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# **Surface Transportation System Funding Alternatives Phase I Evaluation**

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## **Enhancing the Road Charge Pilot Program in California**

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FHWA-HOP-19-044

February 2023



U.S. Department of Transportation  
**Federal Highway Administration**

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## SI\* (MODERN METRIC) CONVERSION FACTORS

### APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	645.2	square millimeters	mm <sup>2</sup>
ft <sup>2</sup>	square feet	0.093	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yard	0.836	square meters	m <sup>2</sup>
ac	acres	0.405	hectares	ha
mi <sup>2</sup>	square miles	2.59	square kilometers	km <sup>2</sup>
<b>VOLUME</b>				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft <sup>3</sup>	cubic feet	0.028	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.765	cubic meters	m <sup>3</sup>
NOTE: volumes greater than 1,000 L shall be shown in m <sup>3</sup>				
<b>MASS</b>				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
<b>TEMPERATURE (exact degrees)</b>				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
<b>ILLUMINATION</b>				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m <sup>2</sup>	cd/m <sup>2</sup>
<b>FORCE and PRESSURE or STRESS</b>				
lbf	poundforce	4.45	newtons	N
lbf/in <sup>2</sup>	poundforce per square inch	6.89	kilopascals	kPa
<b>APPROXIMATE CONVERSIONS FROM SI UNITS</b>				
Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
<b>AREA</b>				
mm <sup>2</sup>	square millimeters	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	10.764	square feet	ft <sup>2</sup>
m <sup>2</sup>	square meters	1.195	square yards	yd <sup>2</sup>
ha	hectares	2.47	acres	ac
km <sup>2</sup>	square kilometers	0.386	square miles	mi <sup>2</sup>
<b>VOLUME</b>				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m <sup>3</sup>	cubic meters	35.314	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.307	cubic yards	yd <sup>3</sup>
<b>MASS</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2,000 lb)	T
<b>TEMPERATURE (exact degrees)</b>				
°C	Celsius	1.8C+32	Fahrenheit	°F
<b>ILLUMINATION</b>				
lx	lux	0.0929	foot-candles	fc
cd/m <sup>2</sup>	candela/m <sup>2</sup>	0.2919	foot-Lamberts	fl
<b>FORCE and PRESSURE or STRESS</b>				
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in <sup>2</sup>

\*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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## LIST OF ACRONYMS

California BPA	California Department of Transportation Business Partner Automation
CAM	commercial account manager
DBUF	distance-based user fee
DMV	Department of Motor Vehicles
FAST	Fixing America's Surface Transportation
FHWA	Federal Highway Administration
GPS	Global Positioning System
MAP-21	Moving Ahead for Progress in the 21st Century Act
MBUF	mileage-based user fee
MFT	motor fuel tax
MRD	mileage recording device
OBD-II	onboard diagnostic standard II
OEM	original equipment manufacturer
RCA	road charge administration
RCPP	(California) Road Charge Pilot Program
RUC	road usage charge
RUCA	road usage charge accounting
RUCPM	road usage charge participant management
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAM	State account manager
SLA	Service Level Agreement
STSFA	Surface Transportation System Funding Alternative
TRB	Transportation Research Board
UBI	usage-based insurance
USDOT	U.S. Department of Transportation
VLF	vehicle licensing fee
VMT	vehicle miles traveled



## EXECUTIVE SUMMARY

This report presents the independent evaluation results of California's fiscal year (FY) 2016 Surface Transportation System Funding Alternative (STSFA) grant project, designed to enhance the Road Charge Pilot Program (RCPP) study the State recently completed. The California Department of Transportation (California) received \$750,000 in FY 2016 STSFA funds from the U.S. Department of Transportation (USDOT). California is one of eight entities to engage in pilots, or pre-pilot planning and development activities, to explore a variety of options to demonstrate user-based alternative revenue mechanisms. The FY 2016 funding and associated grant programs are referenced throughout this document as constituting Phase I of the STSFA Program.

### BACKGROUND

As vehicles are becoming more fuel efficient, the reliability and adequacy of the motor fuel tax as a primary source for transportation infrastructure funding continue to decline. Recognizing this trend, section 6020 of the Fixing America's Surface Transportation Act<sup>1</sup> established the STSFA Program to provide grants to States or groups of States to demonstrate user-based alternative revenue mechanisms that employ a user-fee structure to maintain the long-term solvency of the Highway Trust Fund. The objectives of this program are to:

- Test the design, acceptance, and implementation of two or more future user-based alternative mechanisms.
- Improve the functionality of the user-based alternative revenue mechanisms.
- Conduct outreach to increase public awareness of 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 administrative cost of any potential user-based alternative revenue mechanisms.

Staff from the Federal Highway Administration (FHWA) Headquarters in the Office of Operations have the overall responsibility for administering the program. The FHWA Division office staff provide direct support by overseeing the program in participating States.

The U.S. Congress and the FHWA seek to understand whether user-based alternative revenue mechanisms that utilize a user-fee structure can help maintain the long-term solvency of the Highway Trust Fund, and can be implemented nationally at some time in the future. As part of this endeavor, the FHWA evaluated seven of the eight grantee sites that received funding in Federal FY 2016.<sup>2</sup> The evaluation reports resulting from this process will allow the Secretary of Transportation and U.S. Congress to be aware of progress that has been made, lessons learned from initial pilot and planning efforts, the role of education and outreach, and the potential for any negative impacts on constituents and initial findings on administrative fees, among others.

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<sup>1</sup> Public Law 114-94.

<sup>2</sup> The Phase I evaluation for the eighth pilot site, Hawaii, is delayed due to delays in pilot start.

## CALIFORNIA'S PHASE I PILOT ENHANCEMENT

In March 2017, California completed a mileage-based revenue collection pilot. As part of the STSFA's Phase I program, the State examined four specific program enhancements:

- **Organizational structure design:** Assessing which agencies could administer a Statewide road charge program.
- **Cash-flow model:** Developing a road charge revenue flow model that can be used as a tool to assess costs and benefits of a new program.
- **Enforcement and compliance strategies:** Identifying elements of an enforcement program and associated strategies for ensuring compliance.
- **Pay-at-the-pump/charge point:** Investigating technologies for paying a road charge at gas stations or (electric) charge points.

Due to the passage of Senate Bill 1 in California in 2017, California was not able to significantly advance the education and outreach component.<sup>3</sup> However, California conducted limited public perception research to determine what information the public needs to better understand and make informed decisions about road funding. The research measured the public level of knowledge of transportation funding, California's road infrastructure, instability of the fuel tax, and road charge as an alternative to the fuel tax. The research also tested core messaging related to these topics.

### MAJOR FINDINGS

This evaluation assessed the impacts of STSFA-funded activities. The key findings of the evaluation are summarized below.

#### Key Findings of California's Approach

The key findings of California's Phase I activities are summarized in accordance with the applicable STSFA grant criteria as follows:

- **Flexibility to adapt and expand:** California's proposed approach would benefit from considering the ability of the different components of this system to communicate amongst themselves, including addressing questions of data format and communications protocols.
- **Compatibility with low-technology options:** Pay-at-the-pump/charging station requires digital communications and mileage collection technology and is not compatible with low- or no-technology options for payment of mileage fees.
- **System cost:** California's cash-flow model is helpful for designing a pilot and determining the per-mile fee, in part, because it is capable of taking into account various considerations, such as initial capital, as well as operating and maintenance costs of a road usage charge (RUC) system. However, the tool does not currently provide a means

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<sup>3</sup> This bill created the Road Maintenance and Rehabilitation Program to address deferred maintenance on the State highway system and the local street and road system. Given the backdrop of this legislation and the associated increases in the current tax and fee structure, it was politically unacceptable to conduct a broad-based education and outreach campaign regarding RUC, which was projected to be widely perceived as an additional tax.

to develop an accurate estimation of the administrative costs under different operating scenarios. This could be developed in future iterations of the cash-flow model.

- **The real and perceived equity of an RUC approach:** California' public perception research involved conducting limited public surveys and focus groups. These provided key insights into public perception of RUC and some useful pointers to direct future public outreach and messaging initiatives. The communications report also included recommendations for conducting outreach with target groups. The following emerged as the most important RUC- related issues on the minds of the respondents:
  - Avoiding being double charged/taxed (i.e., being charged both the per-mile fee and the fuel tax).
  - Ensuring all motorists pay their fair share for road use.
  - Securing adequate funding for road maintenance and repair.



## CHAPTER 1. INTRODUCTION

As vehicles become more fuel efficient, the reliability and adequacy of the motor fuel tax as a primary source for transportation infrastructure funding has come into question. Recognizing this trend, section 6020 of the Fixing America's Surface Transportation (FAST) Act<sup>4</sup> of 2015 established the Surface Transportation System Funding Alternatives (STSFA) Program. The purpose of this program is to provide grants to States or groups of States to demonstrate user-based alternative revenue mechanisms that employ a user-fee structure to maintain the long-term solvency of the Highway Trust Fund.

By funding road usage charge (RUC) pilots, the U.S. Congress and the Federal Highway Administration (FHWA) seek to understand whether a user-fee structure such as an RUC, is a system that could be implemented nationally in the future. As part of this endeavor, the FHWA evaluated seven of the eight grantee sites that received funding in Federal fiscal year (FY) 2016, also referred to as Phase I of the STSFA grant program.<sup>5</sup> The evaluation reports will inform the Secretary of Transportation and U.S. Congress of the progress that has been made, lessons learned from initial pilot and planning efforts, the role of education and outreach, the potential for any negative impacts on constituents, and initial findings on administrative fees, among others.

Staff from the FHWA Headquarters in the Office of Operations have the overall responsibility for administering the program. The FHWA Division office staff provide direct support by overseeing the program in participating States. The independent evaluation of the program assessed the impacts of the STSFA funded activities conducted by each grantee in a systematic manner across all sites. The objective of the evaluation was to conduct activities designed to enhance California Department of Transportation's (California) recently completed pilot.

The evaluation team adopted the terminology used by the specific grantee sites in planning and executing their proposed programs. As such, same or similar concepts in different geographies may variably be referred to as mileage-based user fee (MBUF), distance-based user fee (DBUF), or RUC. Given the lack of a standard definition, these terms will be defined within the context of each grantee's program vision and activities.

“As States struggle to keep pace with increasing funding shortfalls and maintenance backlogs, lawmakers are exploring innovative approaches to increase revenues for transportation...A [road usage charge] goes one step further, potentially eliminating the need for a gas tax altogether, by charging drivers on a per-mile-driven basis. Proponents see this as a way to increase transportation revenues even as fuel purchases decrease and vehicle miles traveled increases, due to improved vehicle efficiency.”

Source: National Conference of State Legislatures, “Road Use Charges (RUC)” Web page. Available at: [State Road Usage Charge Toolkit \(ncsl.org\)](https://www.ncsl.org/transportation/road-use-charges). Last accessed December, 2022.

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<sup>4</sup> Public Law 114–94.

<sup>5</sup> The Phase I evaluation for the eighth pilot site, Hawaii, is delayed due to delays in pilot start.

## **ORGANIZATION OF THIS REPORT**

Chapter 1 of this report introduced the user-fee concept and the background and purpose of the pilot. The remainder of the report will address other project activities.

Chapter 2 details the activities planned and accomplished by California under Phase 1 of the STSFA grant program or the FY 2016 grant cycle.

Chapter 3 presents the evaluation framework as proposed under the 2016 Notice of Funding Opportunity, and the key USDOT questions that the evaluation seeks to address and the evaluation team's approach.

Chapter 4 provides the major findings from evaluation of Phase I activities, including lessons learned, finding and outcomes as observed by the evaluation team, and suggestions for further exploration.

Chapter 5 summarizes the key findings and lessons learned from the California experience and explains the implications of these findings for a national RUC program.

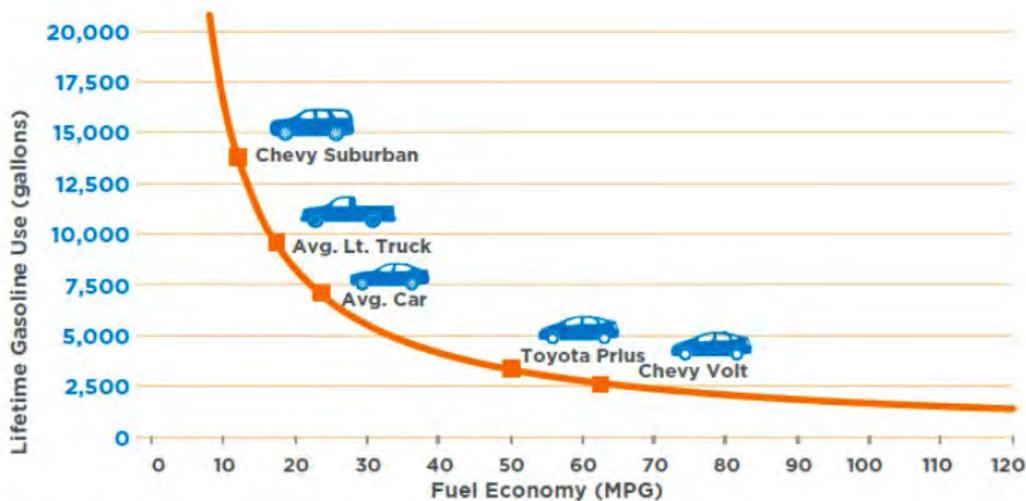
Chapter 6 presents the references that are used in this report.

## CHAPTER 2. ENHANCEMENTS TO THE EXISTING ROAD CHARGE PILOT PROGRAM IN CALIFORNIA

This chapter summarizes California's efforts in enhancing its recently completed Road Charge Pilot Program (RCPP). It provides a background summary of the RCPP, the STSFA program objectives, and a summary of activities conducted as part of the Phase I, during the FY 2016 grant cycle.

### BACKGROUND – THE CALIFORNIA ROAD CHARGE PILOT PROGRAM

This section summarizes California's RUC demonstration conducted prior to the STSFA Phase I effort. California recognized the need for exploring alternative transportation funding mechanisms. In March 2017, California completed a mileage-based revenue collection pilot known as the RCPP. The pilot included over 5,000 vehicles and focused on testing the functionality, complexity, and feasibility of a mileage-based system as a potential new revenue collection method for transportation funding. The pilot launched July 1, 2016, and included multiple mileage reporting methods, including manual and automated methods. Two commercial account managers provided automated methods, including in-vehicle hardware and smartphone apps, while a third account manager (California State Account Manager) handled the manual approaches. In addition to collecting mileage data, account managers processed mock road charge invoices and collected simulated payments because there was no monetary exchange involved in the program. From the final report on the pilot, figure 1 shows the decline in lifetime gasoline use as vehicle fuel economy increases.



*VMT calculated from Tables 3.13 and 4.1 of U.S. Department of Energy, Transportation Energy Data Book (Edition 31, 2012), Table VM-1, Federal Highway Administration's Highway Statistics (2012), and the official MPG estimate for Chevy Volt provided by Environmental Protection Agency.*

Source: California and California State Transportation Agency, California Road Charge Pilot Program Final Report, 2017 on Senate Bill 1077

**Figure 1. Diagram. Increasing vehicle fuel efficiency.**

In the final report on the RCPP, California documented the following observations and findings:

- **Pilot participation:** Participation in the pilot was low from low-income individuals and certain ethnicities and races.
- **Account managers:** The use of these third-party services provided flexibility of services to pilot participants and demonstrated the ability to offer other value-added features, enhancing the user experience.
- **Mileage reporting options:** Offering a multitude of choices caused a level of concern amongst the participants. Participants expressed concern about the clarity of communications and instructions regarding the mileage reporting methods and the technology options available during enrollment.
- **Privacy/data security:** There were no data breaches or data security concerns throughout the duration of the pilot. However, future systems should continue to strive to exceed standard security practices.
- **Participant perception of equity:** Some of the high-level survey results indicate that participants felt a road charge is a more equitable transportation funding solution than the current fuel tax, but additional research is needed before implementation.
- **RUC rate:** The rate of 1.8 cents per mile used in the pilot represented the revenue-neutral rate based on the California fleet average. When compared to the sample of vehicles participating in the pilot, this simulated road charge rate was not revenue-neutral due to the pilot sample fleet having an average mileage per gallon rate that was higher than the Statewide average.
- **Enforcement and compliance:** The inability to adequately test the compliance and enforcement aspect of a road charge results in a level of uncertainty as to the optimal methodologies to employ and the overall cost to enforce. Due to the RCPP being volunteer based, and the fact that no revenue was collected, there is no measure of compliance to be extrapolated for a Statewide program. Testing that incorporates enforcement and compliance is critical to reasonably estimate the administrative costs of a road charge program.
- **Technology:** While the manual options provided the highest degree of privacy and data security, they could be the most difficult to enforce, like with odometer readings. Manual options could also be costly to administer. Of the automated methods, plug-in devices (OBD-II)<sup>6</sup> are the most reliable options. However, as new technology emerges, this methodology could be obsolete by the time a road charge program is adopted. The more technologically advanced methods of the smartphone application with location services and in-vehicle telematics show great promise, but they both need further refinement.

The final report on the RCPP explains the need to explore a payment method or technology that mimics the simplicity, cost-effectiveness, and public acceptance of fuel tax collection (at the pump). The report acknowledged the need to investigate a road charging mechanism that replicates the current user experience. The report also acknowledged that the pay-at-the-pump

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<sup>6</sup> Onboard diagnostic systems give the vehicle owner or repair technician access to the status of the various vehicle subsystems. The OBD-II standard specifies the type of diagnostic connector and its pinout, the electrical signaling protocols available, and the messaging format. It also provides a candidate list of vehicle parameters to monitor, along with how to encode the data for each.

study and demonstration would address mileage collection for vehicles with internal combustion engines, but the proliferation of alternative fuel vehicles requires a method for collecting mileage data, such as in-vehicle telematics.

## **SURFACE TRANSPORTATION SYSTEM FUNDING ALTERNATIVES PHASE I PROGRAM SUMMARY**

“The adoption of built-in vehicle telematics as a means for collecting mileage data could dramatically reduce the impact of adoption, administrative and enforcement costs of the road charge program. However, standardization of mileage information collection and data transference needs to be discussed to allow for open-market application of a road charge.”

~California and California State  
Transportation Agency, California Road  
Charge Pilot Program, Final Report Senate  
Bill 1077, 2017.

Based on the lessons learned from the RCPP, California identified four specific program enhancements to study in detail as part of the STSFA funded program, as summarized below.

**Organizational structure design.** The purpose of this task was to develop an organizational structure of the entity/entities potentially responsible for administering a Statewide road charge program. This design built upon the Interagency Working Group that was formed during the RCPP implementation, which comprised California governmental organizations that either already perform functions pertaining to the current fuel tax or

may take on larger roles for administering, enforcing, and supporting a large-scale Statewide road charge program.

California undertook the following key tasks towards developing a more mature organizational structure design:

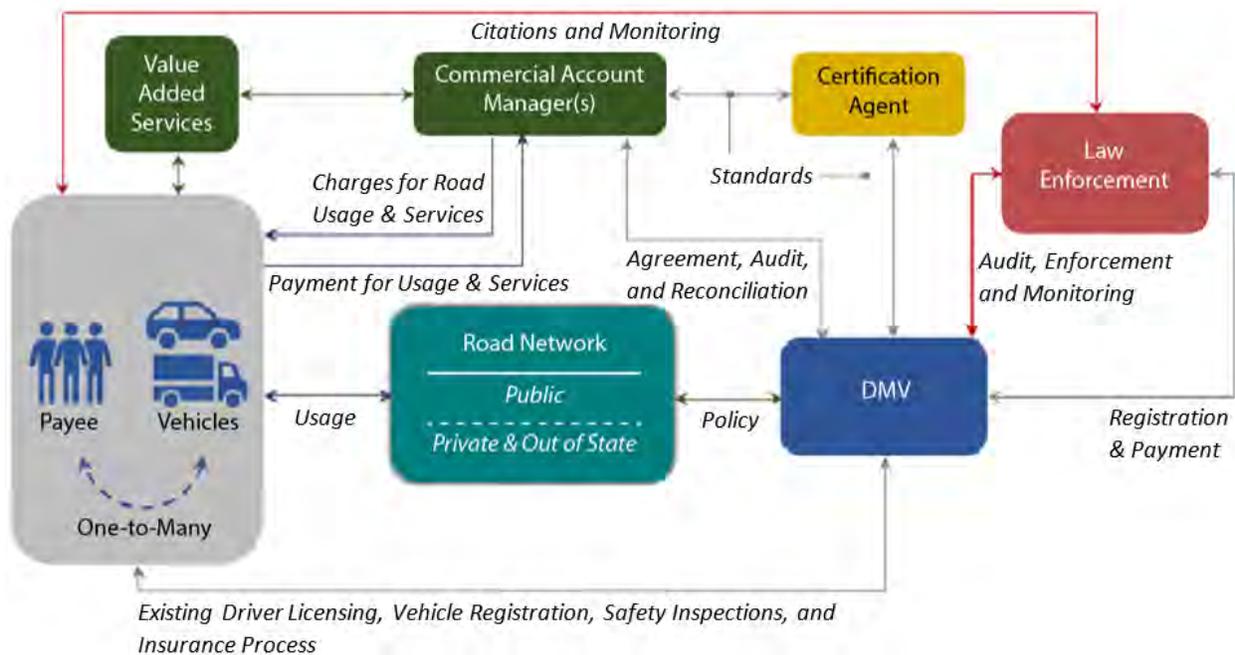
- Stakeholder interviews with staff from various California governmental organizations including Bureau of Automotive Repair, California Department of Insurance, California Department of Motor Vehicles (DMV), California Highway Patrol, California Department of Tax and Fee Administration, Federal Highway Administration- California Division, Sacramento County Agricultural Commissioner and Director of Weights and Measures. The interview questions were organized under two main topics (a) organization/administration and (b) compliance/enforcement. Two scenarios for the Road Charge Administration (RCA) emerged from this process:
  - Scenario 1: A functional unit, identified as the RCA, administers the road charge program. This concept is the “Straw Man” design, developed during the pilot.
  - Scenario 2: The DMV is established as the main entity to deliver the road charge program. In this scenario, DMV would report directly to the California State Transportation Agency (CalSTA), two new units would be established within DMV for Account Management Oversight and Audit and Economic Compliance functions, to facilitate relationships and coordination with other agencies. This scenario was researched further through organizational design workshops. The main findings and outcomes of this process is summarized in chapter 5.

California conducted several workshops with the California DMV to obtain information to help identify the internal changes that the DMV would need to make if the State were to implement

an organizational structure for a road charge program. Several organizational functions were identified and considered both during these workshops and in other discussions, including:

- **Measuring taxable vehicle road usage:** This would include both manual and automatic (technology-enabled) methods of collecting vehicle mileage driven.
- **Certification and auditing:** Commercial account managers (CAMs) would provide the primary interface with motorists, and so CAMs would need to be certified and audited regularly. The CAMs would be responsible for collecting road charge data, distributing invoices, collecting payments, and providing customer service. CAMs would provide the appropriate technology for their offered mileage reporting methods as well as other user services (if applicable). The DMV's role relative to the CAMs would involve developing and maintaining standards and requirements, certifying, managing and auditing, collecting revenue, and monitoring data and activity for potential fraud and non-compliance.
- **State account managers (SAMs):** SAMs would ensure that mileage reporting options extend to all constituents, including those who:
  - Do not have credit cards or bank accounts.
  - Have poor credit resulting in a CAM not being able to support them as a customer.
  - Prefer their accounts be administered by State government rather than a commercial company.
  - Prefer to report miles using methods not supported by CAMs (e.g., manual-based options, such as time blocks, mileage blocks, self-reporting, and odometer readings).
- **Administration and revenue collection:** California envisions that, if the DMV were to administer a road charge program, it would be through the Business Partner Automation (BPA) program, which allows qualified industry partners to process vehicle-related transactions from their remote locations. The DMV would likely require additional staff resources to manage the RUC program.
- **Interfacing with law enforcement:** Coordination with law enforcement is necessary to ensure compliance with the road charging scheme.

Figure 2 shows the RCA process model proposed by California.



Source: California Department of Transportation

**Figure 2. Diagram. Road charge administration process model.**

The main findings of the organizational design research were in relation to the model in which DMV serves as the key entity to deliver the road charge and include:

- DMV can administer road charge although there will be some challenges and constraints.
- Strengths of this model: DMV knows how to manage business practices.
- Challenges of the model:
  - The data DMV captures would need to be limited to collecting bulk billable miles from CAMs.
  - Auditing and enforcement would be substantially affected. DMV would need additional staff and resources.
  - The need for a complete rewrite of the accounting and auditing systems which could take years.
  - DMV Automated Fee System would need to be reprogrammed to make the financial system fully automated, not manual.

**Cash-flow model.** California developed a road charge revenue flow model that can be used as a tool to assess costs and benefits of a new program. For this effort, California incorporated lessons learned from cash-flow models for other road charge pilots. This tool forecasts out to a 40-year time horizon based on revenue inputs, and it considers capital improvements, operating costs, changes in vehicle purchases, mileage, road usage, and enforcement. The cash-flow model has two distinct modules that provide different approaches to decision making, as follows:

- **Road charge calculator:** The cash-flow model can calculate the dollars-per-mile road charge based on vehicle miles traveled (VMT) and a desired revenue target. This would

allow California to determine a road charge that will meet future needs. For example, if the road charge revenue is required to reach a certain point by 2030 to fund needed highway improvements, this enhanced model will output the needed cost-per-mile road charge. As with the prior model, the road charge will escalate and be classified by vehicle type as determined by the user.

- **Road charge levelizer:** The second module in the cash-flow model allows the cost-per-mile road charge to be increased over time to meet a defined future target. For example, if there is a need for increased revenue by 2030 to support capital improvements, this algorithm will calculate an annual increase to the road charge to smooth out the impact on customers.

The cash-flow model considers the following analytical factors:

- Annual California Consumer Price Index escalation (user input forecast).
- Annual road charge escalation (user input forecast).
- Annual vehicle class rate factor (user input forecast).
- User defined operating and implementation costs.
- Revenue and expenditures target.
- Two VMT scenarios (user input and model calculated).

**Enforcement and compliance strategies.** California undertook a task to research best practices in enforcement and compliance. Under enforcement, the task included identifying stakeholders, exploring payment and collection mechanisms, and developing workflows for road charge enforcement and collection and fraud prevention strategies. Under compliance, the task included identifying the compliance structure, certification process and service level agreements. The key findings of this effort are summarized in chapter 5.

California's main findings of the research into enforcement aspects were:

- An enforcement and inspection mechanism between DMV and State and local law enforcement could be established to determine if each California-registered vehicle owner is paying some form of transportation funding (road charge, fuel tax, etc.).
- Enforcement policies could be developed, to include notices of unpaid road charge balances, timeframes when a road charge balance is considered past due, and penalties and charges that can be assessed for unpaid accounts. Recommendations include a period of up to 90 days for invoices to be paid before adjudication processes begin, which can levy collection fees beyond \$200 for any unpaid road charges.
- Contractual requirements could be developed using the DMV BPA program and established State tax codes as guidelines for collecting payments from road charge account managers.
- Existing laws and associated penalties could be leveraged, as well as information from account managers, to prevent road charge fraud. These penalties could be drawn from those similar to odometer rollback fraud or tax fraud.

California's key findings and recommendations for compliance activities include:

- An interdepartmental road charge organizational structure could be created that supports clear, accurate, and well-defined informational flows on policies, performance reporting, and certification results.
- A clear, mutually agreeable (between the State and the road charge account managers), and enforceable initial and recurring certification process and schedule could be developed, that supports auditing and testing against all the established road charge requirements and policies.
- Initial certifications could occur prior to establishing contracts with account managers and recurring certifications should occur every 2 to 5 years, depending on the areas for recertification.
- Service Level Agreements (SLA) could be issued that provide performance metrics related to payment processing, customer service, data reporting, data security, and system management. The SLA could include contractual obligation for managing account manager performance and implement associated penalties for areas of continued non-conformance.

**Pay-at-the-pump/charge point.** For this task, California interviewed four technology providers and determined that technology has evolved to the point where a pay-at-the-pump or charge point system has the potential to be operationally feasible. Chapter 5 includes details on the technologies evaluated in Phase I to accomplish a pay-at-the-pump or charge point system.

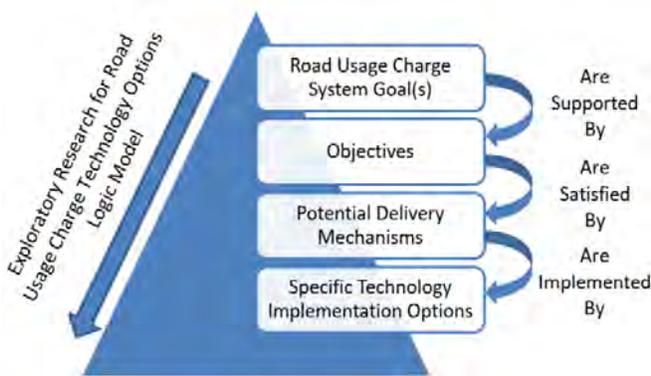


## CHAPTER 3. INDEPENDENT EVALUATION METHODOLOGY

This chapter summarizes the independent evaluation approach and methodology. The study team completed this work in coordination with staff from the FHWA Office of Operations and the FHWA Division office representatives of the respective grantee sites. The chapter defines the evaluation framework and includes responses to key questions that USDOT expressed about RUC approaches and their viability and characteristics if implemented on a national scale.

### EVALUATION APPROACH

As its name suggests, the fundamental concept of an RUC is that users pay a direct charge for the use of a roadway. However, it is important to understand that both “use” and “user” can be defined in several different ways, and the mechanism by which a charge is levied can also vary significantly. This is evident among the Phase I grantee agencies, all of which are using different combinations of technologies and various paradigms and mechanisms to levy charges. Often the fundamental objective of the RUC system is a significant factor in identifying the technology options, data collection, and how fees are levied. Previous research has characterized this phenomenon using an RUC logic model, as illustrated in figure 3.



Source: HDR Inc.

**Figure 3. Diagram. Exploratory research for road usage charge technology options logic model.**

One essential component of this evaluation was understanding the fundamental objectives of the RUC systems as deployed by the grantee sites. The objective provided insight into more detailed assessments and evaluation of the efficacy, costs, and scalability of the systems at a regional or national level. See the discussion in the “[Evaluation Process](#)” section below for a summary of how the study team conducted this evaluation.

### EVALUATION FRAMEWORK – U.S. DEPARTMENT OF TRANSPORTATION QUESTIONS

Table 1 presents the key questions that USDOT examined as part of this evaluation. The evaluation team elaborated on the question and defined the relevant metrics for conducting the evaluation for the specific grant site. While California found some questions highly applicable to Phase I activities, others were marginally applicable. Table I provides the assessment framework, and table 2 provides the system attributes relevant to the evaluation.

**Table 1. Assessment framework.**

<b>No.</b>	<b>USDOT Evaluation Question</b>	<b>Relevant Site Question/ Metrics</b>	<b>Applicability to California's Phase I Activities</b>
Q1	What is the viability of an RUC on a nationwide scale?	N/A	Moderate
Q2	Would the fee assessment and collection mechanisms be scalable?	Was scalability considered a factor in evaluating various technology options for the subsequent phase of demonstrations?	High
Q3	What is the efficiency of the fee assessment and collection relative to the fuel tax?	What did the cash flow modeling illuminate about RUC collection costs? How do the costs compare with fuel tax collection in your State?	Moderate
Q4	What are the system attributes and characteristics of the RUC systems with respect to: privacy, security, user acceptance, ease of use, ability to audit, charging accuracy, reliability, equity, ability for a user to circumvent the charge, and other factors?	See table 2 for detailed metrics.	Moderate
Q5	What is the user and stakeholder perception of RUC in general and of pilot activities?	N/A	Low
Q6	What changes in institutional and financial setting, frameworks, models, and elements are required?	What are the primary results of the organizational design exercise conducted?	High
Q7	What is the financial sustainability of each pilot deployment?	Have you evaluated the financial sustainability of the pilot deployment?	Low

Source: FHWA

**Table 2. System attributes.**

<b>Functional Parameter</b>	<b>Description</b>
<b>User-orientated parameters</b>	
Privacy	Privacy relates to the <i>nature</i> of the information being collected as opposed to the <i>integrity</i> of the information.
Equity	Equity relates to how user costs and other outcomes will impact people in different income brackets and people of different races, ethnicities, and genders; English proficiency level; and travel mode.
Potential for Value-Added Services	Value-added services refer to the ability to add other transportation-related applications or software to the system to enhance system performance, reduce congestion, and improve mobility.
Ability to Audit	Extent to which an individual can contest their charges and have visibility into how those charges were accrued and assessed.
Ease of Use/Public Acceptance	The degree to which the system use is straightforward and the time that a participant needs to spend interacting with the installed system is minimized; the level of acceptance by the traveling public.
Transparency	User awareness, specifically in real time, of what they are being charged.
Cost to User	Cost of equipment or installation to the end-user and cost of the per-mile (or other) charge.
<b>System-orientated parameters</b>	
Data and Communications Security	Data source integrity and storage, transmission and access.
Charging Accuracy	The system's ability to assess the expected charge for each use of the roadway.
Charging Precision/ Repeatability	The system's ability to produce a consistent assessment of fees repeatedly for identical travel.
System Reliability	System "up-time."
Flexibility to Adapt	Ability of the technologies and systems to be upgraded or updated.
Flexibility to Expand	Ability of the system to respond to increased demand/system capacity and add technological capabilities.
Interoperability	Ability for the system to interact and exchange information across multiple jurisdictions.
Compatibility with Low Tech	Assessment based on the system's ability to accommodate users that cannot utilize the technology.

**Table 2. System attributes. (continuation)**

<b>Functional Parameter</b>	<b>Description</b>
<b>System-orientated parameters</b>	
Evasion	Evaluation of how easily the system can be circumvented.
System Costs	Understanding of the full spectrum of investment costs, including initial capital, operating, and maintenance costs.
Ease of Enforcement	Ability of law enforcement to identify travelers that have evaded the system.
Cyber Security	Extent to which the system is vulnerable to a cyber-attack or release of private information.
Ability to Reallocate Revenue	Extent to which the system collects information that can be used to inform allocation of revenue.

Source: FHWA

## **EVALUATION PROCESS**

The evaluation team devised an approach centered on periodic interfaces with the grantee agencies, including a site visit with a subset of grantees conducting pilot deployments, to better understand the rationale and outcomes for Phase I activities.

## CHAPTER 4. MAJOR FINDINGS

This chapter presents an overview of California’s proposed RUC system and a summary of key findings and lessons learned resulting from its Phase I efforts. The findings are presented in accordance with the evaluation framework provided in chapter 4 that is based on the STSFA grant evaluation criteria as provided in the notice of funding opportunity.<sup>7</sup> It is important to note here that California’s Phase I scope included pilot planning and set up activities. Pilot execution was not part of this scope. As such, several evaluation criteria were not directly addressed within the scope of grant-funded activities. California may be addressing additional aspects of an RUC system with non-Federal funds and/or may anticipate addressing some aspects in the future as it advances towards executing a pilot. Given the limitations of scope of this effort, this chapter includes detailed discussion only on the attributes of the proposed system that were explored, examined, or tested during Phase I.

### CALIFORNIA’S MILEAGE-BASED SYSTEM OVERVIEW

California’s Phase I activities primarily comprised a post-pilot enhancement of the system used in the RCPP that ended in 2017. One of the key aspects investigated during Phase I was the pay-at-the-pump/charge point function for road charge to determine whether it would be feasible to make a road charge payment at a gas station (or charge point) as part of another transaction, with no separate invoice coming from an account manager, and then to explore how this might be accomplished.

The research focused on the following areas:

- **Organizational structure design:** Assessing which agencies could administer a Statewide road charge program.
- **Cash-flow model:** Developing a road charge revenue flow model that could be used as a tool to assess costs and benefits of a new program.
- **Enforcement and compliance strategies:** Identifying elements of an enforcement program and associated strategies for ensuring compliance.
- **Pay-at-the-pump/charge point:** Investigating technologies for paying a road charge at gas stations or (electric) charge points.

As noted in chapter 1, while education and outreach to the public on transportation funding and alternative methods of revenue generation were part of the planned Phase I activities, due to passage of Senate Bill 1 in California in 2017, California conducted limited public perception research in place of broad public outreach.

### Technology Options Explored and User Experience of the System

The technology options California evaluated during Phase I are summarized below. Table 3 summarizes the technology solutions and the key features they offered:

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<sup>7</sup> USDOT Notice of Funding Opportunity Number DTFH6116RA00013, issued on March 22, 2016. Available at: <https://www.grants.gov/custom/viewOppDetails.jsp?oppId=282434>.

- **Technology 1:** This technology utilizes a wallet concept, where the participant prepays to add funds to his or her wallet and pay electronically through their pre-established account. This technology uses location-based services such as in-vehicle telematics and OBD-II devices with location capability. The predetermined locations are set up as geofences in the system, so that when the vehicle enters a geofenced area, it triggers mileage reporting to the account manager. Geofenced areas can be established anywhere, such as gas stations or charge points. Payment frequency can be defined as time frequency (e.g., daily, weekly, monthly) or mileage frequency (e.g., every 200 miles). This ensures that road charge fees will still be collected even if a participant never enters a payment location. When a participant enters a payment location, or a frequency threshold is reached, the mileage report to the account manager is triggered and the road charge due is deducted from the wallet.
- **Technology 2:** For this technology solution, the proposed architecture includes the application of a customer loyalty program through a major gas company and its respective stations, coupled with other technologies to extend the architecture to the application of a road charge. This technology uses an OBD-II plug in device to collect vehicle data, including mileage, and communicates that data to a dedicated access point installed at a participating gas station. The OBD-II device and access point communications use a close-proximity wireless ad hoc network. Data are collected from the vehicle any time the vehicle passes an access point, although data collection can be restricted to station stops only (as opposed to simply driving by).
- **Technology 3:** This Software as a Service (SaaS) technology solution allows vehicle fleet operators to track vehicle locations. The system utilizes an interface to on-board telematics for certain vehicles and a plug-in device for all other vehicles with a compatible OBD-II port. The system is entirely cloud-based, so the telematics and OBD-II devices interface with cloud-based services. This technology solution has not been previously applied to a road charge.
- **Technology 4:** This technology is a proprietary in-vehicle payment system deployed at select gas stations. The system allows participants to pay for fuel purchases without having to swipe a physical credit card. The system can also use existing toll transponders for vehicle identification, which means a demonstration could draw from a pre-established pool of participants. Participating gas stations install toll tag readers at the station and install add-on software to their Point of Sale (POS) system. When a participant enters the gas station, their toll tag is read, and they are identified as a participant. The system sends a notice to the participant's mobile device asking which pump number they are using (this message also acts as a two-factor authentication). Once the participant responds, the system identifies the purchase on that pump, and when the transaction is completed, the system sends an e-receipt to the participant's mobile device.

**Table 3. Demonstration system summary by technology.**

<b>Element</b>	<b>Technology 1 In-vehicle telematics + wallet</b>	<b>Technology 2 In-vehicle telematics + customer loyalty program</b>	<b>Technology 3 Software as a Service (SaaS)</b>	<b>Technology 4 Proprietary in-vehicle payment system</b>
<b>Miles driven</b>	Actual*	Actual*	Actual*	Estimated‡
<b>Fuel purchase amount</b>	Estimated‡	Actual † <sup>1</sup>	Actual*	Actual*
<b>Real-time invoice, which includes fuel purchased, road charge, and fuel tax credit</b>	No – Road charge and estimated fuel tax credit only‡	Yes † <sup>1</sup>	Yes*	Yes*
<b>Extendable to electric vehicle charge points</b>	By geo-fencing charge points†	By tracking charge point purchases on purchase card†	By installation of vendor access point at charge point†	By installation of tag reader at charge point † <sup>2</sup>
<b>Ability to determine charge point purchase amount</b>	No‡	Yes † <sup>3</sup>	Yes † <sup>4</sup>	Uncertain † <sup>5</sup>

Source: California Department of Transportation

\* represents optimum characteristics.

† indicates that further verification is needed.

‡ indicates that the technology does not fully meet the criteria at this time.

<sup>1</sup> Uncertain if the amount of fuel purchase can be obtained from cloud transaction data.

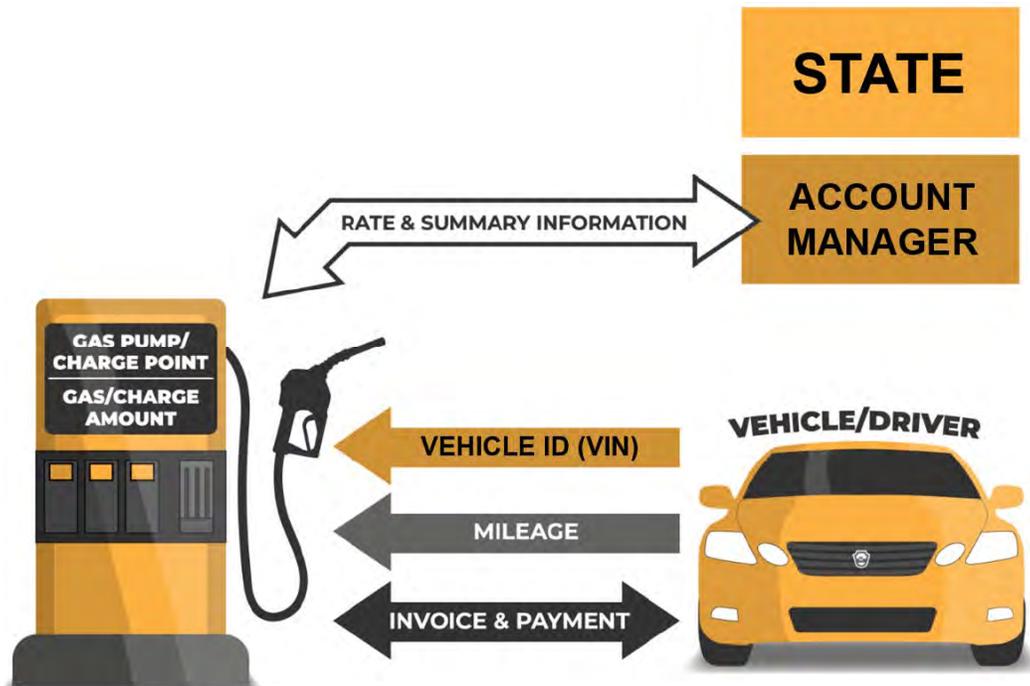
<sup>2</sup> Not clear that the direct payment to registered card can be implemented.

<sup>3</sup> Only if dedicated payment card is used at the charge point.

<sup>4</sup> Only if fleet card is used; it may not be possible to track registered credit card transaction not through point of sale system.

<sup>5</sup> Not clear whether transactions can be tracked on a registered card except through point of sale system.

Figure 4 provides the high-level system architecture for the proposed pay-at-the-pump/charging station system.



Source: California Department of Transportation

**Figure 4. Diagram. High-level proposed system architecture.**

## SYSTEM-ORIENTED PARAMETERS

### Flexibility to Adapt and Expand

**Ability of the technologies and systems to be upgraded or updated.** The scope of the activities under the fiscal year 2016 STSFA funding were limited to early-stage planning of the system and engagement of potential vendors of the technology to determine the limitations, viability, and applicability of currently available technologies. The excerpt below from California’s final report describes the concept and overall intent:

*The long-term concept for road charge is that the collection of mileage-based fees will be an integral part of other services and driver amenities offered by the private sector. Therefore, an approach where road charge data can be collected, processed, and/or transmitted as part of current e-fueling or re-charging processes represents an opportunity for integration within existing infrastructure and emerging pump-based transaction applications that may lower operating and administrative costs, improve compliance, and increase public acceptance of a mileage-based transportation funding mechanism.<sup>8</sup>*

The pay-at-the-pump/charging station is not a mileage recording technology; rather, it is a communications and payment portal that permits the communication of data from the RUC

<sup>8</sup> The California Department of Transportation, Enhancing the Road Charge Pilot Program, Annual Report – Fiscal Year 2017, February 2018.

system in the vehicle wirelessly to the fueling/charging station. The mileage is calculated, and payment is made through the station, along with the fuel and/or electric charging fee.

This approach relies on a different set of technologies within the vehicle to record mileage and data and to communicate wirelessly with the fueling/charging station.

**Key Finding: California's approach would benefit from looking into the ability of the different components of this system to communicate, including exploring questions of data format (compatibility) and communications protocols. The ability of the charging station equipment to be upgraded will depend on how modular the system is within the fueling/charging station.**

Several different systems need to be in place for this concept to function, including:

- **Vehicle RUC system:** Several technologies are being explored throughout the country, many using combinations of OBD-II devices, smartphones, and other technologies capable of recording mileage through a vehicle's telematics or through GPS. This technology must be present in each vehicle using the system, and it must be enabled to communicate with the fueling/charging station technology for this concept to function.
- **Fueling/charging station system:** A set of technologies that will communicate with the vehicle's RUC system, verify the identity of the vehicle, and record the mileage driven since the last payment. This system would need the ability to multiply the mileage driven by the mileage fee, and to apply the mileage fee difference either in addition to or subtracted from the fuel tax (in the case of a fueling station). Integrated payment technology (likely already present) would allow for the payment of both RUC and fuel.
- **Account manager communication:** Once payment is made, the payment amount, mileage, and any other critical data will need to be transferred to the motorist's account manager (public or private) and a record of their payment will need to be made. Whether the funds from the fueling/charging station are distributed to the account manager or directly to the State is yet to be determined.

The flexibility of this system to expand or adapt depends on the ability of the different components of the system to communicate. The vehicle RUC system could be changed or expanded, if the data format and the communications protocols remain compatible with the equipment in the fueling/charging station. The ability of the charging station equipment to be upgraded will ultimately depend on how modular the system is within the fueling/charging station.

### **Compatibility with Low-Technology Options**

California and several other States have tested several low or no-technology options that offer the ability to pay either on a flat fee or a per-mile basis without the use of location tracking or communications technologies. The options California included in the Phase I explorations included a manual odometer reading and a time-block permit (a prepaid permit for unlimited road use during a specific time period). These options are not compatible with a fueling/charging station payment system, as the basic operation of the proposed system would require digital communications from the vehicle to the fueling/charging station and could not be used with a visual mileage recording method or a time-based mileage method.

**Key Finding: A pay-at-the-pump/charging station system requires digital communications and mileage collection technology and is not compatible with low/no-technology options.**

## **System Costs**

**Full spectrum of investment costs, including initial capital, operating, and maintenance costs.** One of the key aspects of California's Phase I program was the development of a cash-flow model.

California states:

*This tool is not intended to provide financial advice; rather, it forecasts a possible way in which debt can change the level of road charge needed to fund capital improvements.<sup>9</sup>*

The cash-flow model, in its current form, is not an ideal tool for approximating system costs, but could potentially be expanded to include system administration costs in future iterations.

**Key Finding: California's cash-flow model is a helpful tool in designing a pilot and in determining the per-mile fee considering various options, such as initial capital, operating and maintenance costs of an RUC system. However, the tool does not currently provide a means to develop an accurate estimation of the administrative costs under different operating scenarios. This could be developed in future iterations of the cash-flow model.**

Additionally, as part of the analysis of organizational structure design, California evaluated several considerations that may have an implication for system costs, including:

- **The role of California DMV:** The Enhancing RCPP final report states that the DMV seems to be best suited to lead the administration of a potential future road charge program as it is already performing most of the necessary functions. Road charge payment penalties could be tied to vehicle registration, and additional enforcement functions would not be required, because they already exist within DMV. These approaches could significantly reduce the system cost. Overall, however, California expects the costs of having the DMV operating as the SAM to be higher than the current cost of fuel tax collection. Some components of the additional costs, based on specific operational scenarios, are likely to be:
  - Additional staff resources to manage the road charge program.
  - Certifying the CAMs and administering cash payments for those who choose not to work with a CAM.
  - Modifying the DMV Automated Fee System to accommodate the road usage charge.
- **The implications of removing fuel tax:** While removing the fuel tax is not an immediate intended outcome for the road charge efforts, there may be unintended implications if this policy is pursued down the line. In the State of California, the local sales tax is a percentage of the gross receipt (on top of the motor vehicle fuel tax). A road charge

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<sup>9</sup> The California Department of Transportation, Enhancing the Road Charge Pilot Program, Annual Report – Fiscal Year 2017, February 2018.

program would result in less sales tax revenues if the fuel tax is removed from the price of gas.

- **Enforcement costs:** Road charges are anticipated to be relatively low amounts, making collective actions for nonpayment less cost-effective. For large fleets (i.e., Uber, Lyft), there could be more substantial enforcement-related costs, and therefore it would be more cost-effective to enforce fee payment among this user group. Several options could be considered to mitigate enforcement costs, including having the private entity (CAM) take on enforcement or a system where the fuel tax is still in place. In the latter case, in the event of road charge non-compliance, the fuel tax would still be collected.

## **Ease of Enforcement**

**Ability of law enforcement to identify travelers that have evaded the system.** In Phase I, California acquired consulting support to study enforcement and compliance strategies. The resulting technical memorandum examined noteworthy practices in other revenue-related transportation programs as part of the process for identifying considerations for enforcing payments and promoting compliance for road charge participants and account managers. The report projected potentially fraudulent activities and proposed prevention strategies for both automated and manual mileage reporting options. The memorandum included examples of service-level agreements with CAMs, including service levels for enforcement, notification, escalation, fraud detection, and reporting.

The key components of enforcement mechanisms include:

- Setting up enforcement policies, including establishing definitions for violations, notifying users of unpaid balances, determining penalties and charges, and defining the threshold timeframes for when the road charge balance is considered past due.
- Establishing enforcement, inspection, and violation processing procedures spanning various agencies, including the CAMs, State account managers, DMV, and law enforcement agencies.
- Setting contractual requirements for private and State entities to follow the enforcement policies, including guidelines for collecting payment.

California determined that while criminal charges are not anticipated for nonpayment of road charges, criminal charges are expected to be applicable to fraudulent activity (e.g., deliberately tampering with mileage collection devices or the odometer).

Since California has not selected a specific technology, the potential to evade road charge through fraudulent activity cannot be conclusively determined; however, table 4 summarizes potential fraud and security issues based on the mileage reporting method used.

**Table 4. Summary of security issues based on mileage reporting method.**

<b>Mileage Reporting Method</b>	<b>Description</b>	<b>Security Summary</b>
<p>Vehicle telematics using a dongle attached to the vehicle’s OBD-II port.</p>	<p>In this approach, the standardized OBD-II port is used to obtain the vehicle’s speed, which is then integrated to produce distance-traveled information. This solution can either use a GPS receiver built into the mileage recording device (MRD) to obtain location data or obtain it from another source, such as an external GPS receiver (e.g., from a smart phone app) or by entering it manually.</p>	<p>Vehicle telematics systems can be thwarted through man-in-the-middle attacks between the vehicle’s data bus (connecting the electronic control units) and the OBD-II port, or between the OBD-II port and the connected dongle.</p> <p>Today, there is no secure, standardized vehicle data access technology in use, therefore access control problems raise potential data integrity and privacy problems.</p>
<p>Smart Phone with Beacon</p>	<p>This approach uses a smart phone application to obtain location and/or distance-traveled information using the smart phone platform’s GPS. A significant technical challenge of this approach is the need to associate a phone to a given vehicle.</p>	<p>Two significant security issues are present with this approach:</p> <ul style="list-style-type: none"> <li>• The RUC system inherits all the security problems of the smart phone platform—some are generally more secure than others; some are easier to “root” and compromise.</li> <li>• The beacon is necessary to correlate position/distance information with a given vehicle. Today, there is no phone/vehicle pairing technique that is reliable, secure, and convenient. Additionally, any mandate to use Bluetooth beaconing effectively translates to privacy losses due to trackability of static addresses.</li> </ul>
<p>Manual Mileage Reporting</p>	<p>This approach is characterized by road use charge program participants either (1) taking vehicle odometer pictures via a smart phone app and uploading to an Account Manager, or (2) drivers having a recording of their odometer readings at regularly scheduled vehicle inspections.</p>	<p>This method is subject to integrity problems at the source if the manual reporting is made by the driver. If the manual reporting is made by a licensed technician or other 3<sup>rd</sup> party, this method is likely the most secure.</p>

## USER-ORIENTED PARAMETERS

### Potential for Value-Added Services

California did not significantly explore the potential for value-added services during the Phase I efforts. However, the agency anticipates that value-added services will be provided by CAMs based on the technology selected. The following are some value-added services that California believes would support a more efficient RUC system and easier public adoption:

- CAMs would be responsible for value-added services like visual trip logs, vehicle health, safe zones and driving scores.
- CAMs could provide a mechanism for drivers to pay their vehicle licensing fee (VLF) in installments. This feature would save significant upgrades in the DMV system of VLF collection while giving motorists an additional option to pay the fee.
- California concludes that service level agreements should allow for flexibility to enhance the participants' experience and agency coordination through value-added services while ensuring compliance with State guidelines.

### Equity and Public Perception

**Disparate impacts across populations—perceived and real.** California conducted an online survey that targeted California residents from all three regions of the State (Southern, Central, and Northern). Demographic characteristics included rural, urban, low-income, and drivers of fuel-efficient vehicles. Of the 1,300 participants, 1,000 completed the survey in English and 300 in Spanish. The key findings of California' survey included:

- **Perception of road conditions was largely positive in the population surveyed:** Most respondents rated their neighborhood roads (63 percent) and State highways (67 percent) as having good or excellent quality.
- **Knowledge of transportation funding is low:** Most respondents (57 percent) were not too familiar or not at all familiar with the concept of road charging. Very few knew exactly how transportation is funded right now:
  - Nearly a quarter of respondents (24 percent) said they did not know how road maintenance and repairs are currently funded in California.
  - Respondents were most likely to identify fuel taxes (46 percent) or vehicle registration fees (44 percent) as funding sources for road maintenance.
  - About a third of respondents said they thought State income taxes (34 percent), tolls (34 percent), or Federal funds and grants (32 percent) funded road maintenance and repairs.
- The most important issues in a road charge system were:
  - Avoiding being double charged/taxed; i.e., charged both the per-mile charge and the fuel tax (27 percent).
  - Ensuring all motorists pay for road use (22 percent).
  - Securing adequate funding for road maintenance and repair (20 percent).

- The least important issues were:
  - Ensuring visitors from out-of-State pay for their road use (23 percent).
  - Having choices for reporting and paying for miles driven (18 percent).
  - Protecting personal privacy (16 percent).
- Other key findings of the survey include:
  - Participants like messages about road conditions and the fuel tax instability that emphasize stable and adequate funding.
    - Respondents agree that “the older our aging roadways system gets, the more repair it needs.”
    - Respondents agree that “deferred maintenance has left our transportation system in bad condition.”
    - Respondents rate current funding for road maintenance and repairs as somewhat adequate.
    - Demographic factors influence perceptions of whether funding is adequate, whether road charging is fair and what road charge issues the responder considers important (see call out boxes).
  - The top message about road charging focused on how all drivers should share the cost of roads was:
    - Most respondents believed that a road charge would be at least as fair as the fuel tax.
    - Top transportation funding messages concern fairness for all drivers and stability of funding.
  - In deciding if California needs an alternative to the fuel tax, most respondents want more information on road charging.

**Demographic Factors Influence a Respondent’s Perception of Road Charge Being Fairer than Gas Tax**

Don’t know how fair road charging is relative to the gas tax (as opposed to about as fair):

- Higher income respondents
- Rural respondents
- Those paying less than they expected in gas tax

**Key Finding: Knowledge about transportation funding among California residents is low and the most important issues of concern among survey respondents were:**

- Avoid being double-charged/taxed (i.e. both per-mile charge and fuel tax)
- Ensuring all motorists pay their fair share for road use
- Securing adequate funding for road maintenance and repair

### **Demographic Factors Influence Perceptions of Whether Funding Is Adequate**

- **As their age increased,** respondents were more likely to say funding is very adequate as opposed to saying it is somewhat adequate.
- **Men were more likely than women** to say funding is somewhat adequate as opposed to saying it is somewhat inadequate.
- **Suburban and rural residents** were more likely than urban respondents to say funding is somewhat or very inadequate as opposed to saying it is somewhat adequate.

### **Demographic Factors Influence What Road Charge Issues Respondents Consider Important**

High importance of “Ensure that I don’t pay both a per-mile charge and a gas tax”

- Persons of color more than White non-Hispanic.
- Younger respondents more than older.

High importance of “provide choices in how I report and pay for miles driven”

- Older respondents more than younger.
- Respondents with higher number of vehicles in the household.
- This issue was of least importance to Hispanic versus non-Hispanic respondents.



## CHAPTER 5. SUMMARY AND IMPLICATIONS FOR NATIONAL IMPLEMENTATION

The key findings of the evaluation of California's Phase I program are summarized below.

- **Flexibility to adapt and expand:** The pay-at-the-pump approach would benefit from considering the ability of the different components of this system to communicate, including addressing questions of data format and the communications protocols. The ability of the charging station equipment to be upgraded will depend on how modular the system is within the fueling/charging station.
- **System cost:** California's cash-flow model is a helpful tool in designing a pilot and in determining the per-mile fee considering various considerations. However, the tool does not currently provide a means to develop an accurate estimation of the administrative costs under different operating scenarios. This could be developed in future iterations of the cash-flow model.
- **Real and perceived equity:** In assessing public perception of a proposed RUC system, California conducted a limited number of public surveys and focus groups. The public communications efforts provided some very critical findings about the public perception of RUC and some useful pointers to direct future public outreach and messaging initiatives. The communications report also included recommendations for conducting outreach with target groups. The following emerged as the most important RUC-related issues on the minds of the respondents:
  - Avoid being double-charged/taxed (i.e., both per-mile charge and fuel tax).
  - Ensuring all motorists pay their fair share for road use.
  - Securing adequate funding for road maintenance and repair.

Some additional considerations for future explorations of appropriate technology—should California intend to pursue the pay-at-the-pump approach—include:

- **Interoperability:** The fueling/charging station concept is a billing method that has a concrete geography where payments are made and data is transferred between vehicle and system at a specific location. However, the RUC system will still need the ability to support the exchange of information across jurisdictional boundaries. Like other RUC systems, California is intending to rely on private account managers to provide technology and interface with customers. California will collect the data and payment from account managers and will be responsible for reconciling fees for miles driven out of State or for miles driven in California by out-of-State vehicles. For each of these scenarios, location data will need to be included and calculated as part of the payment calculation at the fueling/charging station.
- **Charging Accuracy Precision and Repeatability:** The precision and repeatability of charges using a pay-at-the-pump/charging station system would rely almost completely upon the specific RUC technology used within the vehicle. From a payment standpoint, the system would need to verify accurate communication of data from the vehicle to the station. It would also need to be capable of accurately calculating qualifying miles and the RUC mileage fee and applying the difference to the fuel tax in the final payment.

California started out with the pay-at-the-pump/charge point concept. However, the State determined that limiting its research to the pump infrastructure seemed shortsighted, given the pace of technology advancements. Thus, California is expanding its efforts to include a vehicle-to-infrastructure approach and not limiting its efforts to pump infrastructure. One of the main lessons that California learned from the RCPP and the STSFA Phase I evaluation of technology solutions is that if States hone in on a certain technology, it is likely that there will be advancements that will make the selected technology obsolete by the time it is ready for implementation. Therefore, California will focus its future research and exploration on the standardization of data being extracted from vehicles and conveyed to the commercial account managers.

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