. A driver cannot connect with riders if the smartphone is left at home. Thus, the considerable risk of lost miles due to a forgotten (or intentionally left) smartphone is eliminated. Consequently, while in general the use of smartphones and apps to collect mileage is not likely reliable enough to incorporate in a road charge system, in this specific scenario they appear highly effective and reliable.

### **Rideshare systems reliance on smartphones mean it’s not for everyone.**

The reliance on smartphones for a successful rideshare session may pose challenges with demographics who may not use smartphones. Users representing an older demographic or who reside in economically underserved communities may not have access to smartphones or may not wish to install rideshare apps on their phones. Other options will likely serve those groups better.

### **Rideshare systems can support the integration of automated vehicles.**

As part of Phase 4, data from the Easy Mile Level 4 automated shuttle was integrated into Via’s systems and used to successfully calculate a theoretical road charge. The intent of this effort was to determine the feasibility of assessing road charge on Automated, Connected, Electric, and Shared (ACES) fleets. The Demonstration was successful and proved that rideshare systems could support integration of automated vehicle data.



## 6.6 Phase 4 Autonomous Vehicles Lessons Learned

Phase 4 successfully demonstrated that autonomous vehicles provide more than enough data to reliably and accurately assess a road charge.

The Phase 4 automated shuttle provider, Easy Mile, utilized an automated shuttle operating in California to test the road charge data reporting. This data was integrated through Phase 3 rideshare partner Via's systems to accurately assess and report the theoretical road charge.



### Mileage and location data collected by automated vehicles exceed what would be needed to accurately assess a road charge.

The Easy Mile automated shuttle provided data points every second the vehicle was in operation, including distance traveled, speed, and location. This level of granularity well exceeds the level and frequency of data necessary to accurately assess a road charge and could be used to validate road charge data from other mileage reporting options or other services.

### Automated vehicle businesses may have varying levels of comfort levels with sharing data.

The vast amounts of data provided by automated vehicles is introducing a new market where data can be used to enhance operations and be resold for profit to enhance other technology services like traffic monitoring, trip planning, or ridesharing. As such, some automated vehicle companies are reluctant to share the vast amounts of data available. Some have offered tiered subscriptions to clients where lower tiers have access to only small data sets while higher tiers have access to more robust data. This poses a challenge for data ownership, data reuse, and the data resale considerations when the data is being collected for tax reporting purposes.

### The Automated, Connected, Electric, and Shared business model supports a road charge, as long as vehicles are integrated with fleet management business models and systems.

Phase 4 showed that a road charge could be assessed on vehicles that are part of Automated, Connected, Electric, and Shared (ACES) fleets. To make this concept viable, integration of automated vehicle data with a fleet management and transaction processing platform, much like the one used by Via, will likely be required.

**Automated vehicle systems and associated data offer additional opportunities for agencies outside of revenue.** Phase 4 focused on how to accurately, securely, and successfully capture road charge data from an automated vehicle. It was also demonstrated that autonomous vehicles can show real-time traffic patterns, road conditions, temperature, and congestion information. When integrated with other data sources and coupled with data science and analytics, this data could be used to enhance traffic operations, support land use planning efforts, enhance mobility services to underserved communities, and even aid in emergency response.

### Opportunities exist for further development of automated vehicle-based service models.

The use cases for automated vehicles are seemingly endless. Many studies are being conducted to identify potential ways that automated vehicles can offer expanded mobility options, support congestion reduction, and even provide more efficient transport options. One special consideration demonstrated during the Demonstration



focused on exploring how a road charge could be used in conjunction with the Automated, Connected, Electric, and Shared (“ACES”) model. Under this market, fleets of on-demand, fully-electric rideshare vehicles would replace current rideshare services to provide continuous rideshare offerings to customers. During Phase 4, automated vehicle data from the EasyMile automated shuttle was successfully integrated into the Phase 3 rideshare provider Via’s fleet management platform. This effort successfully showed how automated vehicle data could be used to assess a road charge in ridesharing services.



## 6.7 PRIME Lessons Learned

The Platform for Road charge Innovation and Mobility Evolution (PRIME) was a first of its kind data warehouse. Data collected from participants and their demonstration systems was integrated into PRIME, integrated with other California readily available transportation data sources, and then enhanced through predictive analytics to provide a series of operational dashboards that could improve transportation planning, forecasting, and operations.

### Cloud-based systems like PRIME support program flexibility and real-time scalability.

The PRIME platform was based on a cloud-computing enterprise architecture. Under this architecture, data is exchanged securely across multiple, shared servers. This architecture supports the ability to scale data volumes and access needs in real-time. If more resources are needed, additional virtual server space is requested and authorized under a tiered subscription model. There is no need to install new servers or data storage mediums, and business operations can scale almost immediately. This scalable architecture works well for a road charge program where the number of participating vehicles and accounts may change daily, business rules may change on demand, and programs can rapidly scale based on how quickly policy decisions are made.

### Business partners integrated seamlessly with PRIME data warehouse.

PRIME’s capabilities, provided by Snowflake Computing, allowed for seamless integration of disparate data fields from multiple business partners without the need to reformat native systems in potentially inconvenient ways. Application programming interfaces (APIs) were established between PRIME and each business partner system. Data flows were easily supported, and disparate, proprietary interfaces were translated into a common, fully interoperable format with no additional redesign or development costs. This made for an easy and highly successful systems integration between systems that had never been previously connected.



This approach created an easier user experience for potential commercial account managers, which is important in developing an open multi-option system. If connecting to a road charge administrative system is too burdensome or intrusive for a potential account manager, the state will have difficulty in attracting sufficient business to serve all of California's residents.

### **PRIME demonstrated ease of program administration.**

PRIME allowed for the real-time transfer and evaluation of demonstration data. During the design and development activities, an administrative portal with a performance dashboard was created which allowed systems administrators to quickly evaluate project performance. Multiple, disparate data tables were able to be seamlessly integrated and assessed to determine if any facets of the project (i.e. data accuracy, latency, and errors, customer complaints and response times, hardware faults, communications feedback) were not meeting the performance goals. This allowed for quick resolution and communications both with participants and business partner representatives, which promoted quick resolution and ultimate participant satisfaction.

### **Demonstration data was integrated with other data sources to create new use cases for how data can be used.**

PRIME was originally envisioned to serve as a data clearinghouse where road charge data could be integrated with other data sources to enhance transportation planning and operations. Road charge data from participant vehicles, and business partner systems, was sanitized, anonymized, and then integrated into PRIME. PRIME also incorporated data from other sources including Caltrans Intelligent Transportation Systems, transit route data and schedules, electric charging station power consumption, and traffic camera data. These data fields were integrated with one another to create visual dashboards to show how road charge data could be used to support other transportation operations. Some of the dashboards developed include traffic concentrations across metropolitan regions, comparison of driving trip times with transit routes, evaluation of trips relative to sidewalk and intersection availability, energy consumption of electrical powertrains versus combustion engines, and contribution of road charge revenues across vehicle powertrains, fuel economies, and regions.

PRIME also posed policy considerations relative to how road charge data should be used, the specific ownership of the data reported for road charge programs, the state's ability to use this data, and the privacy implications associated with data collection. These challenges are not just germane to road charge and will become more and more prevalent as more data-centric programs come online. In developing PRIME's capabilities, Caltrans felt it important to explore the possibilities of what data *could* be collected and used for in order to inform the state's debate of what *should* be collected and used.

### **PRIME creates a model for regional and possibly national road charge interoperability.**

The ability for PRIME to collect, automatically format, and seamlessly integrate data across disparate formats provides a compelling model for a fully interoperable regional or national road charge clearinghouse. PRIME successfully managed data exchanges between this Demonstration, the 2017 California Road Charge Pilot, and the OReGO Road Usage Charge program. PRIME data was also successfully integrated into OReGO's Road Usage Charge Administration System (RUCAS) for a regional interoperability test. The successful exchange of road charge data across states is a first-of-its-kind effort to show how states can interconnect disparate road charge systems into a fully interoperable data and financial clearinghouse. Working with the Oregon/California Regional Pilot Project, also funded through the federal STSFA program, allowed Caltrans to build upon and expand PRIME in real-time to further its scalable and interoperable clearinghouse functionality.



## 6.8 Communications Lessons Learned

As part of the Demonstration effort, Caltrans commissioned three public polls and twelve focus groups to understand Californians' grasp of transportation funding and their priorities and concerns for a potential road charge system. Overall, there is general awareness of the need for additional funding for road maintenance in California:

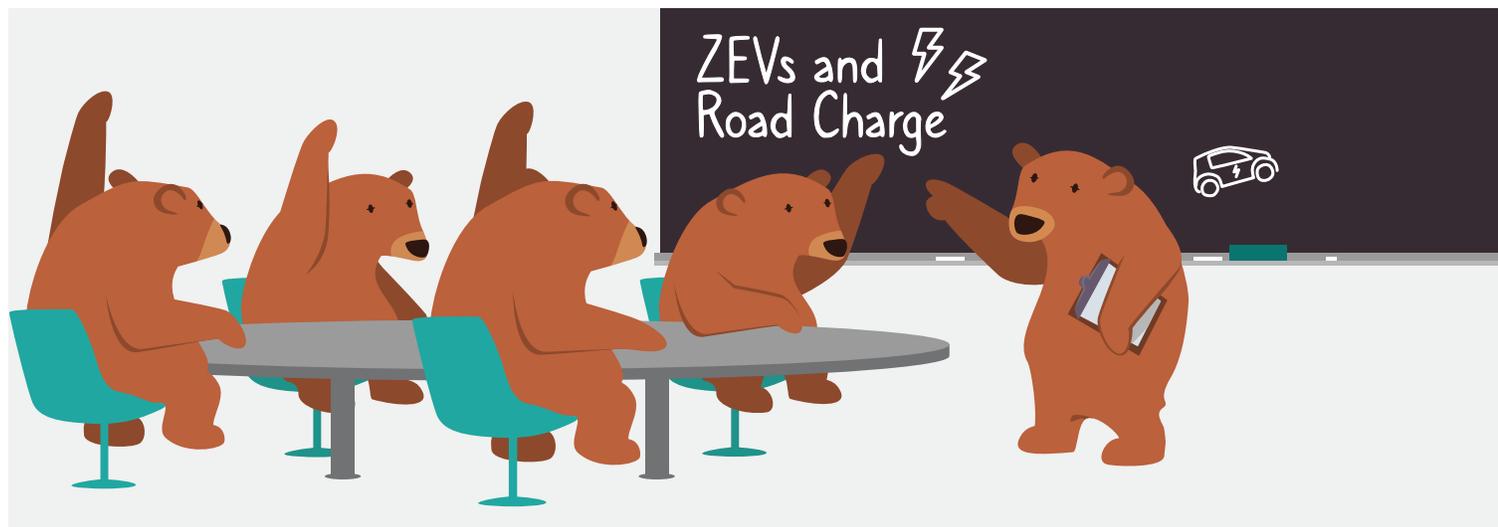
- ▶ More than half of respondents to the two public polls indicated that freeways, highways, and local streets and roadways in their areas are in poor or only fair condition.
- ▶ Furthermore, around 70 percent of respondents to both polls indicated that there is either great need or at least some need for additional funding for transportation.
- ▶ While the perceived need for more transportation investment was apparent, few know where revenues for transportation currently come from.

This general information about the public's understanding of the state of transportation funding serves as a background to the key takeaways on road charge from this research.

### Explaining the gas tax and its limitations is a critical first step toward helping the public see the need for a replacement system.

Communications on road charge should lead with explaining the problem. The public polling and focus group data showed that the public is generally unaware of the challenges facing transportation funding in California, and so do not see the need for a new system. Several focus group members explicitly stated, "If it ain't broke, don't fix it." Explaining the limitations of the gas tax gets people on board to finding a solution, opening a door for the road charge concept. When focus group participants watched an educational video describing the problem, the impact on their thinking was instant and obvious to see. Among polling respondents, information on the funding challenges presented by the current gas tax model pushed support for the road charge concept as a fairer solution from 36 percent to 50 percent.

With awareness of funding challenges being so low, messaging that leads with explaining the problem is more likely to leave people open to the idea of potential solutions.





## As a brand new idea, building public support for a road charge is an uphill battle, but education helps.

As a new and unfamiliar idea, the road charge concept was not initially perceived as a better model for funding transportation programs. With increased explanation of the idea, however, support grew. Presenting road charge after educating about the deficiencies of the gas tax, and explicitly as a *replacement* for the fuel tax further increased acceptance, but it takes a significant amount of education to get a majority of Californians to view a road charge positively. Furthermore, focus group participants expressed skepticism that fuel taxes would actually decrease if a road charge were ever implemented, indicating a general mistrust of government to do what it says.

## Fairness and Equity are Key Points.

The polling confirmed that fairness is an important concept in earning support for road charge, but poll respondents and focus group participants did not immediately believe that a road charge was fairer than the gas tax, even though they knew that everybody would pay the same per-mile fee. This skepticism was due in part because their concept of “fairness” also incorporated concerns about equity; in short, they wanted to know that everyone – including corporations – were participating in the program and that the program would not disproportionately burden low-income, rural, and other drivers who had to drive long distances due to life circumstances. The inequities built into a pay-by-the-gallon model are just not as apparent to Californians, whereas they feel that pay-by-the-mile sounds blatantly unfair to the residents who have no choice but to drive a lot.

Messaging that included themes directly addressing concerns about fairness and equity were some of the most impactful ways to talk about road charge as a replacement for the gas tax, whether those messages were focused on ensuring electric vehicle drivers were paying their fair share for using the roads, or on the inequitable burden of the gas tax on lower income Californians due to their inability to afford newer, more fuel-efficient vehicles.

## Numbers and Implementation Details Matter.

Road Charge as a replacement for the state gas tax is not immediately embraced as the solution to the challenges presented by the gas tax. Most assume it will cost everyone more, and there are many concerns about personal cost impacts, equitable distribution of cost burden, and implementation details. They want to know how much it personally will cost them and the details of implementation before they are comfortable supporting the concept. This can present a challenge to states that are still in research mode, as many of those details may not yet be settled.

The most commonly cited concern among poll respondents was the potential cost of the charge and general opposition to new taxes. More than half thought they would pay more under a road charge than they do now under the gas tax, with a third saying they would pay much more. If specific information is not provided on the cost to them, they assume the worst. The importance of numbers mirrors recent research in the State of Hawaii, which found that their residents wanted to know “what does it mean for me?” and so provided specific cost estimates to individuals to better inform their feedback on the idea.

The details of how a road charge system will work also proved to be important. When learning of the concept, many raised concerns about equity, privacy, costs, and complexity and reliability of implementing a completely new system. Nearly 80 percent of poll respondents indicated they had concerns about the collection of vehicle information for reporting mileage. Without a clear story on implementation details, many assume the worst, such as large and infrequent bills that are hard to plan for, intrusive technology that compromises privacy, policy gaps that allow people to evade the charge, residents getting charged for miles driven outside the state, non-residents not getting charged for miles driven inside the state, etc.

### Commercial Vehicles Should be a Visible Part of the Solution.

Only discussing individual drivers and vehicles leads many to assume businesses are not considered part of the solution, and that undermines the perception that this is a “fair” approach. Commercial vehicles are viewed as chief culprits in terms of damage to roads, and people want to ensure that businesses are also contributing their fair share towards maintenance. At the same time, they expressed cynicism about actual contribution, feeling that large corporations have the ability to figure out how to avoid taxes.

### Understanding the Communication Nuances of Your State is Critical.

As a “user pays” policy, it can conceptually make sense to describe a road charge system as the more you drive/use, the more you pay. However, starting with drive more/pay more brought equity concerns in California respondents: the groups perceived to drive the most are generally assumed to be those who can least afford a significant increase in the cost of driving, like gig economy drivers, super commuters who cannot afford to live close to their jobs, rural residents in areas not well-served by transit, and people who need to work multiple jobs to get by. Describing the uneven burden of the current gas tax, and then explaining that with a road charge everyone pays the same per-mile fee to use the road was a more acceptable approach to the concept for Californians. The interest in knowing commercial vehicles were included in a solution was also a surprise, and moving forward California will aim to include information on this front in its education efforts.

States that are exploring the road charge concept need to take the time to do the communications research to understand their residents’ concerns and priorities. This will make their potential policy a better fit for their state and can be helpful in making a compelling case to the public. The federal STSFA program can continue to be a strong support to states’ communication efforts, as it has been in California. As the federal government looks towards a national education campaign, they will also need to consider the nuances across states, and communications research from STSFA projects can help inform that.

### Key Steps for Engaging Californians in a Conversation About Road Charge:

- ▶ Explaining the challenges with the existing gas tax model is a critical first step toward helping the public see the need for a replacement system.
- ▶ Emphasizing the state's commitment to a solution that works for all Californians, including addressing perceptions about equity for lower income residents, implementation concerns about complexity and privacy, and how it will support continued shift to electric vehicles.
- ▶ Acknowledging that passenger vehicles are only part of the problem and solution, and the state is also studying solutions for commercial vehicles.





## 6.9 Lessons Learned for Other Pilots

With the extension of the federal STSFA program in the Infrastructure Investment and Jobs Act, the Federal Highway Administration will continue to fund state pilots that explore road charge systems. In this section, Caltrans shares lessons learned specifically in operating a pilot that can inform other state efforts.

### **Continual and clear coordination and communication are needed to maintain compliance.**

Early and clear explanation of Demonstration expectations was used to help vet participants and promote a positive Demonstration experience. During onboarding, each participant was required to review and acknowledge a participant agreement which defined the expectations for their involvement, established the communications channels available for participant outreach, and identified the expected incentives at the completion of key Demonstration activities.

During Demonstration operations, continual outreach with participants, including the explicit expectations for their continued involvement was critical to ensuring their compliance. The Demonstration offered several means for participants to engage project team members: Call center, online submittal, and direct correspondence with their phase's respective business partner. Each participant was asked to participate in pre-, mid-, and post-demonstration surveys. Questions about technology offerings, onboarding and offboarding processes, mileage reporting, app download, device installation, customer service, and general operations were asked, and the results were evaluated to make adjustments to improve the participant experience.

### **Traceability between incentive milestones, payouts, and responsibilities promotes proactive participation and responses.**

Participant incentives were based on the completion of key milestones: account establishment, app or hardware installation, participation in Demonstration activities (# trips, # fueling/charging sessions, odometer picture uploads, etc.), survey involvement, hardware return, and account closeout. At the completion of the Demonstration, each participant's completed milestones were reviewed, the results communicated back to the participant, and the eligible incentive paid to the participant. Having this clearly defined traceability between the expected milestone, the role of the participant in completing the milestone, and the incentive tied to each milestone helped clearly communicate expectations and encouraged participation in the Demonstration.

In this Demonstration, participants did not actually receive their financial incentive until the end. Pilots could also potentially explore smaller, immediate rewards upon task completion, to see if instant gratification boosts participate involvement.



### **Clearly communicating any participation restrictions to interested parties helps set initial expectations.**

Clearly communicating any limits on who can participate in the pilot can help set initial expectations. One example of this revolves around recruiting participants for Phase 3. For Phase 3, Via's rideshare service was geographically constrained to West Sacramento. This significantly reduced the number of interested parties who were eligible to participate in Phase 3, and severely limited the team's ability to draw a demographically representative participant pool. The project team subsequently concluded that it was not clear enough when providing information to interested parties at the beginning of Phase 3 recruitment that the phase was restricted geographically.

### **The immediate onboarding of interested parties is critical to maintaining interest and minimizes the risk for losing valuable participants.**

While the Demonstration officially began in January 2021, only Phases 1A and 1B started operations. Phase 2 began in February and Phase 3 began in March. Due to this staggering of phase launches, many participants waited several months to learn of their acceptance in the Demonstration and begin enrollment. This resulted in many interested parties declining to participate or simply not responding to the invitation. Additional participants had to be recruited to backfill those positions left open by interested parties leaving the program before their phase actually started.

### **Pre-established Application Programming Interfaces (APIs) help facilitate seamless integration.**

Working with technology and service partners who have pre-existing APIs facilitates a smoother system development, testing, operations and administration. Having these pre-established connections using standard data interface formats significantly reduced development time and enabled a "plug-and-play" approach for many of the data connections.

### **Demonstration operations should start well after the end of the holiday season.**

Phase 1A and Phase 1B began in early January 2021. The Demonstration Team pushed to launch the Demonstration as expected in January. Participants were slow to enroll, establish accounts, install hardware, and participate in prescribed Demonstration activities. Moving Demonstration launch to a later month would have likely reduced strain on the Demonstration Team to prepare and deploy the Demonstration, and supported more prompt and proactive participant enrollments. In addition, any press releases or communications push to support recruitment can get lost during the holidays, inhibiting their usefulness.

**Early follow-up with participants about their early demonstration experiences promotes continued engagement.** The early and often follow-up with participants during the initial days of their Demonstration involvement can help promote continued engagement and participant satisfaction. Participants who were engaged early in the Demonstration felt like their opinions mattered and their concerns were taken into consideration. Follow up conversations with business partners or other team members helped encourage participation throughout the entire Demonstration and maintained high levels of satisfaction with how the Demonstration was operated.



### **Multiple customer support and outreach mediums are critical to participant satisfaction.**

Having multiple ways for customers to engage the Demonstration Team is critical to participant satisfaction. The Demonstration utilized several methods including: a toll-free hotline with routing capabilities, text messaging, a backend customer support logging and tracking system, a participant portal for web inquiries, customer support emails, and automated reporting capabilities. This reduced the burden on the system administrator and Demonstration customer support team to provide participants customer support throughout the Demonstration.

### **Instructional materials help promote a positive enrollment experience while reducing customer service inquiries.**

Having visual aids and clear instructions for enrollment activities such as: hardware and app installation, account activation, customer inquiry, invoice and statement review, and business partner engagement helps promote a positive experience and can significantly reduce the amount of customer service inquiries. One-page briefs, fact sheets, and/or short videos posted on a demonstration website can help provide quick snippets of information to the participant to support their understanding of how to participate in the Demonstration and reduces the one-on-one customer support engagement required by the customer support team.

### **The COVID-19 pandemic created unique recruiting challenges.**

The COVID-19 pandemic posed challenges to many areas within the Demonstration, including participant recruiting. The original strategy for recruiting participants included a balanced mix of online recruiting, meetings at key events like the California State Fair, presentations at county meetings and civic leagues, and use of telephone screens and opinion polls. During these events, interested parties would be directed to the online portal to express their interest and complete the initial survey to register as an interested party.

With the onset of the COVID-19 pandemic, all in-person recruiting methods were canceled and emphasis was placed on online screening via an interested party form on the program website. Participants from the previous 2017 California Road Charge Pilot were recruited as interested parties and project team members even recruited within their own professional networks, families, and workplaces. While initial stratification goals had to be adjusted based on participant availability, a generally balanced mix of geographic, income level, education, age, and ethnicity were successfully enrolled in the Demonstration.





## 6.10 Next Steps for California

Overall, the California Road Charge Four-Phase Demonstration helped move California forward on its path to developing a fully implementable road charge program for Californians to consider. This project tested how road charge could integrate into some familiar tangential markets including fueling pumps, electric vehicle charging stations, usage-based insurance, rideshare, and the up-and-coming automated vehicle innovation. The State learned important lessons about the value of building off of existing business models and systems, learned more about the public's priorities for a road charge system, and further developed the foundations for an interoperable system.

Next, California will more deeply explore the impacts of road charge across California's rural and tribal communities. Through a 2020 STSFA grant award from the FHWA, Caltrans will test the viability of current GPS technology to differentiate between public and private roads in a road charge system. Through this Public/Private Roads Project, the state hopes to engage rural communities in a conversation about what road charge looks like for them.

In addition, in 2021 the State Legislature passed SB 339 (Wiener, 2021), which authorizes the state to implement a pilot that will collect actual revenue from participants instead of the simulated revenue collection performed in previous pilots. The Road Charge Collection Pilot will allow for more thorough testing of state administrative processes and potentially help further define likely administrative costs.

To learn more about the upcoming pilot or past research, please visit [caroadcharge.com](http://caroadcharge.com) or email [Road.Charge.Pilot.Program@dot.ca.gov](mailto:Road.Charge.Pilot.Program@dot.ca.gov)



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# Terms and Abbreviations

ACRONYM / TERM	DEFINITION
<b>ACS</b>	American Community Survey
<b>API</b>	Application Programming Interfaces
<b>AV</b>	Autonomous Vehicle
<b>BRD</b>	Business Requirements Document
<b>CalSTA</b>	California State Transportation Agency
<b>Caltrans</b>	California Department of Transportation
<b>CTC</b>	California Transportation Commission
<b>Demonstration</b>	The California Four-Phase Demonstration
<b>DSAR</b>	Data Security Audit Report
<b>EMC</b>	EMC Research
<b>EMFAC</b>	EMissions FACtor
<b>EPA</b>	U.S. Environmental Protection Agency
<b>ETC</b>	Eastern Transportation Coalition
<b>EVs</b>	Electric Vehicles
<b>FAQ</b>	Frequently Asked Questions
<b>FAST</b>	Fixing America's Surface Transportation
<b>FHWA</b>	Federal Highway Administration
<b>GPS</b>	Global Positioning System
<b>Highlands</b>	Highlands Consulting Group
<b>ICD</b>	Interface Control Document
<b>MBUF</b>	Mileage-Based User Fee
<b>Mercury</b>	Mercury Public Affairs
<b>MRO</b>	Mileage Reporting Option
<b>PII</b>	Personally Identifiable Information
<b>PRIME</b>	Platform for Road Charge Innovation and Mobility Evolution
<b>RUC West</b>	Western Road Usage Charge Consortium
<b>SB</b>	Senate Bill
<b>SHS</b>	State Highway System



<b>ACRONYM / TERM</b>	<b>DEFINITION</b>
<b>SRS</b>	System Requirements Specifications
<b>STSFA</b>	Surface Transportation System Funding Alternatives
<b>TAC</b>	Technical Advisory Committee
<b>UBI</b>	Usage-based Insurance
<b>UC Berkeley</b>	University of California, Berkeley Transportation Sustainability Research Center
<b>VMT</b>	Vehicle Miles Traveled
<b>VoIP</b>	Voice over Internet Protocol
<b>WSP</b>	WSP USA Inc.
<b>ZEV</b>	Zero-emission Vehicle