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Assessing the Charging-as-a-Service (CaaS) Model for EV Charging Deployment in California

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16. Abstract Charging-as-a-Service (CaaS) is an innovative electric vehicle (EV) charging station model that allows customers access to EV chargers through a contract with a provider responsible for design, deployment, operations, and maintenance. Little is known about the motivations and experiences of stakeholders involved in CaaS operations, including providers, electric utilities, and customers. A grey literature review identified CaaS services, provider-described benefits, and utility-provided CaaS and charging services. Then, we conducted semi-structured interviews with 13 stakeholders to identify critical themes on interactions between stakeholders and the perceptions, challenges, and opportunities of the CaaS business model in addressing charging station needs in California. CaaS may have structural benefits to customer-owned chargers and could improve charger reliability, provide scalable solutions, and reduce customer fatigue with EV charging deployment. However, CaaS faces the same challenges present in the broader charging industry. The findings in this study can guide policymakers in supporting maintenance-related workforce development and streamlining and crafting EV charging infrastructure-informed subsidy programs. Additionally, stakeholders recommend municipal-led EV infrastructure planning and funding for chargers in disadvantaged communities. These interviews clarify the role of CaaS within the EV charging industry and confirm the need for engaged policymaker support to clear roadblocks, support investment, and educate customers about decision-making, which benefits all EV charging stakeholders.			
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The California Resilient and Innovative Mobility Initiative (RIMI) serves as a living laboratory – bringing together university experts from across the four UC ITS campuses, policymakers, public agencies, industry stakeholders, and community leaders – to inform the state transportation system’s immediate COVID-19 response and recovery needs, while establishing a long-term vision and pathway for directing innovative mobility to develop sustainable and resilient transportation in California. RIMI is organized around three core research pillars: Carbon Neutral Transportation, Emerging Transportation Technology, and Public Transit and Shared Mobility. Equity and high-road jobs serve as cross-cutting themes that are integrated across the three pillars.

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Executive Summary

Executive Summary

Access to EV charging infrastructure is critical to advancing state and federal electric vehicle (EV) adoption goals. The complexity and cost of installing and maintaining EV charging infrastructure can be a barrier to EV adoption for anyone transitioning to EV vehicles. Charging-as-a-service (CaaS) is an innovative asset ownership model that shifts the responsibility of procuring, installing, maintaining, and replacing charging equipment to a CaaS provider, simplifying charging access to a monthly subscription fee that may reduce barriers to EV adoption. Little is known about the experiences of stakeholders within a CaaS ecosystem. This study characterizes the CaaS experiences of utilities, providers, and customers. The study identifies interactions between stakeholders, perceptions, challenges, and opportunities of the CaaS business model in addressing charging infrastructure inaccessibility, particularly in California. We conducted 13 semi-structured interviews with individuals involved in managing or deploying EV charging solutions. Of these, six interviews were with CaaS providers, one with non-CaaS EV charging provider, four with electric utilities, and two with EV charging customers. This study illustrates types of CaaS solutions, experiences deploying CaaS in California, business operations, coordination between stakeholders, general perceptions of policies and programs on deployment and access, lessons learned, and perceptions on the future of EV charging deployment as well as the EV industry as a whole.

This study found the following benefits to EV charging deployment through CaaS solutions:

1. CaaS providers seek long-term relationships which also increases the longevity of EV charging infrastructure.
2. CaaS providers are dedicated experts that can manage EV charging infrastructure projects and fulfill knowledge gaps of EV charging customers.
3. CaaS solutions are flexible and well-positioned to scale EV charging infrastructure.

This study proposes the following policy recommendations for government authorities involved in promoting EV charging:

1. Encourage electrician and EV charger maintenance-related workforce development.
2. Streamline existing and develop new subsidy programs that are EV charging infrastructure informed.
3. Municipalities should develop strong EV charging infrastructure plans.
4. Develop comprehensive educational resources for EV charging infrastructure that provides clear guidance on technical and economic considerations for diverse customer segments.
5. Strengthen and expand EV charging infrastructure incentives in disadvantaged communities (DACs)

Contents

Introduction

Access to electric vehicle (EV) charging infrastructure is a well-established EV adoption barrier. In 2021, the California Energy Commission (CEC) found that California would need “nearly 1.2 million public and shared chargers by 2030 to meet the fueling demands of 7.5 million passenger plug-in electric vehicles” (California Energy Commission, 2021). Over the years, there has been extensive public and private investment in California to expand EV charging infrastructure. However, there are currently just 152,356 total public and shared private electric vehicle chargers in the state (California Energy Commission, 2024). To better understand EV charging expansion and accessibility in California, this study examines an emerging private investment business model called charging-as-a-service (CaaS).

CaaS is an innovative asset ownership model in which a CaaS provider supplies charging equipment and electricity for a simple monthly subscription fee. CaaS relieves EV owners of the responsibility for purchasing, installing and maintaining home or business EV chargers and dealing with the electric utility providing the power thereby “streamlining and speeding the design, installation, and maintenance of [Electric Vehicle Supply Equipment¹], and reducing up-front cost” (Trinko et al. 2023). Given the high cost and complexity of EV charging infrastructure the CaaS model may be able to reduce barriers to EV adoption.

CaaS operators are capable of handling critical peak load and voltage problems and can dynamically adjust charging to respond to changes in available grid capacity for EVs and fairly balance charging services across customers (Danner and de Meer, 2021). CaaS charging management can also monitor and maintain “fairness of service recipients while supplying chargeable electric power to multiple EVs” (Miyahara et al., 2020). One proposed application of the CaaS model would match EVs in need of a charge with EVs that can supply mobile battery packs (Qiu and Du 2021). Such a mobile charging solution could be used in low EV adoption markets. Another example of a mobile charging solution would “dispatch service vehicles that carry modular battery units to provide light-duty electric vehicles ... with a ‘mobility and on-demand battery delivery’ service” (Guo et al., 2020).

There is a paucity of research on the opportunities and challenges for CaaS. This study interviews stakeholders within the emerging CaaS community to identify key themes regarding the CaaS business model. Interviewees mentioned a variety of different policies, programs, and regulations that they deal with. Appendix C provides information on those that were mentioned in interviews and other major policies, programs, and regulations in California.

This study provides a qualitative analysis of the perspectives of CaaS providers and EV charging stakeholders in California. It will hopefully increase awareness of the CaaS business model to encourage more widespread adoption of EV charging infrastructure.

¹ The charging equipment including both hardware and software supplying electricity to the EV.

Research Questions

This study investigated the following areas to identify key themes related to interactions between stakeholders, perceptions, challenges, and opportunities of the CaaS business model in addressing barriers to improving charging infrastructure accessibility in California:

Area 1: CaaS and EV Charging

What are the CaaS and EV charging infrastructure services in California?

Area 2: Equity

What types of equitable plans are there for EV charging infrastructure?

Do CaaS models support equitable distribution of EV charging infrastructure?

Who are the target communities of equitable EV charging plans?

Area 3: Stakeholder Relationships within the EV Charging Landscape

How do CaaS providers, electric utilities, and EV charging customers interact?

What are the experiences of their interactions?

What do these experiences tell us about how CaaS operates within the EV charging industry?

Area 4: Benefits and Challenges

What are the benefits of using CaaS and the challenges of implementing CaaS?

Area 5: Policies and Programming

Are there any current public policies, programs, and funding mechanisms that interact positively or negatively with the CaaS model?

Area 6: Lessons Learned and Future Outlook

What lessons have CaaS providers, EV charging providers, and electric utilities learned from their experience with EV charging deployment?

What do CaaS providers say about the future of the EV charging industry?

Research Plan

This research report consists of two parts. First, we present the results of the content analysis we conducted of CaaS grey literature to build an understanding of CaaS solutions being offered and the policies, services, and programs that support EV charging infrastructure in California. This grey literature also helped the research team to create a list of candidate stakeholders to invite for interviews. Second, we discuss our semi-structured and open-ended interviews with 13 California stakeholders consisting of CaaS providers, electric utilities, and CaaS and non-CaaS customers. The analysis focused on defining CaaS and describing the electric utilities' EV charging infrastructure services. The selection process and interview protocols are described in Appendix A and Appendix B, respectively.

Grey Literature Review

The grey literature documents we reviewed were collected from CaaS provider websites, news articles, YouTube videos, policy briefs, and blogs. A total of 48 CaaS provider-related documents were analyzed. Due to a lack of CaaS customer documents, the research team could not evaluate customer experiences of CaaS in this review.

Ten CaaS provider websites were analyzed to understand how providers define CaaS, what are the various services offered with a CaaS solution, and how these solutions are tailored to customers. Nine of these ten CaaS providers screened had examples of projects in California as of December 2023.

All nine California CaaS providers offered services to fleets (including commercial fleets, school buses, and transit). Five provided services to businesses and four offered to supply multi-family dwellings. Only one provider mentioned that a CaaS solution was available for single-family homes.

Most providers (55%) used the technical phrase “charging as a service” to describe their solutions. They frequently described it as a “turnkey” service to emphasize that the customer would be able to start using it as soon as it was installed. Providers used a number of other phrases to describe their holistic approach, financial advantages, and flexibility to meet customer needs:

- “Flexible financing” and “easy-to-understand”
- “Specialized plans that meet your businesses’ needs”
- “Simple” and “comprehensive project management and amortized costs” and “most comprehensive solution”
- “End-to-end”
- “No upfront costs” and “zero up-front cost option”
- “Custom turnkey offering” and “one-stop-shop” and “simplified monthly fee”
- “Customized to meet the needs of fleet vehicle operations” and “accessible financing options”

The California CaaS providers mentioned a variety of services they offer to customers, typically as a part of their CaaS solution, including design and planning services, warranties, construction, and installation services. **Table 1** breaks down these available services by customer type, showing the count of providers providing a specific service. It is important to note that public-facing websites may only mention some services provided to customers. Thus, a “0” in the cell means that no provider explicitly mentioned this service in the grey literature search.

Table 1. California CaaS Providers' Services Offered by Customer Type

Provider Service Types	California CaaS Providers' Customer Types (n = 9 CaaS Providers)			
	Single-Family Homes (n = 1)	Businesses (n = 5)	Multi-Family Dwelling (MFD) (n = 4)	Unspecified Fleet (n = 9)
Design & Planning	0	3	1	5
Funding & Bidding	0	1	1	3
Utility Connection	0	1	0	2
Construction & Installation	0	2	1	5
Hardware	1	4	3	8
Software	1	4	3	8
Operations Management	1	4	2	7
Support	0	2	1	2
Maintenance	0	2	1	4
Warranty	1	2	2	2
Future Proofing	0	1	0	1

Notes: “Design & Planning” = the design of the charging infrastructure site, including implementation-ready plans (e.g., data-driven needs analysis, engineering plans, and permit approval). “Funding & Bidding” = identifying financing sources, like rebates, and shopping for different product options from private companies and utilities (e.g., grants/rebates and quotes from vendors). “Utility connection” = working with local utilities to energize charging infrastructure and, if necessary, upgrade the front-of-the-meter connection. “Construction & Installation” = behind-the-meter construction (as required) and installation of electrical panel, switchgear, and EV charger(s). “Hardware” = behind-the meter-infrastructure and EV charger(s), including connecting customers with (preferred) vendors and advisors for acquisition (if the company does not provide it). “Software” = smart charging software services, including connecting customers with (preferred) vendors and advisors and advisors for acquisition (if the company does not provide it). “Operations Management” = managing and optimizing charging operations. “Support” = customer services for operations and product support. “Maintenance” = ongoing maintenance of EV charging operations and infrastructure. “Warranty” = warranties and warranty support for EV, EV chargers, and labor. “Future Proofing” = long-term strategizing towards EV charging operations and infrastructure longevity.

Providers advertised several benefits to potential customers. The most mentioned benefits were no upfront cost, guaranteed assurance of project completion and an operational product, and risk avoidance. **Table 2** provides a breakdown of provider-described benefits offered to customers under the companies’ CaaS solution.

Table 2. California CaaS Providers' Self-Described Benefits to Customers Under CaaS

Provider-Described Benefits to Customers	California CaaS Providers' Customer Types (n = 9 CaaS Providers)			
	Single-Family Homes (n = 1)	Businesses (n = 5)	Multi-Family Dwelling (MFD) (n = 4)	Unspecified Fleet (n = 9)
Up-Front Cost Avoidance	1	2	1	7
Risk Avoidance	1	0	1	1
Schedule Certainty	0	1	0	0
Management	0	0	0	2
Ease	0	0	0	2
Customization	0	0	0	3
Assurance	0	2	1	3

Notes: “Up-Front Cost Avoidance” = avoiding upfront costs by flexible (monthly) repayment/subscription plan/financing terms. “Risk Avoidance” = avoiding financial risks and inadequate charging infrastructure and gaining reliability associated with EV charging project management, infrastructure, and operations. “Schedule Certainty” = streamlined and time savings in the process of planning, implementing, and operating charging infrastructure. “Management” = comprehensive management of the EV charging project and operations. “Ease” = simplifies processes to access and operate EV chargers. “Customization” = financing and operational plans are specialized to customer needs. “Assurance” = guarantee of completing infrastructure project and operations under contract.

A subset of California electric utilities (n = 13) was selected for a grey literature review to identify the types of customers receiving utility-funded (subsidized) EV charging station services and the types of financial incentives/rebates/offers available (at the time of the grey literature search), and to determine if the utilities had an EV charging station ownership model, meaning that build and operate EV chargers. Four major investor-owned utilities (Liberty Utilities, Pacific Gas and Electric Company [PG&E], San Diego Gas & Electric [SDG&E], and Southern California Edison [SCE]) were analyzed since they have the most extensive geographic and customer coverage. Several large publicly owned utilities were also studied (Sacramento Municipal Utility District [SMUD], Alameda Municipal Power, San Francisco Public Utilities Commission, City of Palo Alto Utilities Department, Los Angeles Department of Water and Power [LADWP], Anaheim Public Utilities, Glendale Water and Power, Pasadena Water and Power Department, and Imperial Irrigation District [IID]). Of these utilities, most (76%) had a dedicated EV charging team.

A total of 37 electric utility-related documents were analyzed. Of the 13 electric utility providers studied, all provided EV charging services to businesses, 11 supplied multi-family dwellings and ten served single-family homes, while only four serviced vehicle fleet customers (which may be due to utilities classifying fleets as business customers). Less than half of the electric utilities we studied in California had a charging station

ownership model. Most utility EV charging infrastructure incentive programs involve a rebate for purchasing an EV charger (across all customer groups). **Table 3** shows utility-provided incentives or programmatic support offered to different customers. While most utilities offered EV charger rebates to all customer types, half offered installation rebates to single-family homes. About a third offered businesses site consulting, which is technical assistance that can include evaluating onsite power to right size options. About a third offered multi-family dwellings turnkey solutions and site consulting, and half provided fleets with turnkey solutions and joint rebates for infrastructure and EV chargers.

Table 3. California Electric Utility Provided Incentives or Support by Customer Type

Electric Utility EV Charging Station Services	California Electric Utility Customer Types (n = 13 utilities)			
	Single-Family Homes (n = 10)	Businesses (n = 13)	Multi-Family Dwelling (MFD) (n = 11)	Unspecified Fleet (n = 4)
Site Consulting	10%	30%	36%	25%
Turnkey Solution	0%	15%	36%	50%
Infrastructure & EV Charger Rebate	0%	23%	23%	50%
EV Charger Rebate	100%	76%	61%	75%
Installation Rebate	50%	15%	23%	25%

Notes: “Site Consulting” = site planning and design support. “Turnkey Solution” = utility takes complete ownership of EV charging infrastructure with a complete package consisting of connection to the meter, behind-the-meter, and EV charger at no cost to the customer except electricity bill. “Infrastructure and EV Charger Rebate” = front-of-meter connection at no cost to the customer plus a rebate for EV charger(s). “EV Charger Rebate” = rebate for qualifying customers’ EV chargers. “Installation Rebate” = rebate for qualifying customers’ EV charger installations.

Interview Results

This section presents responses collected from the interviewees organized by the six research areas mentioned in the introduction: charging provisioning, equity, stakeholder relationships, benefits and challenges, policies and programming, and lessons learned and future outlook. The results represent the views and the experiences of the participants interviewed and may not represent the varied views of all those in this industry. Individual names, city names, client or utility program names have been redacted to provide anonymity. Each participant is identified by their stakeholder type and unique number.

CaaS Services in California

This section describes CaaS providers, electric utilities, and CaaS customer's charging needs.

CaaS Providers

CaaS Solutions and Services Offered to Clients

All but one EV charging provider offered a CaaS option for customers; of these all but one of the providers had an active or existing CaaS project in California. These had a CaaS option where the company finances the upfront capital cost for purchasing and installing EV charging infrastructure and recovers the cost over the contract period with the customer paying a subscription fee for services. Some CaaS providers had unique aspects to their CaaS service. One CaaS provider referred to their CaaS offering as an “infrastructure-as-a-service model,” emphasizing their role in providing a comprehensive service. In their view, EV charging involves much more than just the ability to charge vehicles. They also hired third-party vendors, which they said emphasized their holistic EV charging service approach through CaaS:

We get top-quality vendors involved. We do not value engineer things. You know, that's a big challenge. Our goal is to make sure we have the most robust, best stuff we can find to make sure that it lasts, especially in geographies that are challenging, like those along the coast. It's a real challenge when you get rust, corrosion, and other things. It's a big issue... So, we don't put in long-term commitments, but our goal is to have a hundred-year relationship with our customers because we want to be there to support them. It's a relationship to us. We want to solve problems, and we make sure that infrastructure is always, you know, safe, reliable and improving forever because you have to have it. (CaaS Provider 02)

CaaS Provider 02 stated their model was advantageous for themselves and their customers because they could customize their CaaS package, and thus its cost, to match the customer's needs. CaaS businesses can establish a long-term relationship with a customer, which is essential to maintaining safe and reliable EV charging infrastructure. Provider 02 and another provider also give customers the option to lease EVs in CaaS packages. A few providers have created charging depots where customers pay a fee for access. Charging depots allow a

CaaS provider to sell EV charging spaces at their facilities to a variety of clients who need charging en route between operations or even secure overnight parking and charging access. Depots and extending CaaS to EVs help customers with complex electrification needs:

So, we sell a few different products at each one of our depots. Sometimes, the subscription is time-based. For instance, someone might want to drop their truck off each night and pick it up each morning—just utilizing the charger for an overnight charge. Many of our sites have personal parking, so that person will come in their personal car, jump into the fully charged truck, drive it for the day, bring it back to the charger, get back in their personal car, and leave. We offer a dedicated dispenser or a dedicated charger as well. So that's 24/7/365 access to said dispenser charger, same [as] in a subscription model, obviously [at a] different price point than, you know, the overnight hours offering or product.... We also offer truck leases to help people kind of navigate all the different subsidies that are available to make the total cost of ownership of the vehicle more attractive. So, some of our customers will choose to own their vehicle, and just sign up for the charging services, and others of our customers will ask us to be the owner of that truck asset, monetize all the subsidies, and deliver it at a lease price to them. (CaaS Provider 07)

Lastly, one provider offered a wireless charging solution where EVs could be charged while parked. Their wireless charging solution projects were in the infancy. Aside from CaaS solutions, providers sometimes also offered an EVSE solution where customers could simply buy their EV charger or network services outright.

CaaS Provider's Clients and Priority Locations

CaaS providers may prioritize specific areas and types of clients to maximize their profits. They may target areas where there is a high number of EVs such as metro centers:

We go to all of these states and cities with the highest level of electric vehicle registrations. So, we follow that. I mean, we try to deploy chargers where all of these, EV drivers, live, work, play. (CaaS Provider 04)

And that's actually the reason that those priorities are what they are: They basically follow vehicles in operation. The highest percentage of vehicles in operation are private citizens; you and I driving EVs. (CaaS Provider 03)

Providers may also favor certain types of fleets such as drayage, freight, middle and last mile, as well as municipal fleets. Municipalities are common CaaS clients because CaaS providers benefit from contracts with durable entities that can make long-term commitments for essential infrastructure. Governments form a core client base as EVs become a part of their basic operations (e.g., government fleets, government employee parking lots). CaaS providers value these clients because they can provide the long-term relationships required return their investment and provide more certainty their services will be needed in the future:

We need two things. First, it's got to be essential infrastructure. It's got to be something that our customers have to have in place, has to be working, and that they care about. The second thing, the

component that you have to make it just a beautiful fit for what we do is we have to have a durable entity. It's got to be something that's going to be around for the next, you know, 50 to 100 years. And so that's, you know, that's your cities, your state agencies, it's your counties, it's your hospitals, it's your schools. And so, if you have stuff that people care about, they need to make sure is functioning and you have a long-term entity, it's a match made in heaven as far as what we can put together because we're looking at the long term. (CaaS Provider 02)

We interviewed one non-CaaS provider who provided insight on why a company may not choose to offer a CaaS solution:

I think CaaS is a pretty challenging business right now.... Utilization is the big thing that CaaS has to rely on, right? ... I think that even with sort of the high fees that some of them are collecting per kilowatt, it's still not enough to operate. The business is just tough. There's no way to guarantee the utilization of a site. You don't know if 20 people are going to charge there a day or two people are going to charge there a day. You don't know if they're going to use an AC charger or a DC charger, depending on the equipment that you have at the site. And then you also have people who, if they're pulling energy off the grid, God forbid you get hit with demand charges, and you don't know if that kilowatt that you just dispensed for that customer is going to cost you 15 cents a kilowatt or 70 cents a kilowatt. So, unless somebody is really looking at all the economics of the business overall, it's hard to say if Charging as a Service right now makes sense for a lot of people. Unless they're doing those calculations, and it makes sense, it pencils out, in regard to energy costs and what they're going to charge for dispensing it. (EV Charging Provider 05)

The CaaS business model requires extensive financial modeling and monitoring of utilization to obtain a sufficient return on investment. This CaaS provider explained that the business model may not be the right choice for all EVSE companies.

Electric Utility Services

Three of the interviewed electric utilities are classified as publicly owned utilities (POU), and one was an investor-owned utility (IOU). Two POUs did not have a dedicated EV team; however, one POU had a loose team in charge of transportation electrification. The IOU had a dedicated team, with specialized groups to provide services to specific cases. The POUs without dedicated EV charging teams had individuals who balanced EV charging responsibilities with other energy or sustainability responsibilities. One electric utility takes part in the Southern California Public Power Authority (SCPPA) (SCAPPA, 2024), a joint power authority which grants it access to the expertise of larger departments:

So, being part of SCPPA allows me to have the expertise of bigger department cities who have engineering departments in-house, who have support staff who have done this. (Electric Utility 01)

Utility Programs, Rebates, and Charging Services Offered

All electric utilities offered rebates to a mix of clients, including residential, commercial, fleet, and curbside projects. Two electric utilities offered technical and advisory assistance programs. These programs provide information about the necessary components and costs of EV charging installation and how to install EV charging equipment, which helps customers make informed decisions. One electric utility provided two infrastructure service incentive programs, which either provide front-of-meter infrastructure or behind-the-meter incentives. The front-of-meter infrastructure includes pole and wire upgrades between the distribution system transformer and customer's meter. Behind-the-meter programs include support for trenching, conduit, electrical wiring, and panels needed behind a customer's electric meter.

Electric utilities were motivated to provide EV charging incentives or programs for various reasons. These included environmental or social reasons, such as improving air quality and health effects or supporting equitable transportation and accessibility. An electric utility describes these motivations to provide an EV charger incentive:

We are always looking at being equitable in the transformation [to net-zero], making sure that we make power and charging stations accessible, and to support our clean air mission.... [Our] goal is in alignment with the state of California to reach carbon neutrality by 2045. Significant electrification is necessary to decarbonize the economy feasibly and affordably. (Electric Utility 03)

Other reasons were experimental—electric utilities wanted to understand their EV customer base and see where they could grow charging infrastructure presence. Two providers explained that they were learning through their incentives about EV charging demand:

Multifamily was something I knew I had to deal with. So, it was easy, and it was an experiment, which is why I did all the grant funding for those, because I figured we have a very low rate. (Electric Utility 01)

I think it was 2018... we went and said, okay, we're going to offer all these rebates to our customers, but in return, we would start learning behavior. As far as how they're charging, when they're charging, where they're charging. And so we initially started off with just residential EV chargers. We grew that to commercial and we grew it to infrastructure. And then we actually took it one step further and we started installing our own public Level 2 chargers. (Electric Utility 02)

Lastly, EV charging services increased their revenues:

As an electric utility, it increases our revenues. I think that's not always the case with our programs. But it is with this one. And so, it's an extra bonus, when we think about the benefits of the program. (Electric Utility 04)

CaaS and EV Charging Incentive Program Clients

CaaS providers and electric utility incentive programs had many similar clients (**Figure 1**). CaaS customers typically use a combination of CaaS solutions and electric utility incentives to establish their EV charging infrastructure. As a part of a CaaS solution, CaaS providers seek available funding for EV charging infrastructure to offset the cost for themselves and customers. CaaS customers (or clients) also approach CaaS providers at different stages of electrification (**Figure 2**).

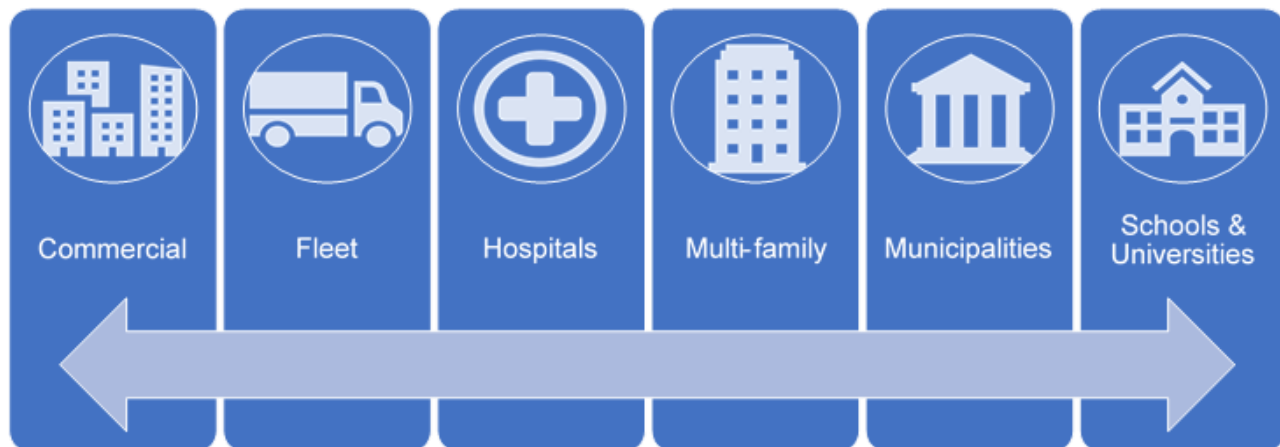


Figure 1. Types of Clients that Seek CaaS EV Charging Infrastructure Services

Those at the beginning stage look for expert guidance and if they do not receive it, they may revert to the conventional vehicle of choice—combustion engine vehicles:

Most everybody is saying we don't know what to do. You know, we have some ideas. And it's kind of the Wild, Wild West because they're in, they're looking for you know what options should we take?, and there's a lot now ... That's the thing: people will get burned out a lot on things and say, you know what? this EV thing is just not working. It's too hard. And so, I think that's where [CaaS] makes most sense, and that's what we've seen as well is working... Things that are easy, people will do. If it's hard, even though there's a good environmental impact for it, they won't do it. (CaaS Provider 02)

CaaS providers expertly guide clients through electrification options and assist them in making informed decisions about their EV charging infrastructure. Whether clients have initiated their electrification transition by purchasing EVs or are in the planning phase and need assistance on charging what they plan to buy, CaaS providers say they are flexible and able to step in. Lastly, CaaS solutions can also meet the needs of others that are further in their electrification process. As an example, these clients have purchased chargers but need upgrades or a scalable solution to accommodate more vehicles:

Some of them, made a mistake to purchase or buy some sort of charging solution, mostly like dumb chargers that are not cloud-connected. They put it there because they wanted to offer the charging solution for the first couple of drivers maybe, but now that the population is growing, they need, you know, a smarter solution. (CaaS Provider 04)

So, I have customers who have built a few chargers and own trucks in their own yard, understand that challenge, or maybe have used up all their power. And now, as they expand their fleet, want to use our [depot] facilities. (CaaS Provider 07)

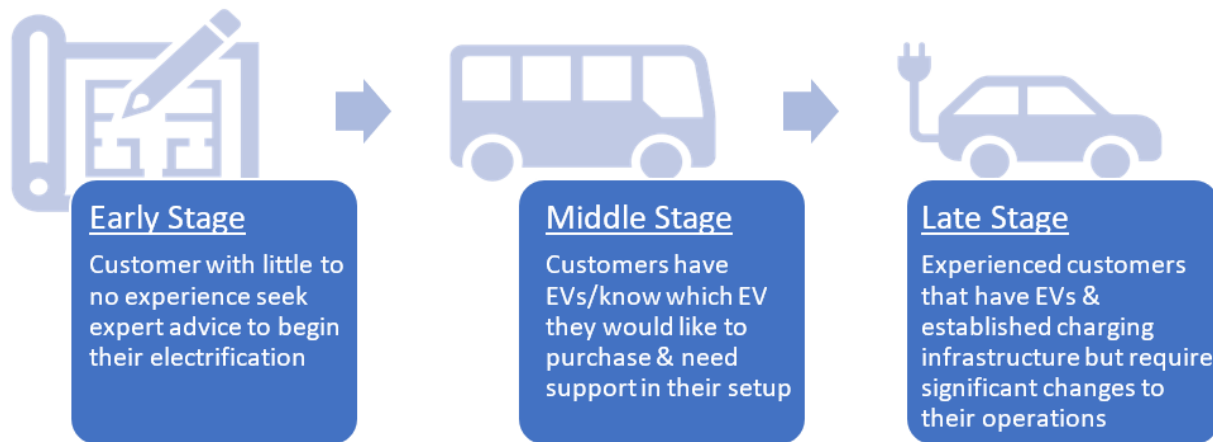
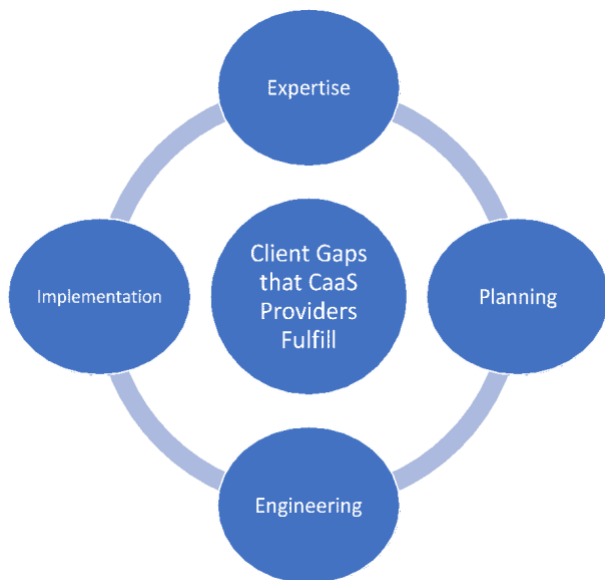


Figure 2. Different Stages When Clients Approach CaaS Providers for Support

Some customers seek CaaS providers to fill knowledge gaps and infrastructure gaps. They include customers unfamiliar with the growing EV charging market and infrastructure requirements and those who have already established EV charging infrastructure but seek expert support designing scalable EV charger infrastructure plans (**Figure 3**). Some customers with EV chargers find they need more support:



[Some] people approach us and want to buy parts of our solution only. And when we would politely refuse, they'll typically go off and try to do it themselves and, more often than not, you know, two years down the road, they'll come back to and say, "wow, it was a lot harder than we thought it was going to be. We thought it was really easy to just buy a charger, you know, bolt it to the ground, add power to it, and run it. We now learned that it is actually quite a bit harder. So now we're interested again in talking to you about your CaaS solution." (CaaS Provider 03)

Figure 3. CaaS Client Gaps that CaaS Providers Fill

We interviewed two clients of EV charging companies, both of whom had EV chargers in California. One interviewee was a municipal customer, and their EV chargers were largely in off-street city parking lots in the downtown core and some neighborhoods but they also had CaaS agreements to establish EV chargers in city-owned garages due to cost considerations.

The other client was a property developer, and their EV chargers were mostly behind the gate for residential buildings and thus closed to the public. While the charging provider they work with offers a CaaS solution, they preferred charger ownership with a contract only for equipment insurance and a cloud plan to obtain charging utilization data. This data helped the developer recover the cost of electricity by setting an appropriate access fee for each station. This customer chose a direct ownership model because they wanted more control over their operations to ensure quality customer service for their residents:

We saw value in owning and controlling our destiny more, and we carefully evaluated different vendors as we were acquiring buildings. We got to see different providers. It was important for us to understand. You know some [chargers] are more resilient than others, and we would rather have the full ownership of them because customer service is very important to us. And so, we would rather kind of control our destiny a little more in terms of maintaining uptime, not be relying on somebody else to do that. So, it's mostly around customer service and resilience. (EV Charging Customer 01)

Equitable Charging

This section describes the types of equitable plans that are available for EV charging infrastructure, which CaaS models support equitable distribution of EV charging infrastructure, and which communities could benefit from equitable EV charging plans.

CaaS Provider Equity-focused Plans

CaaS providers promote equity by providing more affordable services through a CaaS package, establishing programs or targets to increase charging access, and hiring employees through internal diversity, equity, and inclusion initiatives. All California-serving CaaS providers interviewed had clients in disadvantaged communities (DACs). These clients included municipalities, commercial, and fleet customers. A core part of CaaS services is to lower the barrier to entry to EV charging infrastructure. CaaS providers cover the upfront infrastructure costs and work with customers on subscription rates to make the infrastructure agreement affordable and advantageous.

CaaS services can also promote equitable access to EV charging infrastructure. One way that many CaaS providers do this is by making charging rates cheaper than fuel rates:

Well, I think the most important factor is the fact that charging rates are 25 or 30% cheaper than fueling rates That is perhaps the most important contribution to the budget of every single family in the country who happens to drive electric. (CaaS Provider 04)

CaaS providers can make EV charging more accessible to customers through their charging prices. These prices are also a strategic component for EV charging providers, especially CaaS providers, because offering a desirable price to customers also builds their customer base. Another way CaaS providers can extend access to EV charging more equitably is by making their charging stations publicly accessible. To make this possible, CaaS providers can engage in extensive fundraising:

We wanted to make our charging station all publicly accessible... Now, how can we keep putting the money into this and we don't get [it back] until we complete the project? We don't get any rebates or grants until that... Our company has been doing runs after runs of fundraising. So, we need to constantly seek additional funding to cover, ... grants and rebates, and those are very important to us. But also, we need to continue seeking outside investment. (CaaS Provider 06)

CaaS providers that get rebates and grants typically do not receive those funds until later in the project and so they need to pay the capital upfront before reimbursement.

While cost savings alone can promote equity to some extent, a CaaS provider can also reach out to environmental justice (EJ) communities directly with distinct programs:

So, we actually try to build a certain percentage of all of our public charging in EJ communities. And so obviously that can be more than just economically disadvantaged, right? That can also be environmentally disadvantaged and a broader definition of disadvantage. And we establish a goal every year as to how much we want to grow that in proportion to the rest of our public network. (CaaS Provider 03)

Lastly, CaaS providers may promote equity through DEI workforce initiatives, which provide a pathway into the EV charging infrastructure industry:

We have our own initiatives internally ... as part of our own DEI initiatives. It's a great way of motivating and hiring people to work for our company as well, right? Because we have the notion that not only are you doing a job, but [it] is a job worth doing because of the impacts to communities and the impacts to the overall planet. (CaaS Provider 03)

We asked CaaS providers to share their thoughts on how the public and private sectors collaborate to expand charging access equitably. Some mentioned examples of successful programs and provided insights on unrecognized market demands. The Charging and Fueling Infrastructure (CFI) grant program was noted as a successful program for expanding charging infrastructure equitably:

We just did some funding applications from CFI by the Biden Administration. So, we actually partner together, which means the private, us, the business. We would be in charge of all the turnkey solutions. Of course, the installation, and all that, and provide some kind of match fundings and the public sectors, they would be the leading force to build the charging station, having the blueprint and plan out the locations of the chargers. So, working together, I think we're stronger in the way that we have both

the equity side and the forecast of planning side figured out. So, this model is likely to be funded. And when we implement it, then it'll benefit the community. (CaaS Provider 06)

Programs like CFI establish private and public partnerships to deploy EV charging infrastructure. With this organized structure, the shared workload of EV charging infrastructure leans on different organizational strengths and can yield better equity-focused outcomes. Another CaaS provider provided a different insight into equitably expanding charging stations. They challenged a common assumption that there is no demand for EV charging in DACs so most providers are hesitant to install chargers there, stating that there is unrecognized demand for EV charging in DACs:

But actually, even more interestingly is the market demand. So, for instance, when we work with the transportation networking companies, their drivers as you might expect disproportionately live in some of these disadvantaged communities. So, it actually is to our economic advantage to build charging there, regardless of subsidy, because there is actually a significant demand already within that community for fast charging. (CaaS Provider 03)

Electric Utility Equity-focused Plans

Electric utility providers promote equitable distribution and access to EV charging through their incentives, however, some providers consider additional factors to better ensure their success. One electric utility noted that low-cost charging and working with EV charging networks to drop required deposits for each new network they sign up for (i.e., adding \$10 to \$20) are two actions that make charging more accessible for residents in DACs.

Another utility stated that simply offering an incentive program, including those earmarked for low-income communities, may not result in EV charging implementation. They explained the difference between market rate and affordable housing and how cost becomes a significant consideration for incorporating EV chargers into new development. Affordable housing developers may not implement private EV charging because the demand for charging is not there, and the cost to set up charging infrastructure is too high. The property owner cannot raise the rates like market-rate housing does to provide additional amenities. This electric utility has considered providing free charging for a limited term in addition to its new-build incentive:

I would say, for affordable housing, low-income equity customers, it's been tough, and we're looking at other ways to help. One of those ways would be perhaps on the ... rate side, providing free charging for a limited term ... Maybe that lets the building owner skip the charging-as-a-service need if they can just put in a plug and not have to worry about billing anyone for it. Just as an example. So those I mean, those are just ideas we've been bouncing around. But at the end of day... we don't believe that our current incentive, the 20% kicker, we don't think that's enough." (Electric Utility 05)

Making a return on investment for EV charging infrastructure can be challenging in lower-income and affordable housing. To implement EV charging, an affordable housing owner would either have to pay for the upgrade upfront, which would be a very expensive investment not likely to be returned, or they could choose a

CaaS solution. However, if the financing terms are based on a certain number of charging sessions, the CaaS provider's would run a higher risk of losing money if the service were not used as expected. Further, the building owner would have to pay a subscription fee that they may be unable to recover. In a market-rate housing situation, the building owner could charge higher rents for providing EV charging to recoup their costs.

CaaS and EV Charging Infrastructure Locations

Both EV charging customers we interviewed had chargers in DACs but neither had sought DAC-specific funding at the time of interview.

Stakeholder Relationships within the EV Charging Landscape

This section describes how CaaS providers, electric utilities, and EV charging customers interact, and what those experiences tell us about CaaS operates within the EV charging environment.

Electric Utility and EV Charging Industry Interactions and Relationships

Electric utilities interact with CaaS providers as regular customers, either customers using electricity or customers using their EV charging incentive programs. Of the four electric utilities we interviewed, two had a CaaS solution with a vendor, and two did not. We asked the electric utilities to describe their relationships with EV charging companies, if any. The electric utility that did not have a direct relationship with a CaaS provider treated CaaS providers as a regular customer:

We're agnostic to any vendors ... other than just talking to vendors in the course of helping a customer through [their EV charging incentive program]. That that would be about it. There are vendors that reach out to us as a utility, outside the program, just because we provide the power in the city. And so, we have vendors that want to understand how to implement curbside charging—how they would do that through us as the power provider. We have vendors that reach out to us on behalf of sites that they want to put chargers in at. So, they need a service upgrade or something like that. So, they just get in touch with us about that. (Electric Utility 04)

Noticing that CaaS providers are key customers, electric utilities have begun advertising their programs to them to better ensure that the program funds allocated to them are used:

We do have a budget ... as part of our outreach efforts and try to make sure that we evangelize the fact that the program is available. The motivation really falls in being able to provide access to charging that is ultimately going help a lot of the fleets that don't necessarily have the access to, or the wherewithal to actually be able to install the infrastructure at their locations. We see a lot of small fleet operators where they're literally parking behind their properties, maybe parking in the backyard somewhere or potentially leasing out space, so the feasibility of them to be able to deploy public access, infrastructure, or privatize infrastructure is lessened at that point. So, we do see where charging-as-a-service and charging service providers do hold a place in the marketplace. So that is one of the major

functions, and also because they do meet the program requirements. They're able to leverage the [program name] funds in order to complete their initiatives.” (Electric Utility 03)

When the electric utilities were asked if there were challenges or experiences that customers had with installing EV chargers that would make them consider offering a CaaS-like service themselves or develop a relationship with an EV charging station vendor to create a CaaS service, they indicated that they did not intend to pursue this type of offering. They indicated that it is difficult to make a return on investment because they were uncertain about having the client base and it is difficult to recover costs especially in DAC areas:

I just don't know how anybody can make any money, return on it, because it's a loss. I'm not going to recover my costs without it being grant-funded today. Now, you can't charge 20 cents or 40 cents and get your money back fast. You got to charge a lot more. (Electric Utility 01)

Thus far, it hasn't been that compelling for us to pursue.... I don't think we necessarily see the business model there for us. A lot of the charging providers today don't actually seem to turn a profit with their activities. And they're able to do that through, I assume, you know, venture capital funding, or whatever, which we don't. Really, you know, that's not how we operate. (Electric Utility 04)

Additionally, utilities were not interested in working with a CaaS provider because they did not want ongoing maintenance and contract fees with a CaaS provider:

Your question of what our customers are experiencing and whether that's driving any of this. I think we do get a lot of questions from them about how are we supposed to? is this going to be an ongoing fee that I'm responsible for? because I think that turns a lot of people off. I know it does for us. When we're going to buy something, we usually just want to buy it. It can be really hard for the city to contract. And so, as a public agency, and especially us as a public agency that has electricians and people that can maintain electrical equipment, we never want to get stuck with an ongoing maintenance contract. I think our some of our customers—you know, private customers—have had those thoughts as well. (Electric Utility 04)

Electric utilities with the means to maintain their charging stations are less interested in providing or engaging in a CaaS offering. The two electric utilities with a CaaS solution were located in DACs. They have fewer resources, leading them to get support from a CaaS provider. In describing their relationship with the CaaS provider, both utilities pointed out challenges with CaaS services, especially with regard to customer service:

So, we have this great relationship in that group. They would come out and present to us. But the minute they sold to [EV Charging Company] that relationship is null, there is no relationship. They're just customer service. They contracted out overseas. They don't do anything when you call and say something's failed, and they don't give us any updates or follow-up. So, it's just not a good model. And ... we had a great model with [EV Charging Company] before they sold or merged. (Electric Utility 01)

So, I talked about the [service] that we contracted with our EV charger vendor. I've not been shy about it, but it was horrendous. It was a horrible experience and the company we chose, as I mentioned, I would have thought we would have gotten better customer service or more streamlined customer service.... I don't know if it was turnover or just, we would get new people all the time. The turnaround time to get answers is just way too excessive.... It was a nightmare, honestly. (Electric Utility 02)

Customer service for operational and hardware issues is a key need for electric utilities on a CaaS agreement. The EV charging industry is young, and worker turnover, mergers and acquisitions can lead to organizational instability, impacting electric utilities seeking to implement EV charging infrastructure on a CaaS agreement. Both EV charging customers indicated that they have had positive interactions with their EV charging provider. The client that owns their EV charging stations was content with the attention they have from their provider, the insights they learn from their charging management software, and the resiliency of the equipment:

So, we have a dedicated account management team. And we're a large account, so we do have their attention. Never always smooth sailing, but we do have a team that works through those challenges. We have good insight into the use of our network by station, so we like the front-end portal that we have. We found their equipment, for the most part, to be fairly resilient. (EV Charging Customer 01)

The EV charging customer with a CaaS service was satisfied with the partnership with their provider. Similar to the other customer, they were content with the CaaS provider's responsiveness and charging management software:

In general, I found them to be a good partner. We've been working with them for pushing 13 years now and I've found them, in general, to be responsive. Good to work with. I've always been a big fan of their reporting platform and their website that they manage to support everything. So, I like them. Yeah. And they are the only provider that we've worked with directly in the city since 2011. (EV Charging Customer 02)

We asked EV charging customers about their interactions with electric utilities. One EV charging client did not interact much with electric utilities unless they were using a rebate program, in which case they worked closely with electric utilities to install EV chargers and navigate their rebate process. The other EV charging client was a municipal client and had a direct relationship with the municipally owned utility.

CaaS Service Changes in Response to Customer Needs

CaaS services are flexible to meet the demands of EV charging infrastructure and its stakeholders. We asked CaaS providers if they had received feedback from customers and whether it resulted in a change in their services. Many CaaS providers said that they did modify their services.

Customers expressed the need to know whether their charging efforts have had an environmental impact and requested environmental, social, and governance (ESG) tracking. CaaS providers have included ESG tracking in their hardware and software.

CaaS providers can respond and adapt to unforeseen consequences, such as shared electricity bills in multi-unit residential buildings. One CaaS provider also mentioned that they began reimbursing the cost of electricity to their residential customer so that non-EV drivers do not incur EV charging costs:

We were not reimbursing the cost of electricity ... and now we are doing it. And it makes complete sense because, imagine that you live in a community and some of your neighbors, they charge, but then the electric bill is paid and shared by all ... residents within that community, regardless of whether you drive electric or not. So that will be an unfair situation ... because nobody needs to ... subsidize the fueling cost of others. So, the moment we started understanding that and fully reimbursing the cost of electricity [so] only those who drive electric and use the charging stations ... pay for the electricity while they are paying for the sessions is perhaps the most transparent and clear way to offer the solution and to remove the barrier of ... unfair increase in utility cost [being] absorbed by those non-EV drivers. (CaaS Provider 04)

CaaS providers can adjust their models to support the diverse demands of EV owners. A CaaS provider noted that customers approached them with the need to extend the range of their EVs and requested as-needed charging access. The CaaS provider opened their charging depot to meet this demand:

We've recently had some customers that only really want opportunity charging at our site. They have some charging at their own facility, but they know that if they come through our [depot] facility here at [location], that they would be able to extend the range of those vehicles, which, you know, in the first year, we didn't really think about that. And so, we continue to evolve our products against the demands of our customers. (CaaS Provider 07)

CaaS providers strategically support clients when there is a gap between the utility's capabilities and capacity with the customer's wants. CaaS providers support clients through education, good relationships, and charging strategies. Electric utilities' ability to provide additional power to a site can be constrained, and CaaS providers help explain this to their customers:

First of all, the utility has to wait for a long time. One area, they just couldn't bring the power until, they said, two years later. So, we have to work with the utility and explain that to the customer. (CaaS Provider 06)

Similarly, CaaS providers help inform customers about the charging infrastructure process to help set expectations about the actual need and scalability of an EV charging site:

Education mostly. The first time you approach a property, [the customer] typically asks for the faster and more powerful charging solution available in the market, multiplied by the number of vehicles they're expecting to have in the next five years... So, the customers always overestimate the need for charging services. The reality is that you don't need a charger per every car every day. EV drivers, they charge their vehicle maybe twice a week. So, these charging stations could be shared among all

residents or members within a community. So, one charging point is good to ... fully take care of the charging needs of five or six vehicles. So, understanding that is very important. (CaaS Provider 04)

On the other hand, some CaaS providers develop good relationships with electric utilities to meet customer demands. CaaS providers establish relationships with electric utilities so that they can quickly assess electric capacity and inform customers:

So particularly in California, we have very good relationships with all of the IOUs and some of the larger municipal utilities. In many cases, we now have access to the distribution planning capabilities of those utilities. So, we can fairly quickly assess for perspective customers. (CaaS Provider 03)

CaaS providers are careful about the sites they choose for depots, so that they know what they can offer to customers beforehand:

We're pretty strategic about the sites that we choose, so we will work with the utility on the front end to understand the power availability before we make a full commitment to purchasing or leasing that land. But they do have programs in place where they can bring power to your site over some amount of time. And so, we run into situations where ... maybe we want 4 megawatts of the site, and on day one, there's 2 megawatts, and so we'll still go and lock in that property, and then bring power in over time, working directly with the utility to maybe ... land a second transformer and whatever they need to do on their side of the meter in order to get the necessary power to the site. (CaaS Provider 07)

Even if electric capacity is not available, CaaS providers can design a phased-in implementation of EV charging, from Level 2 charging to DC fast charging, as power availability comes online:

We just really have to work with the load balance, and we have to work with the utilities. See if maybe we can do a different phase. So, we do have some customers [who] were promised only like the Level 2s right now. But, ... in the future, we'll do the phase 2 to add DCs because of that reason. (CaaS Provider 06)

CaaS providers also establish charging management strategies to monitor and balance charging demand and electric capacity. For instance, CaaS providers have developed software to shift charging time and vary charging speeds to put less stress on the grid. They can also build up to the desired capacity but run the stations at a lower speed (or power draw) to stay below grid capacity constraints:

We have developed some smart software that can actually operate a site that is at a nameplate higher than the interconnect, but it can then constrain itself to an interconnect level either permanently, or until that interconnect can grow in capacity. (CaaS Provider 03)

Benefits and Challenges in the EV Charging Industry

This section discusses the benefits of using CaaS and the challenges for CaaS providers and electric utilities to implement EV charging in California. There are also challenges to deploying a CaaS service. However, there are also many benefits to using a CaaS business model for developing EV charging infrastructure.

Challenges to Deploying Charging Stations in California

CaaS providers and electric utilities have brought up various challenges in implementing EV charging in California. These challenges may be seen as general challenges for any organization deploying EV charging infrastructure in California and they may also apply across other states in the US, however, interviewees specifically spoke about challenges within California. Costs were a key challenge to EV charging infrastructure deployment. The cost of labor, upgrading old infrastructure, energy, and the need to beat the price of fuel were challenging for CaaS providers. Meanwhile, electric utilities had difficulty upgrading infrastructure in order to place their own EV chargers. In particular, EV charging deployment can be delayed because building codes could significantly increase the cost of adding charging stations:

Oh, there's a lot. So, I mean, specific to [City] being a 100+ something year old. Infrastructure-wise, it is a nightmare. When I want to put EV chargers anywhere in our fire stations or our police stations, the current code requires all the stuff that wasn't there. Everything's fed overhead on transformers that are like poles and wires. Now, the code requires vault underground wiring, and you're looking at an additional close to \$100,000 in costs. So that has been my biggest challenge, just trying to figure out how can I even afford this when, infrastructure-wise, I'm practically redoing their entire electrical for any commercial/industrial, including my own, and nothing's free. So, it's just kind of, my costs have skyrocketed. That's kind of put a dent on my advancement of any [city-owned] fleet infrastructure at this time. (Electric Utility 01)

The other thing that's, I would say, really challenging for us are the local codes, building codes, and fire codes. And this again might be a [location] thing, but the fire codes for EV charging here are very, very challenging, or they can be, ... it increases the ... hazard rating for the building. So, you need to have more sprinklers. And I think it's more than just a little more, it's costly to get to that, or it can be very costly. And for existing buildings, it can be just cost prohibitive, even for a new construction, it can be cost prohibitive. I mean, we have had customers basically say, this, your [rebate] program is great. That's fantastic but we're not going to do it because we're not going to deal with this fire code stuff. So that's a major barrier for us. (Electric Utility 04)

Additionally, costs have increased since COVID-19, requiring electric utilities to re-visit their cost analysis used in their incentive programs.

Electric utilities may also experience challenges with the complexity and time commitment to apply for and receive grants or other incentives that could help reduce their costs:

[Location] also took part in those incentives to help reduce our cost... The grant process that's been put through the State. Challenges all the way around. Not easy. We've never fought so hard for many. And I think, if I was just a customer, would I have spent all that energy to try to recoup that? To recoup those dollars? They make it exhausting. And I've had many of conversations with these organizations that, look, we all have the same intent. You guys are asking for unrealistic documentation and that's a whole other subject. But it's just been so challenging. I think a customer probably wouldn't put this much effort, or will have given up at some point. (Electric Utility 02)

The application process and documentation requirements can burden electric utilities; this can be a barrier to installing EV charging, particularly in areas with low EV utilization. Applying for grants can require extensive coordination and resources. Similarly, funding requirements have been challenging for CaaS providers with established EV chargers. Since the EV charging industry is still in its infancy, technological capability gaps make it challenging for CaaS providers to meet specific funding requirements, even if they are well-intentioned, as in the case of charger reliability.

I think we're still at the beginning of this industry. So, there are still some industry pains. For example, the charger stations are not very stable. The technology is not quite there to communicate with all different parties. For example, if the charger has to communicate with the network, sometimes the manufacturer has issues with the SIM card, it was the network party. So, the communications are not as smooth as we want, although we have a standard that the funding entities always ask to have, like 97% of the uptime. But it's realistically, that's a very high number. There's always a chance that your chargers break down, and then you need to evaluate which part is having the issue. Is that like hardware issues or communication issues? So that still hinders the 97% uptime. (CaaS Provider 06)

Similarly, customers noted challenges applying for and understanding incentive programs. One customer mentions that rebate opportunities can be challenging to navigate with their patchwork nature:

There are different rules and regulations and timing and windows that open and close at different times. Paperwork is different—requirements for submitting paperwork. You know, so we manage it in California, but whether you're in [SCE] or you're PG&E, the rebate programs for the CEC program. They're all got different challenges for us, too. So, we have to go for all of it and then decide some you can stack. So, it just creates a lot of paperwork and navigation at times. (EV Charging Customer 01)

Moreover, the CaaS EV charging customer stated that it is challenging to find the right municipal parking locations that also meet grant requirements while also remaining advantageous for their own operations:

There's been a lot of grants triaged that have ... different or slightly different color, right? They have outlined with the goals of serving specific communities. This one, and slightly different communities than that one, and some of them dictate the type of charger they want you to put in, and some of them don't. So that poses challenges just in terms of what are right, if our facilities are the best location to put charging to serve some of those communities. That's the challenge. Assessing what are right,

because it's not just because they're available. There's space available doesn't necessarily mean it's the best place to put the charging. (EV Charging Customer 02)

Electric utilities may also be challenged by making sure there's electric service available for service upgrades:

But we live on top of [another utility's] transmission distribution infrastructure. So, for our municipal customers, getting service upgrades can be really complicated... But that is a pretty major barrier. So maybe just more broadly, I think, just making sure that there's electrical service available... We've seen some of the projects that our customers want to do... It's a lot of power sometimes that's being requested and that can be challenging for us just on the utility side. (Electric Utility 04)

Power availability is a challenge across California for a variety of reasons, such as infrastructure costs, energy costs, and delays in acquiring critical infrastructure, such as transformers. CaaS providers also found it challenging utilities had slow response times and completing planning studies that would inform CaaS providers on how much power is available. EV charging customers also had plans to expand their EV charging infrastructure but faced challenges in accessing their desired power levels.

CaaS providers have also noted site selection can be tough in California. CaaS providers need to identify sites that will have enough energy for the chargers and enough customers that will use them:

But there's certainly, you know, it's definitely a challenging offering to make to customers from identifying the right places on the utility distribution system that can provide the amount of power. (CaaS Provider 07)

CaaS providers also said they had difficulty working with permitting authorities that need to get up to speed on understanding EV charging sites:

So, the authorities having jurisdiction over permitting these sites are challenged to understand these sites, and even ask the right questions. I think there could definitely, given California is mandated through CARB [California Air Resources Board], I think that they could probably work with the different permitting departments to make it a little bit more streamlined. Make it easier to have one set of permitting expectations by each one of them. (CaaS Provider 07)

A streamlined process could help resolve the delays in permitting due to knowledge gaps in EV charging or different priorities by each authority having jurisdiction over permitting.

Even with all of these challenges, there is a benefit for CaaS providers when operating in California. CaaS providers mentioned that the make-ready and charge-ready programs were advantageous for their operations:

California tends to have a smart program where if we leverage the load to a certain element, obviously the utility can pay back its capital investment, but there are other states where utilities totally won't do that. So, we have to buy the transformer, I have to buy the switchgear, and often we have to pay for the interconnect back to some point of demarcation on the utility. And so that, all of that increases our

costs. But a portion of that could be their capital investment, which they will recover easily because the one thing about our load that we've built is it is only up and to the right. (CaaS Provider 03)

Unique Challenges to CaaS Providers by Offering a CaaS Service

There are risks to CaaS providers by using a CaaS model to deploy EV charging infrastructure. Foremost, providers offer no upfront costs to customers and recover their investment over a contract period. Naturally, providers are selective and prioritize locations with large EV charging demand and have developed analytical tools to understand risk:

When we do CaaS on our own private network that's publicly available, the only way we make money is if people charge. And so there we take the full risk of, will there be sufficient vehicles in operation? Will they come to our charging stations, and will we be able to competitively price our product—energy—so that we can make a return on that investment? And then again, like I said, we have some very sophisticated analytics that help us figure that out. And that allows us to, quite literally, on a station-by-station basis, predict what the return on that investment ought to be. And, of course, if it's unattainable, then we won't build. (CaaS Provider 03)

Yeah, we definitely take on significant risk. We are choosing our locations where we can site power and have sites that can work in where we see the network of these drayage trucks moving where the freight moves the most frequently. But then, you know, we make pretty big commitment to those sites prior to finding the customers that will use those sites. We also monetize subsidies along the way. So, we'll often lead forward before we've gotten a grant, or a subsidy confirmed like Energize or a CEC Grant or an [Air Quality Management District] grant, and depend on those for the economics that will make it attractive to the customer. But they don't always come prior to us being able to sign up the customers. So that's a big risk. (CaaS Provider 07)

Some CaaS providers' contracts include terms to minimize the risk of underutilization harming their payback period through a minimum use requirement:

So, if we've made the full investment, they typically have what's called a take-or-pay type of contract where they have to use that facility to a minimum amount. And that minimum amount is calculated so that we have a reasonable break-even somewhere within the life of that location. (CaaS Provider 03)

Inflation and supply chain delays have also challenged the CaaS model in recent years. CaaS providers say that delays in acquiring critical equipment and obtaining final approvals increases the time between investing upfront capital and obtaining revenue from customers. Although CaaS providers take on these risks, they also benefit from providing a CaaS service. CaaS providers with a network of chargers are able to gain an economic return and grow their business presence:

Yeah, the benefits are we own and operate the chargers... In the future, we can have traffic and we gain some of the sales from the electricity. And we gain the network [foot]print of our network brand. (CaaS Provider 06)

CaaS Customers' Challenges of Working with CaaS Providers

Although the EV charging customers interviewed said they had positive interactions with EV charging providers, collaborating on EV charging projects was challenging. Echoing the utilities, an EV charging customer noted they experienced problems with CaaS providers' organizational instability:

There's been challenges, as with any kind of company in growth mode. There's been a lot of employee turnover. Some of the people we used to be able to know in the organization were senior. We kind of get passed around [now] a bit from person to person. They've been restructuring [or] reorganizing probably every year for the last eight years ... We do try and keep everything [with one CaaS employee] ... So, we don't want just [any] person. We want that one-stop shop, so [the challenges have] mostly been around organizational challenges. (EV Charging Customer 01)

Similarly, an electric utility with a previous CaaS agreement that did not include maintenance services faced burdens due to their CaaS provider's organizational shifts, which included a bankruptcy and merger with another EV charging company. This resulted in lower-quality equipment and services, which increased the electric utility's costs:

The company that I liked, that did all the back-end monitoring for me, sold their company and merged which [EV Charging Company], and I feel like [EV Charging Company], has made it their mission to make every charger fail every day. They are not very helpful and they're very expensive. If I have to call someone else to fix one charger, it's around \$2,000 every unit. (Electric Utility 01)

Challenges Operating in Disadvantaged Communities

CaaS providers and electric utilities explained the challenges of operating within DACs. One POU operating in a DAC said its municipal government lacked the funding to upgrade infrastructure to install EV charging stations. They remarked that their slow transition to EVs and charging stations was due to a lack of upfront capital. While CaaS solutions may assist with offering no upfront costs, not all providers bundle vehicles with charging, which is another expensive upfront purchase for many residents, businesses, and agencies in DACs:

I've worked on [getting EVs] with all my heart and written everything out there, grant-wise, to get funding. And it's like now the cost of everything, it just seems, it almost seems crazy. For example, one vehicle for heavy duty [use is] \$190,000. I mean, for a poor city like us I had to write three grants to get that one vehicle that took over a year to make [happen]. So, I think that's kind of like, just, when you look at disadvantaged communities like, how on earth am I supposed to catch up? And I started in 2014. I actually consider myself pretty advanced compared to most cities because of what I started a long time ago. (Electric Utility 01)

In addition to capital barriers, some fleet owner-operators in DACs are hesitant to transition to battery-electric alternatives because they do not have a place to install EV infrastructure. However, not all interviewees were aware that some CaaS providers have already developed a depot model to meet freight electrification needs in DACs:

If we're looking at medium and heavy-duty charging in particular, a lot of fleets are smaller owner-operators, and in some scenarios, they might not necessarily have the land to actually deploy EV infrastructure. So, if a person's charging at their home, or they're renting a location, they're going to be dependent by a third party CaaS Provider to be able to provide that infrastructure to support their electric vehicles. So right now, the infrastructure piece of it is still a big component, especially in the DAC communities. (Electric Utility 03)

Even with more funding going towards DACs to reduce capital cost barriers, CaaS providers say that there are economic and security risks of investing in DAC EV charging stations. In the past, EV chargers have been vandalized, including having cables cut, which has made it more challenging to maintain these sites:

There is a risk to charging stations in the DAC area a lot of times. It's a security issue. So, we had chargers vandalized and all that. So, we're trying to add more kinds of security-related items, like lights, and try to make sure that those projects are still alive after a couple of years because there is quite a bit of concern on that. If your cable gets cut, if your charger is vandalized. That's not only us, but a lot of people who install in DAC area have experienced a similar situation. (CaaS Provider 06)

Lowering the risk of vandalism, such as by installing lights, adds costs and repairing vandalized equipment delays a return on investment:

What I've learned is vandalism is one of those things that I didn't plan for, necessarily. I think people thought there was some type of value to the wires in these charges, or maybe the credit card swipe had money inside of it. So, I didn't anticipate all of the damage—and one cord... cost me at like \$1,900 to replace just the cord. Then I have to pay the company to come out, which is another \$2,000, just to fix. (Electric Utility 01)

However, many challenges, like vandalism, are not specific to DACs. CaaS providers said they observed similar challenges no matter the location:

Nothing different [by location in] the challenges kind of I brought up before about jurisdictions, permitting, needing streamlining, better understanding. And that's not DAC specific, so no, nothing that's a specific challenge to a DAC. It's just all the more difficult things about the development. (CaaS Provider 07)

General Challenges in the EV Charging Industry

In interviews, CaaS providers and electric utilities mentioned challenges in the EV charging infrastructure landscape. A provider who primarily works with medium- and heavy-duty truck customers said that the cost of electric trucks is a major challenge to freight electrification:

The truck asset is really expensive. It's a \$400,000 to \$450,000 investment, and that's before sales tax and Federal Excise Tax (FET). As a matter of fact, I would say that that's a place where the State and the Feds could really help. 12% FET on top of a \$450,000 truck quickly pushes it into over a half a million dollars. Sales tax as well, adding, 10 point something depending on where, what county, you're located in. So, the expense of the vehicle is a tremendous challenge. (CaaS Provider 07)

Electric utilities and CaaS providers said they can face challenges when projects require landowner permission. In particular, utility make-ready programs require utility easement and program participation agreements with landowners:

[CaaS providers] have to have landlord buy in, in order for us to be able to construct on their locations. And these are elements that we do ask for upfront. So, for example, if I'm talking to a CaaS provider that is leasing and they're looking at leveraging [program name] as a program, there is a 10-year program participation agreement that they do have to abide by. The ticker starts as of date of energization, which takes anywhere between a year and a half to 2 years on average. So, at that time, like you almost have to give yourself a 12-year runway, and then the landlord has to be okay with the easements and agreed to them with no red lines as well as a program participation agreement. So sometimes that is a hindrance depending on the scenario. (Electric Utilities 03)

Another challenge observed in the interviews was maintaining reliable charging equipment, which is a growing concern in the industry (Rempel et al. 2024). A small POU stated that they did not have the resources or technical workforce to maintain their EV chargers:

[You] can't wait for someone to drive all the way up from Los Angeles or Burbank or Anaheim, because just for traffic, they're charging me \$200 just to get out there.... [I'm] having to carry my toolbox with me to work and ... when they fail [try to] troubleshoot it myself... And I'm trying, and I'm not electrician. I'm a sustainability person trying to figure this out. (Electric Utility 01)

I have some charges I actually haven't been able to fix yet. And so, I'm working on doing that right now, slowly, but it's expensive. (Electric Utility 01)

Benefits of the CaaS Business Model

There are a range of benefits to using a CaaS solution to deploy EV charging infrastructure. Foremost, the CaaS solution shares risks between the provider and the customer, helping to offload concerns about charger reliability by tying return on investment to well-maintained equipment:

A lot of the way that cities and states generally fund their infrastructure projects is with debt and bonds, and quite frankly, the bonds and those banks they don't care about the stuff. They just care about a payment. And so, we kind of looked at the reason why infrastructure was failing across the board and so something's got to be changed so we got to do something different. And we got to care about infrastructure and the money that goes into our infrastructure is going to care about the long-term care of it ... We're going to make sure it's maintained over the long haul and supported. (CaaS Provider 02)

The result of this incentive structure is a well-informed and educated EV charging provider that uses its knowledge on past projects to quickly diagnose issues and prevent similar problems from occurring in future projects. In some cases, CaaS providers have fostered relationships with EVSE hardware original equipment manufacturers (OEMs) to identify issues and stockpile replacement parts:

If you just build it and walk away, I think people don't understand how complex these operations truly are to keep things operating efficiently, and so I think it would leave, it would slow down the adoption of electric vehicles, because people will be having a bad experience. They won't understand why a charger isn't [working]. So, you really need people that are good at this type of technology in order to ensure that these assets operate correctly ... The technology is changing all the time as well; we've had good and bad experiences with some chargers. So, to the point where we've ripped out chargers that we weren't happy with and replaced it with different chargers that we're more happy with, or we have better support from the company in terms of maintenance and operations, or parts availability when you have an issue and so having that deep relationship with the EVSE OEMs, as well as the EV OEMs, where we can have this two-way communication of, you know, this is an issue, or this seems to be a part that has lots of failures. You guys should be stocking that in your local warehouse so we don't have to wait for it to come. (CaaS Provider 07)

Interviews uncovered additional benefits that were not known in the grey literature review. For strategically important sites, some CaaS providers have introduced profit sharing arrangements as an additional incentive for site hosts:

We always are adjusting our model little by little ... Now we actually sometimes do profit share with the site host. In some cases, key strategy point place site hosts, we would offer some good profit share with them. (CaaS Provider 06)

Policies and Programming

This section discusses the three stakeholders' perspective of policies, programs, and funding mechanisms that positively or negatively influence their operations. Many CaaS providers and utilities pursue funding opportunities to acquire and install EVs and charging equipment. While the interviews were not designed to investigate specific programs, many interviewees reflected on strong experiences they could recall.

These policies and programs include the federal 30C tax credit for EV charging, Americans with Disabilities Act (ADA) requirements for charging stations, the National Electric Vehicle Infrastructure (NEVI) program, Low Carbon Fuel Standard (LCFS), California air district programs, Clean Vehicle Rebate Program (CVRP), CALeVIP, the California Type Evaluation Program (CTEP) certification, Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), Innovative Small E-Fleet (ISEF) program, Advance Clean Fleet, AB 579, EnergiIZE Commercial Vehicles project, and various municipal ordinances, electric utility programs, and standards.

CaaS Providers' Reflections on Policies and Programs

Providers were supportive of more stringent EV sales targets and vehicle purchase subsidies that have supported their industry. However, grants that fund the deployment or maintenance of EV chargers were conditionally supported. CaaS providers use grant funding to help defray the upfront cost they do not immediately recover as part of their contract with the customer. This business model is challenged when requirements prevent the provider from stacking funding, which may lead CaaS providers to withhold the CaaS solution to prospective customers. Further, some request for proposals (RFPs) asking for a CaaS solution do not understand the longer-than-average payback period of CaaS projects and may be suppressing the number of applications submitted to grant programs:

They need to understand that if they are expecting any vendor to upfront the capital, they need to allow enough time for that vendor to make the money back. So, some of these RFPs have an unreasonably short term. It's like, oh, you, the vendor is expected to pay for everything, but the term is only three years. Well, guess what?, three years is not even close to the amount of time it takes to get your money back on this. So, you know, if they will be more reasonable and allow terms, let's say, 10 to 15 years, then that is a very interesting proposal and they will get tons of responses. But the term is a critical factor that needs to be clearly understood. (CaaS Provider 04)

I will tell you that some of the subsidy programs, from our perspective, are so onerous as to make the benefit almost negligible. Meaning that the constraints... either the requirements of what we have to do to obtain it or the duration it takes to actually get the money back, can sometimes be so difficult that it's not worth our while to actually even get the subsidy. We're simply better off investing the money ourselves because it doesn't end up helping us in terms of actual ROI. (CaaS Provider 03)

Some programs, particularly from utilities, only award funding to projects using pre-approved equipment that is designed to benefit current or future utility operations. This requirement adds additional time when equipment lists are not standardized:

So, we can only select the charging station that has those standards, and also, each utility companies have their own standard ... We can't just go to with the charging station we want, or the charging station that's most cost-effective. We have to choose the one that passes all the standards. (CaaS Provider 06)

Providers also mention that certain subsidy and regulatory requirements are practically if not technically infeasible. The first example provided is uptime for both the hardware and software elements. Although providers agree reliability is important for customers, they urge regulators to look closely at current industry capabilities when establishing requirements. Sometimes increasingly more stringent requirements can move faster than what has been developed, which limits EV charging projects pursued by CaaS providers:

So, there's a requirement on the hardware and also the [software]. I kind of mentioned about the 97% uptime. That's one of the policies that definitely affects us because we have to catch up with that standard... I think we're still at the beginning of this industry. So, there is still some industry pains... The funding entities always ask to have like 97% of uptime, but it's realistically, that's a very high number... I do think, we need to really consider the technology development. So, are the manufacturers actually up to the point today as the policy required? What can, you know, the manufacturer improve? Can the policy wait for manufacturer? Wait for the technology to achieve it before actually the policies come out? (CaaS Provider 06)

The second example is about regulations that may have expensive compliance costs. The California Department of Food and Agriculture's (CDFA) Division of Measurement Standards (DMS) developed Weights and Measures requirements for commercial charging stations that defined accuracy down to one-tenth of a watt-hour, a fraction of the power drawn from a 60-watt incandescent light bulb. While accurate measurements benefit consumers by fairly charging EV drivers for the electricity delivered, CaaS providers have had to rebuild their hardware and software to meet that level of accuracy. While not a California example, Washington state required CaaS providers to put stickers on all grandfathered, non-compliant equipment already distributed across the state instead of a sticker on new equipment leaving a factory.

In other instances, subsidy requirements that have align with other policy goals, like energy efficiency, do not provide exemptions or reasonable accommodations. As a result, providers receiving subsidies might end up delivering a worse charging experience for customers:

Energy Star then began to enter into public charging in an extremely nonsensical way. And there are public subsidy programs, I believe, CALeVIP 2.0 being one of them, that requires adherence to Energy Star. The requirements are so onerous that, for instance, we can't put lighting at our chargers that we can turn on at night to make them safe for drivers because that violates the requirement of efficiency of that station. And so, you're kind of faced with you have a terrible customer experience because you'll have people that won't come to the station based on where it might be located after dark because they simply do not feel safe to be there. Or we don't take the subsidy and putting lighting and build the right customer experience. And so sometimes the things are looked at as the right direction, but they can have significantly unintended consequences such as that. (CaaS Provider 03)

At the municipal level, building ordinances and electrification plans may spell out the type and number of EV-capable or -ready parking stalls required for new construction. EV-capable means that a parking space has the power capacity to support a future EV charging station, while EV-ready means that the space also has the

wiring and outlet to support the installation of EVSE. CaaS providers supported EV-capable building ordinances, since it requires sufficient electrical capacity for a set number of parking spaces. However, providers did not support EV-installed ordinances that asked new construction to install EVSE for a minimum number of spaces, especially if the regulation would oversupply for the site's demand². They explain that, like other types of technical equipment, it is not advantageous to invest in a large amount of equipment that may not be fully utilized and become obsolete:

But deploying like 50 chargers in one location on day one, it is a waste of resources. It will be comparable to purchasing today, a pile of 50 laptop computers for the employees that you are planning to hire 5 years from now. So, in 5 years when you hire that new employee, guess what? That laptop is already old. And has been collecting dust in the corner, nobody is using that. And then you get a new employee with an old laptop, right? You don't need that to happen. (CaaS Provider 04)

One CaaS provider offered a counterintuitive critique of California's HVIP subsidy structure. They argued that by making the largest subsidies available to small truckers while requiring large fleets to purchase 30 unsubsidized trucks before accessing incentives, the policy may have inadvertently slowed EV adoption:

It might sound a little bit counterintuitive, but we should have made those largest subsidies available to the largest trucking companies, and they'd be now two or three years into those first generations trucks and that OEMs would have had to have made thousands and thousands of trucks instead of a couple of 100 each. And now that second sale market would become available to your smaller trucker, and I think it really would have increased adoption... In an effort to make it more equitable, I think they really slowed down the adoption. (CaaS Provider 07)

They pointed out that traditionally, major carriers like J.B. Hunt and Schneider purchase new trucks and sell them to smaller operators after several years of depreciation. By supporting large-scale purchases from major fleets, the policy could have accelerated manufacturing scale, improved technology through extensive fleet testing, and created a robust used EV truck market accessible to smaller operators.

The same CaaS provider highlighted an unintended consequence of California's Advanced Clean Fleets rule that was slated to ban fossil fuel-powered drayage trucks from obtaining new registrations to serve the state's ports³. Rather than accelerating the transition to zero-emission vehicles, the January 1, 2024, deadline prompted a surge in diesel truck registrations. Under the rule, these newly registered diesel trucks can continue operating until they reach either 18 years of age or 800,000 miles traveled, with high-mileage trucks (over 800,000 miles) limited to 13 years of operation. As the provider noted, while CARB's intentions were

² CaaS providers similarly noted that customers may request more EV chargers than necessary to satisfy demand. They educate customers on charger utilization and encourage a wait-and-see approach to adding additional EVSE. Still, providers will work with customers to ensure scalable solutions, such as having more EV-capable work upfront.

³ As of January 15, 2025, CARB has withdrawn its request for a waiver from the US Environmental Protection Agency to enforce its Advanced Clean Fleets regulation.

positive, the policy "actually increased the amount of combustion engine vehicles that we had in our marketplace" (CaaS Provider 07).

Electric Utilities' Reflections on Policies and Programs

Electric utilities described policies and programs that are needed to support EV charging. Two electric utilities emphasized that insufficient electrical infrastructure in existing buildings could become a major bottleneck for the state's decarbonization goals. As one utility explained, "without getting our infrastructure updated, it's the chicken before the egg" (Electric Utility 01). Another utility highlighted the compounding challenge of building electrification:

I think the concern there is getting the service upgrades that that we think will be required. And when you also consider a lot of these buildings are planning to transition to be off of natural gas, there's just not enough power. Just big picture ... That's a statewide problem. (Electric Utility 04)

The high cost of EV charging in California presents a significant barrier, particularly for low-income customers⁴. One utility representative explained that charging costs are driven by both high electricity rates and operational expenses:

Charging your car in California is really expensive because we have really high rates... not only is there the electric rate you have to pass along but also any sort of fees related to operating and maintaining the equipment, or in some cases paying for the equipment ... I think the cost of charging is too expensive, especially for low-income customers. I think we need to find a way to make it cheaper for them. (Electric Utility 04)

Utilities described significant challenges in the EV charging implementation process they have encountered from adding chargers, even with their expertise, which suggests challenges that inexperienced customers may face without the assistance of a dedicated CaaS provider. One utility provider offered a detailed perspective on the customer experience:

If I want to put [a charger] at my business, what challenges am I going to have? ...The incentive process. The grant process that's been put through the State. Challenges all the way around. Not easy. We've never fought so hard for [grants]. And I think, if I was just a customer, would I have spent all that energy to try to recoup that? To recoup those dollars? They make it exhausting ... [The programs] are asking for unrealistic documentation ... I think a customer probably wouldn't put this much effort, or will have given up at some point. So, grants been hard, permitting had been hard. Just knowing the cost by the time you add it all up, right? ... I wish there was a handbook for customers to understand how to actually make a streamline approach on how to install an EV charger... Because if it's challenging for [a]

⁴ Although low-income customers may qualify for discounts on their electric bill through the California Alternate Rates for Energy (CARE)/Family Electric Rate Assistance (FERA) Program, eligible customers who may not have home charging access would not receive a similar discount when charging at a public CaaS charging station.

utility to do so, as us owning and operating the actual charger, I can't imagine what it's going to feel like from customer experience, right? (Electric Utility 02)

A utility highlighted the need for the California Public Utilities Commission (CPUC) to streamline permitting processes and licensing agreements:

As a public utility that's regulated by the CPUC, we have to get permission to do everything. For example, a line extension, or upgrades to a substation or a transmission system, those all take several years to complete, and a lot of it has to do with permitting processes. Getting buy in from the areas having jurisdiction and streamlining the process will help us achieve our greater mission, which is a high-electrification future. (Electric Utility 03)

This challenge is particularly significant because EV charging infrastructure deployment operates on a different timeline than traditional grid upgrades. Many EV charging stations require licensing agreements between property owners and EV charger operators, such as CaaS providers. Since EV charging infrastructure is expensive to put in and take out, a specific licensing agreement needs to be established between landowners and operators. Without a streamlined approach, resources are put into developing an agreement on what to do with expensive electrical infrastructure at the end of a property lease term.

Municipal electrification plans significantly influence EV charging implementation and can influence private actors to install chargers in those communities. One utility explained that it is easier to deploy charging infrastructure when municipalities have a clear plan for EV charging in their city and they notice significant differences among municipalities within their irrigation district. Another utility emphasized how local EV readiness ordinances helps shape their incentive programs:

We wouldn't be here today without [it], or the [incentive] program would look different without it. So, we definitely meant to have our program work together with the local code. I think that's probably unique ... You can really kind of shape how your program is meant to step in and help. I think that's worked well for us. (Electric Utility 04)

Electric utilities identified a critical need for local EV charging maintenance expertise. One small publicly owned utility was frustrated with a lack of local electricians in their service area who could repair utility-owned charging stations. They described a vision for addressing this gap by creating a state-certified curriculum at community colleges for EV charger maintenance:

What I wanted to do was create a certificate program at a local college here because I need people that can come here locally and fix my EV chargers when they fail. I can't wait for someone to drive all the way up from LA or Burbank or Anaheim, because just for traffic, they're charging me \$200 just to get out there. [What] if we could build a workforce of college students with certifications that don't need a four-year degree? Then, I could have access and develop a program where they can intern with me and kind of learn the ins and outs of the different chargers... Pasadena went one step forward and has the curriculum. They're taking it to get adopted up at the state as a class certification that you would get in

addition to becoming an electrician. I want to duplicate that same curriculum here at our [Community Colleges]. (Electric Utility 01)

Utilities said programs like the statewide LCFS and South Coast Air Quality Management District (SCAQMD) grants have been crucial for implementing EV charging in DACs. One utility established its own EV charging rebate program using LCFS credits and installed curbside chargers through air quality district grants, while another was allocating LCFS credit revenues towards EV rebate applications benefitting DACs:

I applied for grants because we are a disadvantage[d] community, and I saw a need that I couldn't afford to fulfill which was installing EV chargers in multifamily. We are a 50% renter population here in [City], DAC, over 99%. ... I was able to put in the curbside EV charging with grant funds ... fully paid for, and then I would add a few [chargers] down the road when I had LCFS credits. (Electric Utility 01)

Part of the requirements on the LCFS is that we spend a certain percentage of our dollars in DACs ... As our rebate applications are coming in, we're confirming if they are actually in a DAC ... We want to be able to target those specific areas and customers. (Electric Utility 02)

EV Customer Reflections on Policies and Programs

EV charging customers identified several areas needing improvement in infrastructure deployment. One customer experienced an 18-month delay with LADWP in processing a rebate application for four sites in downtown Los Angeles, highlighting how delays in rebate programs can impact service delivery to residents. They emphasized the need for streamlined processes, from permitting to rebate applications. They said a lack of communication around the program, specifically the period of time spent waiting should be improved.

Another customer described challenges with infrastructure costs and utility prices. Without access to CPUC's Rule 29, which enables utilities to cover service extension costs for EV charging stations, certain customers are stuck with an unexpected bill:

And, for example, a project we were looking at to try to do.... [The utility] came back recently and estimated the full cost of getting all the power there at 20 million dollars. (EV Charging Customer 02)

We would just need some high-level political sport to try to figure out our kind of upfront cost challenge because of the specific natures of [location]. Having to deal with PG&E and no rule 29, making the projects pencil better. The support we could, I've said to people, not only can we get all the way to the mayor. It's like, hey, can we call [our representative's] office? Call him, call the Governor... I mean, if we really need some political support, if it's worth it. If you really want to expand, maybe we should be trying to get this on the radar of people who could actually get some of these massive agencies to potentially make a policy change that would help these projects pencil out better in [location]. (EV Charging Customer 02)

The customer emphasized the need for high-level political support to address these cost challenges, suggesting engagement with elected officials to facilitate policy changes that would improve project economics.

Multi-Sector Collaboration to Expand EV Charging

CaaS providers were asked to offer perspectives on how to public and private stakeholders can collaborate and how to optimize limited public funding to expand EVs and EV charging infrastructure. One CaaS provider advocated for broader thinking beyond traditional plug-in solutions: “We have to think of utilizing current infrastructure as-is as a charging asset” (CaaS Provider 01). They emphasized that wireless charging could be more efficient than conventional approaches and urged public grant programs to be more open to alternative technologies.

Another provider stressed the importance of using EV purchase incentives (e.g., CVRP, HVIP, and ISEF) to target the most polluting vehicles, particularly in the heavy-duty sector:

At the end of the day, what we're really trying to do is not just deploy as many vehicles as we can, but truly clean the air, [so we should] concentrate on the worst polluting vehicles ... To take a Prius off the road to replace it by an EV is just a pebble in the pond, whereas taking a heavy-duty truck off the road and replacing it with the EV will make a much greater impact on our air ... Pushing more money in that direction to getting the oldest, most polluting vehicles off the road is probably the best thing. (CaaS Provider 07)

Government leadership emerged as a key theme. One CaaS provider emphasized the potential for public agencies to lead by example. Government-led projects might be easier since governments own the land, are permitting themselves, and can guarantee some utilization because they have consistent vehicle duty cycles. Another recommended municipalities open their parking facilities for public charging, noting particular benefits for DACs and low-income communities:

I think you do it with fleet and government ... Show we can do this; all the government vehicles are electric. You know, we established that it works. And you kind of have to prove to communities that this is something that's viable and you expand out from there. (CaaS Provider 03)

That will kind of build the first step for the community to adopt the EV. We did this with a county in the north [of California]. We duplicated the same model to a second county.... And a lot of these locations are in DAC and low-income communities, which hugely increased the possibility for the people to drive an EV and also increased even the Uber/Lyft. The kind of driver activities in the area which creates the job opportunities there, which is really good. (CaaS Provider 06)

Providers also suggested innovative approaches to collaboration that are private-private partnerships that benefit the public. One said they see an opportunity for joint planning among providers to help fill charging location gaps for different fleets:

I could be working with [company name] and [company name] in order to help accommodate mutual customers who might need an opportunity charge from one of us, but their overnight dwell charges are being provided by one of my competitors. I think that the same thing could be done with some of the public charging that's available as well. Maybe this charging depot would really help someone adopt an

EV that a public agency is putting to market because my network happens to complement the routes that a transit bus might need or a school bus. For instance, I have a site in [location] and it's a little bit of a challenge for drayage because there's not a lot of warehouses right nearby. (CaaS Provider 07)

A possible deterrent to EV charging installation identified across interviews was rebate program complexity. A provider mentioned that their contacts in the EV charging industry are avoiding certain programs like NEVI with strict requirements. While this may reduce the competitiveness of applications, the provider said companies might "just go ahead and put up the money themselves" to build the charging station (EV Charging Provider 05). Program managers have the difficult task of developing a counterfactual—would a provider build the charging station if no public funding was provided?

Finally, utility rate structures were highlighted as an area for improvement. One provider suggested creating special rate categories for EV charging to address demand charges, which are part of commercial customers' electric bills in an attempt to cover the costs of operating an electric grid at a higher peak demand. If exposed to high demand charges, providers will have to pass on higher costs to EV drivers, possibly impacting EV adoption:

If utilities kind of understand that when it is in cases of EV charging, they have a preferred [rate] or they can cap all of these demand chargers to a point that will make the charging business viable without the need of subsidies ... that will be a game changer. (CaaS Provider 04)

Lessons Learned and Future Outlook

Interviews closed by asking stakeholders to share lessons learned to other CaaS providers, electric utility providers, EV charging customers, or California policymakers.

Lessons Learned

Reliability and maintenance emerged as the most critical concerns among CaaS providers and a foremost lesson they learned or would like to share with other stakeholders. One provider's quote effectively captures this industry-wide challenge:

I think there's a higher emphasis on maintenance now, because that has been one of the major complaints... I think the communities and the users are just so fed up of driving up to a charger and it's broken, like the cables broken, or it's down because maybe the cell connection got lost and so they can no longer take payments ... So, I think there's going to be a higher emphasis on maintenance of the charging stations. (CaaS Provider 02)

Building on this reliability concern, CaaS providers emphasize that successful infrastructure deployment requires more than just installing chargers—it demands functional, reliable, and well-maintained systems. This includes having sufficient resources for repairs and enough technicians in the field to service chargers

promptly. Through their experience in the field, CaaS providers have learned they will need to invest in a workforce who can maintain their equipment:

Make sure your chargers are always working [is essential]. Operations, maintenance, and replacement, and taking care of your charger are perhaps the most important factors. I believe that we all have seen dozens of headlines of people complaining about unreliable chargers or needing to charge, and as soon as they get to a particular location, the charger doesn't work, and the app didn't say that. So, that person now has a dilemma ... So, it is important that every charger needs to work. And you need to have in your company, in your system, in your business model, enough resources to take care of maintenance and repair the chargers within your network. (CaaS Provider 04)

One sector I'm really looking into is the operating and maintenance service because now we have installed a good number of charging stations, especially in California. And now, these charging stations have started seeing problems. So, the whole operation and maintenance service has not yet been developed well. I mean, there are companies starting to do this and starting to put boots on the ground. But I think one of the reasons that we couldn't achieve the 97% of uptime is because we're lacking that kind of service ... If we don't catch up on this issue then there will be a collapse in the industry. (CaaS Provider 06)

The challenges of maintaining EV charging infrastructure extend beyond operations. Electric utilities who have installed chargers have also experienced their fair share of low-quality hardware and software components. Although utilities experimented with different configurations, such as retractable cords, they found this new functionality increased failure points, and early models were costly mistakes.

Beyond equipment challenges, financial monitoring and resource allocation have emerged as crucial factors for success. CaaS providers stress the importance of careful operations monitoring to identify capability gaps and proactive growth opportunities in a competitive industry. This extends to funding management, particularly for companies offering CaaS models where cash flow needs rapidly expand with business growth. Some public funding announcements are first come, first serve and CaaS providers must monitor opportunities to apply before all funds are allocated.

Further, EV charging providers said customers need to understand that receiving supplemental subsidies may come with extensive long-term commitments. These commitments require additional hurdles when the EV charging customer is not the property owner:

Everybody loves to talk about this free money that's out there, but nothing is free ... if you want to utilize this funding, these are the things that you need to provide. For example, [the utility] will pay for the [front-of-meter] infrastructure and then you have to have commitment to do reporting and have the [charger] connected for ten years. Are you okay to comply with that? (EV Charging Provider 05)

Similarly, electric utilities have learned that transparent communication and early engagement with customers and their EV charging providers can prevent many common problems, such as insufficient capacity issues or

complications from change orders. The latter is a formal request by the customer to modify the original project scope, design, or electrical infrastructure access requirements after the project is planned or initiated. New changes, from upgrading charging speed to adding localized solar or battery storage systems, require new engineering analysis, permits, and delays if the revisions require higher-capacity transformers:

Making sure that customers know the utility infrastructure installation process is vital. That process of education, or lack thereof, could be detrimental to a project. So, any sort of change orders or not engaging with us early enough, is also another situation where we see where customers sometimes are not successful on their deployments. (Electric Utility 03)

Understanding the permitting [process] ... the timelines that go into [projects]. Some of them took up to eight months to install, [but] everyone thinks that you can just throw one in the ground tomorrow. (Electric Utility 02)

Making sure that the customer gives themselves enough time because a lot of these infrastructure projects could take a long time to build out depending on the scenario. Every single project is a major construction endeavor. It's one of the things that we stress upfront. (Electric Utility 03)

Utilities also highlight the importance of early engagement. For fleet electrification, utilities stress earlier-than-usual engagement since this information allows utilities to integrate customer plans into their short-term grid planning process, ensuring they can meet future charging demands. Utilities are increasingly proactive in reaching out to fleet operators, emphasizing a “help us help you” approach to improve grid readiness and support fleet electrification efforts (Electric Utility 03).

Building relationships with key stakeholders, such as local building code authorities, is another recommended lesson. Electric utilities have fostered relationships to stay informed about regulatory changes and adapt their EV charging incentive programs accordingly. Aligning programs with updated codes help utilities meet customers where they are, reduce code compliance challenges, and increase EV charging access.

Future Outlook

CaaS providers expressed optimism about the future of the EV charging industry, anticipating continued growth driven by increasing EV adoption, expanding charging infrastructure, and evolving business models. Even with occasionally slower-than-expected growth in EV adoption, EV purchase prices will continue to decline and soon will be comparable to gasoline-powered vehicles:

Once [EVs] are actually cheaper [to purchase] than their comparable gasoline vehicles, then there's no way to stop it... [EVs] are much more reliable, easier to operate, and cheaper to maintain... The future is bright in the industry. (CaaS Provider 04)

Competition among providers was also viewed positively, as it spurs infrastructure growth and benefits all stakeholders:

When we build stations with more stalls, our utilization goes up. If competitors build a station near to it, our utilization goes up. And this all basically supports the underlying notion that there's an insufficiency [in infrastructure]. The more that there is, the more surety customers have ... and the more usage seems to increase for all the parties. (CaaS Provider 03)

Providers also predicted that new ownership and operational models would emerge, with large companies potentially entering the market to build their own charging networks, whether for internal use or as direct competitors. This competition is seen as critical for addressing unmet demand, reassuring customers, and fostering market growth.

Conclusions

There are various ways that the CaaS business model might benefit the expansion and access to EV charging infrastructure:

1. CaaS providers seek long-term relationships which also increases the longevity of EV charging

infrastructure: CaaS providers make investment decisions based on expected utilization, location, and longevity. Long-term relationships are essential to CaaS providers because they need time to make a return on their investments given the nature of returns on EV charging (i.e., the cost of electricity and the amenity value of EV chargers on properties). As a result, CaaS providers have many incentives to maintain EV charging infrastructure such as their own economic benefit and environmental benefits. This also benefits EV charging customers and EV drivers because they are more likely to have reliable EV chargers.

2. CaaS providers are dedicated experts that can manage EV charging infrastructure projects and fulfill

knowledge gaps of EV charging customers: Individuals and organizations quickly learn through experience that EV charging infrastructure is most successful with a dedicated team to manage the EV charging projects. Not all those that are interested in deploying EV charging can dedicate themselves or resources to undertaking EV charging infrastructure projects. Moreover, those that take on the responsibility of EV charging infrastructure must be knowledgeable about EV charging infrastructure timelines, components, and subsidy requirements. CaaS providers can and do play a role in filling knowledge gaps in these areas and can play the role of an intermediary between customers and electric utilities.

3. CaaS solutions are flexible and well-positioned to scale EV charging infrastructure: CaaS providers have stated that their solutions are flexible to meet the needs of their clients and the realities of the field. With power capacity limitations, CaaS providers often cannot immediately meet the demands of their customers. However, they have developed their technology and their relationships with electric utilities to plan for and scale EV charging infrastructure when power capacity becomes available.

However, the CaaS model may only fulfill the needs of some customers due to a combination of factors. One, the bundled subscription model may include benefits that are not needed, like maintenance of hardware and software, which one public entity that owns and operates garages said their agency could do in-house. Second, CaaS companies are not immune to organizational instability, which is often found in nascent markets with high rates of mergers and acquisitions as well as bankruptcies. Customers may wish to avoid being locked into paying for services from a provider that can only sometimes deliver. Third, some CaaS contract terms include minimum use requirements (i.e., take-or-pay) that may pose a risk to customers with low EV charging demand, while other CaaS terms are on a month-to-month basis. Finally, the CaaS model invites another entity onto the land, often in a leasing agreement, and this can create new challenges when applying for external funding, like electric utility rebates that require minimum ten-year landlord lease agreements.

While the CaaS model may offer several benefits to customers, providers and utilities noted that CaaS experiences the same challenges of the broader EV charging industry. The interviews uncovered evidence of supply chain delays impacting the timely installation of transformers, insufficient electrical capacity at certain properties, inconsistent permitting processes and subsidy program requirements, and the need for a skilled maintenance workforce to maintain uptime.

Policy Recommendations

The interviews we conducted provided insights on CaaS operations as well as EV charging deployment in the field. Throughout this study, stakeholders offered extensive thoughts on policy recommendations in a myriad of areas. This study proposes three central policy recommendations for government authorities involved in encouraging EV charging infrastructure through planning, policies, and programs. These recommendations would support CaaS operations but also greater EV charging deployment.

1. Encourage electrician and EV charger maintenance-related workforce development: CaaS providers, electric utilities, and customers of EV charging providers experienced challenges with maintenance. CaaS providers recognize the gap in their maintenance capabilities and are dedicating significant resources towards building their workforce to maintain EV chargers. Electric utilities also had difficulty with their own ability to maintain their chargers or they had challenges with CaaS providers maintaining their chargers in their CaaS agreements. EV charging customers and electric utilities had difficult experiences with CaaS providers and EV charging providers that were unstable (i.e., employee turnover, bankruptcy and merging). Ongoing maintenance of publicly supported chargers could help stabilize EV charging operations and reduce concerns among new car buyers. As one utility noted, a local community college has developed courses to train students on EV charger installation, operations, and maintenance. These classes could be adopted by other community colleges around the state.

2. Streamline existing and develop new subsidy programs that are EV charging infrastructure informed: Across the board, stakeholders had challenges with existing incentive opportunities and requirements imposed on EV charging infrastructure. Challenges ranged from contract terms that would hinder returns on investment to long and complicated application processes and program requirements. Stakeholders had to dedicate significant resources to incentives and this is a barrier to those that cannot dedicate their resources towards subsidy efforts. In other cases, subsidy program requirements can be too disadvantageous, strenuous, or both, that companies opt to self-fund their EV charging projects. In other situations, incentive program exclusion criteria delayed fleet electrification plans, or the funds were not fully used.

3. Municipalities should develop strong EV charging infrastructure plans: CaaS providers and electric utilities explained that municipal authorities had a notable impact on EV charging deployment. For CaaS providers, having a contract with a municipality is often an ideal contract because they are more likely to be reliable customers. Municipal contracts could be improved with a better understanding of EV charging investment and economic returns to make CaaS services more viable. Electric utilities also found that when

municipalities had strong EV charging infrastructure plans, they could more efficiently develop their incentive programs for more seamless EV charging deployments. Municipalities can also lead by example by sharing charging resources, particularly in DACs or low-income neighborhoods, as they electrify their fleet.

4. Develop comprehensive educational resources for EV charging infrastructure that provides clear guidance on technical and economic considerations for diverse customer segments: While CaaS providers and electric utilities dedicate resources to educating existing and potential customers, a centralized state-sponsored repository of case studies, technical assistance materials, and best practices can help potential customers navigate charging infrastructure challenges, including site assessment, power capacity constraints, and investment evaluation early on in the process. Filling knowledge gaps is a key first step that CaaS providers and electric utilities can take with their customers, but a central resource codeveloped with partners could increase access to this information and support the successful deployment of more EV charging stations.

5. Strengthen EV charging infrastructure incentives in DACs: Contrary to assumptions that EV charging in DACs might not be advantageous, both CaaS providers and electric utilities stated that there is a demand for EV charging in DACs. However, there is still a lack of resources for those locations to grow EV charging stations. Targeted subsidies can help meet and realize the demand for EV charging infrastructure in DACs.

CaaS providers, electric utilities, and EV charging customers explained various different components about their EV charging experiences in California. This table summarizes key interview results by stakeholder type and research area (Table 4).

Table 4. Summary of Research Findings

Research Areas	Results by Stakeholder (13)			
	CaaS Provider (6) & EV Charging Provider (1)	Electric Utility (4)	CaaS Customer (1)	EV Charging Customer (1)
Area 1: CaaS and EV Charging Provisioning				
	Where EV charging is prioritized: • Highest vehicles in operation • Fleet • Municipalities	Program incentives: • Rebates • Technical and advisory assistance • Infrastructure services	Chose CaaS because of the modest price difference for benefits received	Chose ownership model because they wanted more control over the quality of operations and customer service
Area 2: Equity				
	Promotes equity by: • CaaS is cost-effective and is flexible to needs (current operations & scalability) • Equity programs and targeted deployment goals DEI workforce initiatives	Additional factors to consider for equitable distribution: • Membership auto-load requirements can be too high for DAC residents (need workaround) • Provide free charging temporarily for affordable housing as possible solution	N/A	N/A

Research Areas	Results by Stakeholder (13)			
	CaaS Provider (6) & EV Charging Provider (1)	Electric Utility (4)	CaaS Customer (1)	EV Charging Customer (1)
Area 3: Stakeholder Relationships				
	CaaS is flexible to modify its services for new customer needs: ● ESG tracking ● Electricity cost reimbursement for non-charging tenants ● Opportunity charging for fleets at CaaS depots CaaS Providers help customers with electric utility approvals, education, & creating charging strategies. Acts as intermediary with utility.	Utilities did not want CaaS contract (ongoing fees) & paying for maintenance (in-house expertise), challenges with CaaS customer service	Direct relationship with their electric utility	Little interaction with electric utility aside from rebate programs
Area 4: Benefits and Challenges				
Challenges in California	General Costs: ● Labor ● Upgrading old infrastructure ● Energy constraints ● Beating refueling prices Grant incentives, site selection to meet charging needs, hardware and software compatibility, authorities need education on EV charging realities, vandalism	General Costs: ● Old electrical infrastructure ● EV charging hardware & software reliability	Electric service availability to meet charging needs, grant incentives	Electric service availability to meet charging needs, grant incentives

Research Areas	Results by Stakeholder (13)			
	CaaS Provider (6) & EV Charging Provider (1)	Electric Utility (4)	CaaS Customer (1)	EV Charging Customer (1)
Area 4: Benefits and Challenges (<i>Continued</i>)				
CaaS Provider Challenges	Economic risks (upfront investment & uncertain charger utilization)	N/A	N/A	N/A
Challenges working with CaaS Providers	N/A	Organizational instability	N/A	Organizational instability
DAC Operating Challenges	Vandalism & maintenance costs, challenges are similar to non-DACs	Vandalism & maintenance costs, available land constraints on parcels for EV charging General Costs: • Infrastructure upgrades • EV affordability	N/A	N/A
General EV Charging Challenges	Stakeholder burnout, cost of EV trucks, landowner-tenant EV charging's leasing agreements	Maintenance cost, lack of EV charging technician workforce, inflated EV charging deployment costs, difficult to incentivize EV charging installation in affordable housing	N/A	N/A
Benefits of CaaS	Expertly support & educate customers, maintenance of infrastructure, relationships with EVSE & EV OEMS (higher-quality charging operations), strategic deployment plans (future-proofing)	N/A	N/A	N/A

Research Areas	Results by Stakeholder (13)			
	CaaS Provider (6) & EV Charging Provider (1)	Electric Utility (4)	CaaS Customer (1)	EV Charging Customer (1)
Area 5: Policies and Programming				
Experiences & Advice for EV Charging Policies & Programs	Requirements can increase deployment costs, EVSE-ready ordinances prepare future growth vs. EVSE-installed may result in obsolete equipment, hardware and software may not meet reliability requirements, subsidy requirements may force trade-offs (like reduced utilization), stricter subsidy requirements can limit participation, need for EV truck subsidies (including for large operators), grants should be written for EV charging (not gas station in mind)	Need more funding for electrical infrastructure upgrades, more support for low-income EV drivers' charging needs, drivers need education on EV charging options, streamlined licensing and permitting processes, strong forward-looking city goals/ordinances needed, need to grow electrician workforce, continue LCFS and AQMD grants (which support DAC charging stations)	Need for high-level political support to improve programs that fund electrical upgrades (like expanding Rule 29 to other customers)	Streamlined incentive programs
Collaborating to Expand EV Charging	Expand support to alternative charging solutions, governments can lead by example with fleet electrification, focus on large fleet customers, simplify subsidy program terms, cost of electric utility demand charges should be studied, share EV charging stations across fleets/customers	N/A	N/A	N/A

Research Areas	Results by Stakeholder (13)			
	CaaS Provider (6) & EV Charging Provider (1)	Electric Utility (4)	CaaS Customer (1)	EV Charging Customer (1)
Area 6: Lessons Learned and Future Outlook				
Lessons Learned	Have reliable suppliers, charger maintenance needs grow and is prioritized, need to constantly monitor funding & balance sheets, educate customers early on subsidy program requirements & charging operations	Charger longevity is necessary to have reliable & effective charging services, maintaining public chargers is difficult (diagnostics, labor, spare parts), subsidy incentives are competitive & hard to obtain, successful projects require early & extensive communication between stakeholders, EV charger deployment & planning can be complex (and iterative), build relationships with building code authorities/agencies to align rebates/incentives, educate customers on charger requirements	N/A	N/A
Future Outlook	Anticipates sustained growth in EV charging industry	N/A	N/A	N/A

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Appendices

Appendix A: Screening Protocol

Stakeholders were invited to complete a brief 5-minute screening survey that included an invitation to participate in an interview. Stakeholders were contacted by email, phone, or by submitting an intake form on company websites. The screening survey was distributed to nearly 100 identified stakeholders (response rate of 24%). A copy of the screening survey is reproduced at the end of this appendix A. **Table A-1** reports the count of those contacted and survey responses by stakeholder groups.

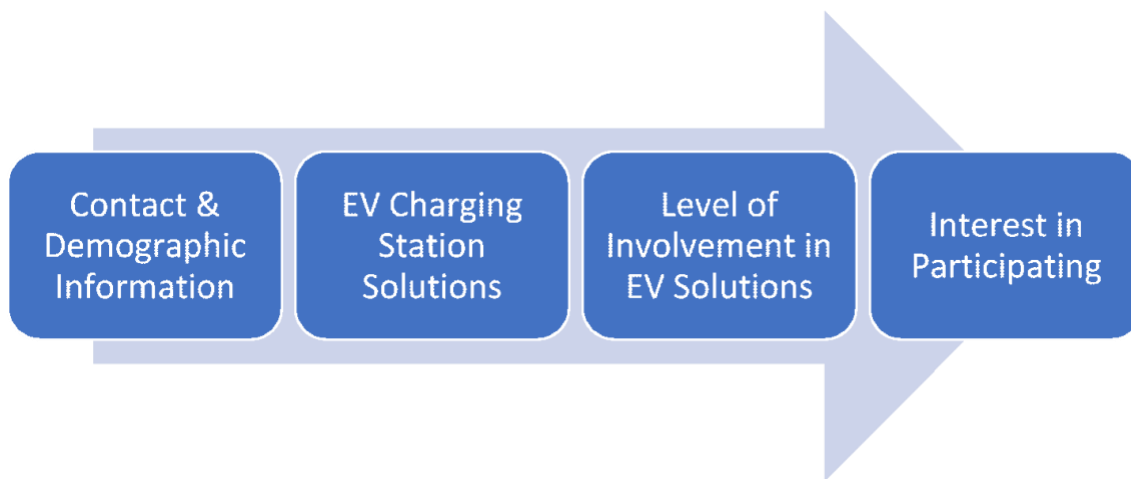
Table A-1. Stakeholder Identification and Screening Counts

Stakeholder Type	Contacted	Survey Responses *
Charging-as-a-service Providers	45	11
Electric Utilities	26	9
Charging-as-a-service Customers	25	3
Total	96	23

* Includes completed and partially completed responses.

Web-Based Screening Survey

The screening survey served a few purposes (**Figure A-1**). First, we sought to identify CaaS providers and electric utilities, and their EV charging services. As for customers, we sought to determine the EV charging solutions received. Second, the survey collected the participant’s involvement in the execution of EV charging solutions and whether they or someone from their organization would be willing to be interviewed. Completed surveys by willing participants and those partially completed were contacted with more information and invitations to participate in the study.



x

Web-Based Screening Survey

Welcome, and thank you for assisting with the *Understanding Charging as a Service (CaaS) in California Study*.

Access to EV charging infrastructure remains a barrier for many residing in multi-family dwellings (MFDs) and for fleets wanting to transition to all-electric vehicles. While charging station providers have long offered different services, like planning and design, hardware and/or software management, new asset ownership models now shift the responsibility of planning, installing, and maintaining charging equipment from the customer and to the charging station provider. This study examines the role that this new ownership model, Charging as a Service (CaaS), plays in providing charging infrastructure to different end users' needs in California.

We are particularly interested in the relationship between CaaS providers, customers, and electric utility companies. This survey will ask you for background information about your role in this focus area. **This survey will take approximately 5 minutes to complete.** After you complete the survey, we may--with your consent--contact you to request and schedule a more in-depth conversation about the specific experiences, attitudes, perceptions, and case studies of CaaS you have mentioned in your responses. We would appreciate your response prior to January 1st.

Both this form and the follow-on conversation are optional, and you may decline to participate in them at any time. Your responses will be used to inform ongoing research that will be shared with the public through written reports, webinars, and academic journal articles. For more information about this study or to request copies of our outputs, please email Dr. Matthew D. Dean at matthew.dean@uci.edu.

When you are ready to proceed, click the button at the bottom right of your screen.

Q1) Please provide your name and email address:

Name: ____

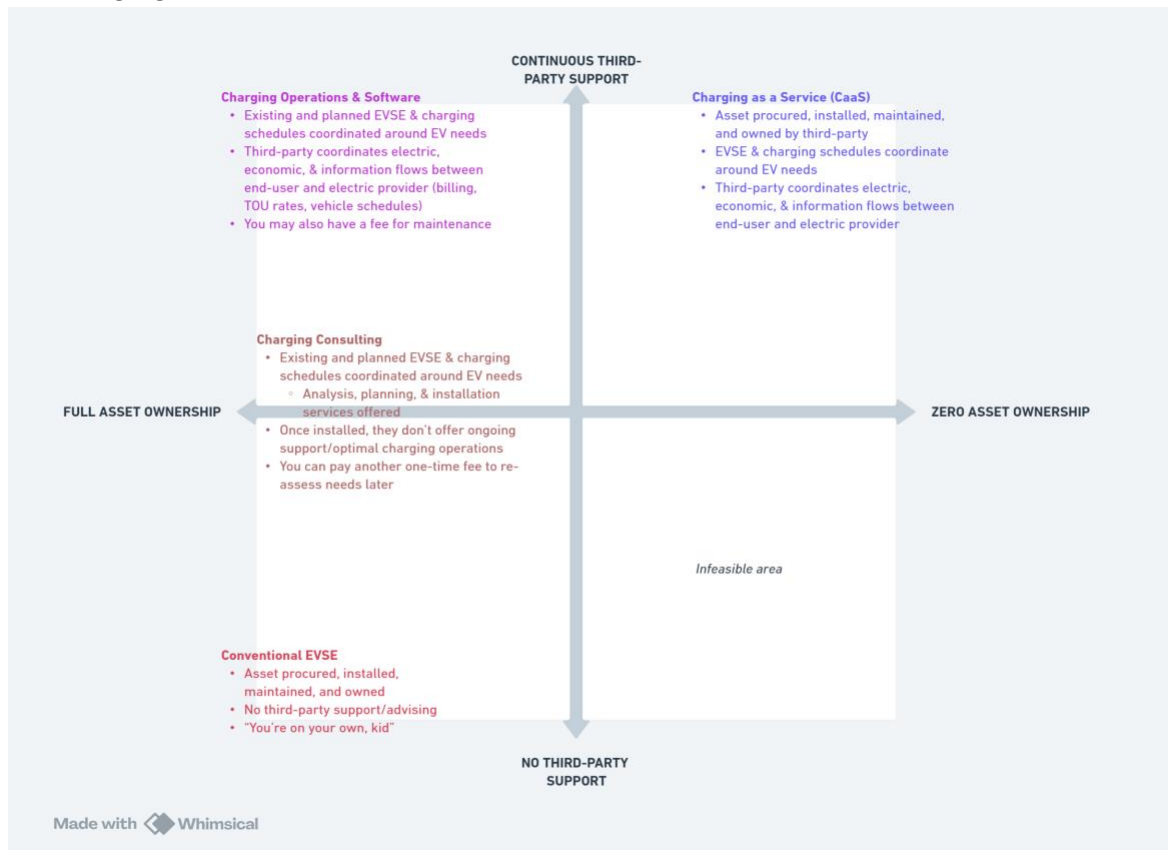
Email address: ____

Job title: ____

Q2) Please select which CaaS stakeholder you represent and the name:

1. Charging Station Provider (may include CaaS): ____
2. Electric Utility Company (may include CaaS): ____
3. CaaS Customer: ____

If Charging Station Provider



Q3) As a CaaS provider, please select all the types of charging station services your firm provides. In the next question, we will ask you to select from a more detailed list of services.

- a) CaaS
- b) CaaS adjacent

c) Std Charging

d) Other: _____

If Electric Utility Company

Q4) As an electric utility, please select all the types of charging station services you provide:

Site Consulting: site planning and design support

Turnkey Solution: utility takes complete ownership of EV charging infrastructure with a complete package consisting of connection to the meter, behind-the-meter, and EV charger at no cost to the customer except electricity bill

Infrastructure and EV Charger Rebates: front-of-meter connection at no cost to the customer plus a rebate for EV charger(s)

Rebates EV Charger: rebates for qualifying customers and qualifying EV chargers

Rebates Installation: rebates for qualifying customers and qualifying EV charger installations

a) CaaS installation + rebates

b) Charger rebates

c) Charger installation rebates

d) Planning & engineering

e) Consulting

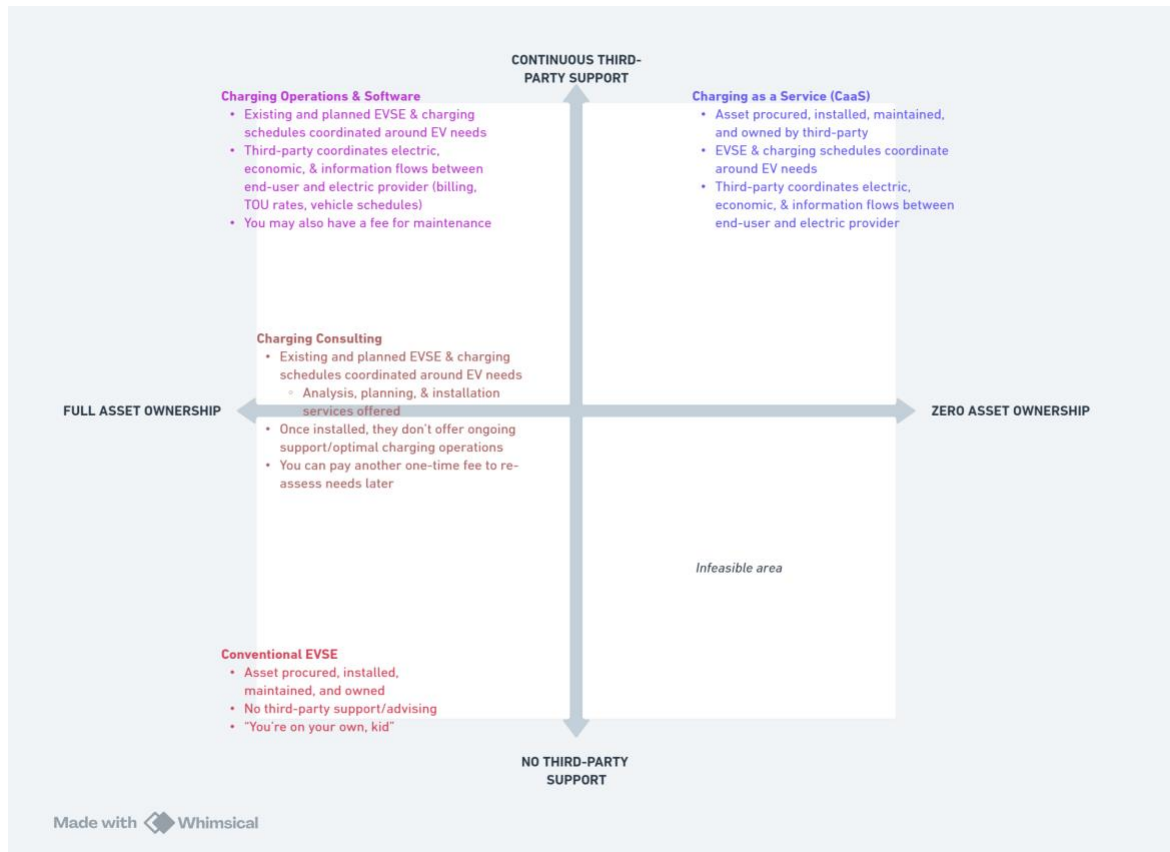
f) Dedicated EV Charging Team

g) Vetted Hardware List

h) Vetted Construction Company List

i) Other: _____

If CaaS customer



Q4) As a CaaS customer, we are interested in what charging station solution your company has selected. Please select all that apply

- a) CaaS (you pay for the hardware & installation, recover capital costs over lifespan of equipment)
- b) CaaS adjacent
- c) Software-as-a-service
- d) Energy-as-a-service
- e) Std Charging
- f) Other: _____

If Charging Station Provider

Q5) If this your company has a name other than CaaS, please enter it below:

Q6) As a potential CaaS provider, please select from a list of more detailed services that you can offer, according to each customer-type:

Design and Planning: the design of the charging infrastructure site, including implementation-ready plans (e.g., data-driven needs analysis, engineering plans, and permit approval).

Funding Bidding: identifying financing sources, like rebates, and shopping for different product options from private companies and utilities (e.g., grants/rebates and quotes from vendors).

Utility connection: working with local utilities to energize charging infrastructure and, if necessary, upgrade the front-of-the-meter connection.

Construction and Installation: behind-the-meter construction (as required) and installation of electrical panel, switchgear, and EV charger(s)

Hardware: behind-the meter-infrastructure and EV charger(s), including connecting customers with (preferred) vendors and advisors for acquisition (if the company does not provide it)

Software: smart charging software services, including connecting customers with (preferred) vendors and advisors and advisors for acquisition (if the company does not provide it)

Operations Management: managing and optimizing charging operations

Support: customer services for operations and product support

Maintenance: ongoing maintenance of EV charging operations and infrastructure

Warranty: warranties and warranty support for EV, EV chargers, and labor

Future Proofing: long-term strategizing towards EV charging operations and infrastructure longevity

	Design & Planning	Funding Bidding	Utility Connection	Construction and installation	Hardware	Software	Operations Management	Support	Maintenance	Warranty	Future Proofing	Other
Single-family homes												
Businesses												
Multi-Family Dwelling (MFD)												
Fleet (unspecified)												

If Charging Station Provider

Q7) As a CaaS provider, have you installed a CaaS-type project in California?

- Yes
- No

If Q7 is Yes & *If Charging Station Provider*

Q8) Briefly, please explain the type(s) of clients that you have worked with. As an example, you could write “XYZ Transit Agency’s BEB charging depot, ABC Property Company’s 8 L2 chargers”

If Charging Station Provider

Q9) We would like to interview CaaS providers for this research. To make a good fit, we would like to know if you were personally involved in planning, implementing, and/or evaluating a CaaS installation?

- Yes, I led or was substantially involved in planning, implementing, and/or evaluating a CaaS installation
- I was involved in planning, implementing, and/or evaluating a CaaS installation, but did not play a substantial role
- I was not involved in planning, implementing, and/or evaluating a CaaS installation

If Electric Utility Company

Q10) As an electric utility, are any of your services income-constrained or specified for DACs?

- Yes
- No
- Unsure
- Other (please specify): _____

If CaaS Customer

Q10) As a CaaS customer, are any of your CaaS projects in low-income areas or disadvantaged communities (DACs)?

- Yes
- No
- Unsure
- Other (please specify): _____

If CaaS Provider

Q10) As a CaaS provider, has your company installed charging stations under a CaaS agreement in low-income or disadvantaged communities (DACs)?

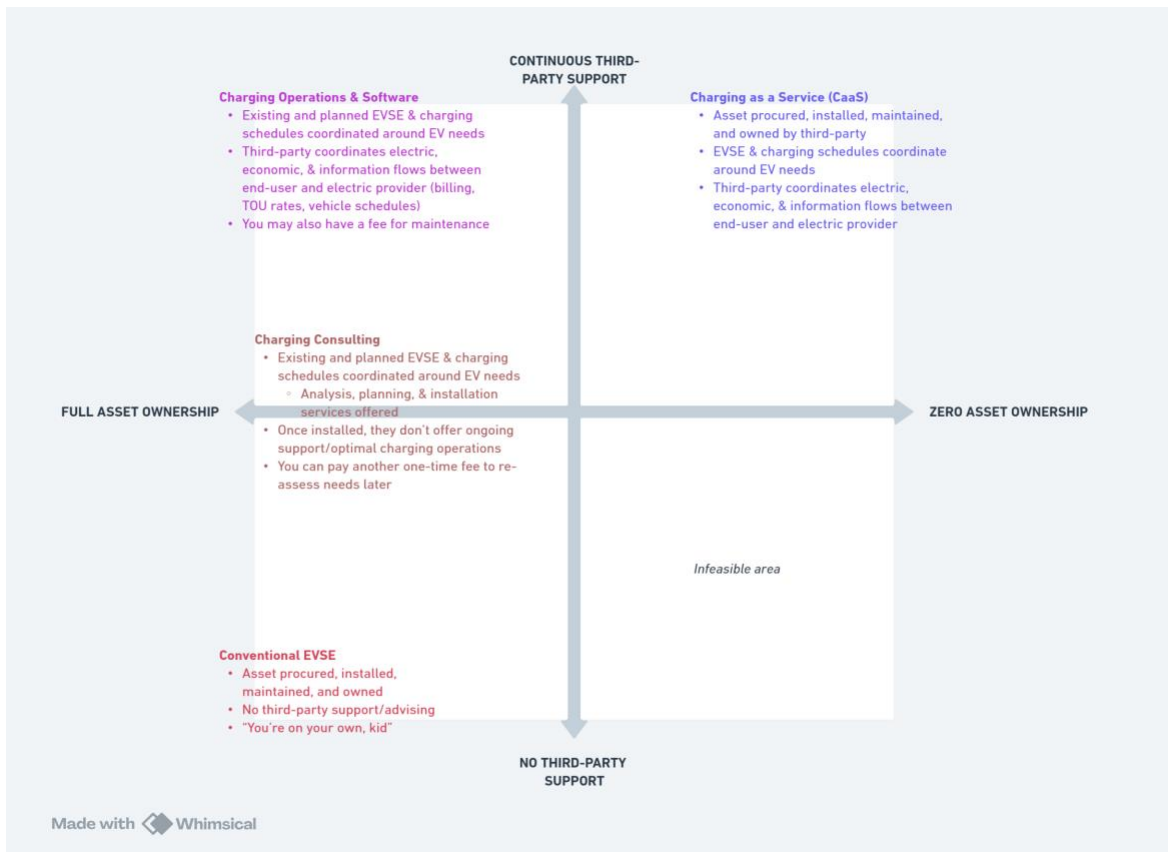
- Yes, our company has installed charging stations under a CaaS agreement in these areas
- No
- Unsure

If Electric Utility Company

Q11) As an electric utility, are any of your services income-constrained or specified for DACs? Does your utility have a history, is currently, or has plans to directly install and maintain EV charging infrastructure? Please select all that apply.

- a) Yes (historical)
- b) Yes (current)
- c) Yes (future – in planning stage)
- d) Yes (future – in talking stage)
- e) No
- f) Other (please specify):

If Q4 is Shown



Q12) Has your utility worked with an EV charging company. If so, which ones (select all that apply)

- a) CaaS
- b) CaaS adjacent
- c) Std Charging
- d) Other: _____

If CaaS customer

Q13) As a potential CaaS customer, we are interested in what services you received when installing your charging station(s). Please select which ones you have received.

Design and Planning: the design of the charging infrastructure site, including implementation-ready plans (e.g., data-driven needs analysis, engineering plans, and permit approval).

Design and Planning: the design of the charging infrastructure site, including implementation-ready plans (e.g., data-driven needs analysis, engineering plans, and permit approval).

Funding Bidding: identifying financing sources, like rebates, and shopping for different product options from private companies and utilities (e.g., grants/rebates and quotes from vendors).

Utility connection: working with local utilities to energize charging infrastructure and, if necessary, upgrade the front-of-the-meter connection.

Construction and Installation: behind-the-meter construction (as required) and installation of electrical panel, switchgear, and EV charger(s)

Hardware: behind-the meter-infrastructure and EV charger(s), including connecting customers with (preferred) vendors and advisors for acquisition (if the company does not provide it)

Software: smart charging software services, including connecting customers with (preferred) vendors and advisors and advisors for acquisition (if the company does not provide it)

Operations Management: managing and optimizing charging operations

Support: customer services for operations and product support

Maintenance: ongoing maintenance of EV charging operations and infrastructure

Warranty: warranties and warranty support for EV, EV chargers, and labor

Future Proofing: long-term strategizing towards EV charging operations and infrastructure longevity

Other:_____

Q18) Please check the box below only if you do NOT want us to contact you to discuss your answers in more detail.

- check box (Do not contact me to discuss my responses in more detail)

Q19) Is there someone else we should contact to discuss this program instead?

- No
- Yes (please provide their name and email) _____

Q20) Is there anything else that we missed in this screening survey that you would like to share with the research team?

End of Survey

Appendix B: Interview Protocol and Questions

Interviews were semi-structured and open-ended to explore the complex relationships between CaaS ecosystem actors. An advantage of this interview format is that interviewees have flexibility in answering questions from their perspective, and contextualize their responses to their organization’s view (Edwards and Holland, 2013). The responses were transcribed with the support of Zoom’s voice-to-text transcription. All but one participant permitted a recording to allow researchers to review each transcription for accuracy. Transcripts were edited to de-identify stakeholders and their organizations from their responses. A total of 13 interviews were conducted (**Table B-1**). Interviews ranged from 30 minutes to an hour. A copy of the interview guide is presented at the end of this Appendix B.

Table B-1. Types of Stakeholders Interviewed

Stakeholder Type	Interviews
CaaS Provider	6
Non-CaaS EV Charging Provider	1
Electric Utility	4
CaaS Customer	1
Non- CaaS Customer	1
Total	13

The transcripts were analyzed using elemental and exploratory coding methods (Cresswell and Poth, 2018). Both techniques were simultaneously used throughout the coding process. Elemental coding created structured content-based higher-level codes to create an inventory of what interviewers said. For exploratory coding, codes were grounded in the data; what was said was what the code described. NVIVO was used to code the data (NVIVO, n.d.), and NVIVO and excel were used to explore the data. Each research area of interest was directly connected to interview questions. As a result, coded data was directly connected to a research area (Figure B-1). Interviews were structured to provide insights into the research areas. Although data was coded into discrete research areas, according to the interview question posed to the interviewee, interviewees’ comments sometimes addressed multiple research areas. In these cases, code placement was flexible to allow for comments to be categorized in their respective research areas.

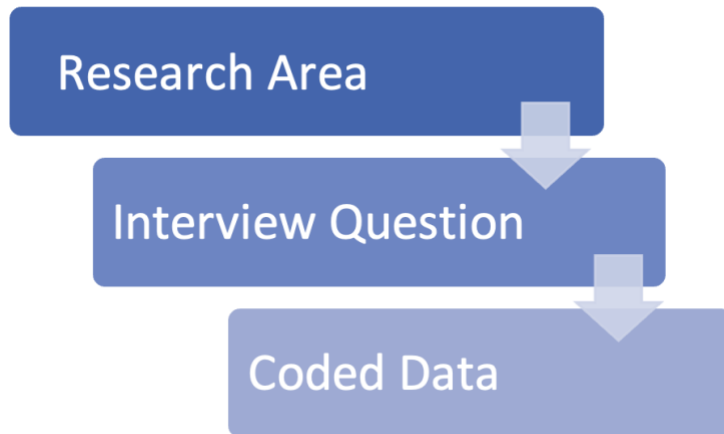


Figure B-1. Data Coding Structure

Interview Guide

Begin with introductions and check-in on time available for interview.

We're all aware of California's aggressive EV goals and targets and the need to support the installation and maintenance of charging equipment. One way to quickly provide access to a functional system is through turnkey solutions, specifically Charging as a Service (or CaaS). Our study conducts semi-structured interviews with CaaS providers, electric utilities, and CaaS customers on their experiences with EV charging installations, and reflections on equitable access, policy, and programming support.

We would like to learn about your company/electric utility in the EV charging space and how turnkey charging solutions might or have already impacted your decision-making, business calculations, and/or operations. For the purposes of this interview, we are interested in a specific type of turnkey solution, the Charging as a Service (CAAS) turnkey solution. CaaS is where your organization invests the capital for the infrastructure and recovers the cost over a contract period with the customer who pays a subscription fee for installation, maintenance, and on-going support for the duration of that contract. Throughout this interview we will reference CaaS based on this definition.

As mentioned in our information sheet, your participation is voluntary. You may choose to skip any question or refuse to participate or discontinue your involvement at any time, please notify us with any questions or requests at any time. For our research purposes, we would like to record the interview to verify transcription accuracy. We do require voice-to-text transcription. All recordings will be deleted, and transcripts will be de-identified. Do you have any questions at this time? Do you consent to being recorded and beginning the interview?

Charging-as-a-Service Provider

General Information

- 1) We would like to start with an introduction, could you describe your position at your company?
- 2) Does your company offer a CaaS solution?
- 3) Do you have CaaS customers in California?

Customer Relationships

- 4) Are your clients typically coming to you with charging equipment or EVs on hand or at the beginning of the process? What solution typically gets paired by these client types?
- 5) What types of clients typically seek CaaS/bundles for EV charging solutions?
- 6) Broadly speaking, where is your organization prioritizing CaaS or bundled EV charging investment in California? We're interested in locations and types of clients.

Bundled CaaS Models

- 7) Are there benefits or risks to your company when you provide CaaS or a similar bundled service?
- 8) Have you received feedback from customers or potential customers regarding the elements of your CaaS bundle and have they resulted in any changes to your service offerings?

Operational Insights

- 9) When there is a gap between the utility's capabilities and capacity with the customer's wants, how do you handle it?

Investment, Policies, and Programs

- 10) What are the current public policies/programs that make an impact on your organization's charging stations?
- 11) How should the public and private sectors collaborate to expand charging access?
- 12) Where should public sector agencies and electric utilities prioritize EV charging funding or programs to make the best impact in electrifying California's vehicles?

Equity

- 13) Turning solely to equity, how can the public and private sectors collaborate to expand charging access equitably?

14) How is equity implemented in your services or where your company installs charging stations?

Future Outlook

15) What lessons have you learned that can be shared with other CaaS installations?

16) Given what we have discussed in this interview, we want to know where do you think the EV charging industry is moving towards in the future?

Electric Utilities

General Information

1) We would like to start with an introduction, could you describe your position at your utility?

2) What types of EV charging station services or programs does your electric utility provide to customers?

Customer Relationships

3) What were the motivations for offering EV charger services or programs?

4) What types of clients typically seek EV charger solutions?

5) Can you describe your relationships, if any, with EV charging companies? (If they need a little more context, explain that this could include partnerships for hardware/software, advancing planning for future year installation/growth (studies), or just run-of-the-mill project-specific approvals with EV charging companies).

Operational Insights

6) If they don't have a relationship with CaaS providers: Could you walk us through what it's like working with a customer who is receiving an EV charger incentive?

If they work with CaaS providers: Could you describe what it's like working with or interacting with EV charging providers to provide EV charger incentives or programs?

7) Are there operational challenges to incentivizing or installing EV chargers? (Institutional capacity)

Investment, Policies and Programs

8) What are the existing policies and programs that successfully support EV charging adoption in your service area?

9) What policies and programs are needed to support EV charging in your area?

10) Have there been any considerations of integrating CaaS into existing electric utility EV incentive programs?

Equity

- 11) What are the experiences of your utility in supporting EV chargers in DACs vs non-DACs?
- 12) What are the barriers or issues with supporting the installation of more chargers in DACs?
- 13) Are there any challenges or experiences that your customers have had with installing EV chargers that make you consider offering a CaaS-like offering as the utility or develop relationships with charging station vendors to create a CaaS-ecosystem (construction, installation, ongoing support, and maintenance)?
- 14) How is equity implemented in your services or where your company installs charging stations?

Future Outlook

- 15) What lessons have you learned about supporting EV charging infrastructure that could be shared with other electric utility providers?

Charging-as-a-Service Customer

General Information

- 1) We would like to start with an introduction, could you describe your position at your company?
- 2) Could you tell us about your company and the types of vehicles that are currently using your installed charging infrastructure?
- 3) Could you tell us where your CaaS infrastructure is located?

Adoption Motivations

- 4) How did you hear about CaaS?
- 5) Given your charging needs, what led you to choose a CaaS model for your EV charging solution?
- 6) How did you compare CaaS to other charging infrastructure options?
- 7) What barriers or challenges, if any, did your organization face in adopting EV charging infrastructure?
- 8) What benefits have you observed, if any, due to choosing the CaaS solution during the installation phase and after?

Interactions with CaaS Providers/Electric Utilities

- 9) Could you describe your interactions with the CaaS provider?
- 10) How would you describe your interactions and communication with the electric utility?

User Experience

11) Can you share your experiences with the specific planning, installation, and maintenance process facilitated by the CaaS provider?

12) In what ways has the CaaS subscription model impacted your organization's approach to EV charging?

13) How did (residents, shareholders, customers, employees, etc.) respond to the CaaS service?

Policies and Programming

14) Did you benefit from any EV charger incentives or programs?

15) Are your EV charger installations in Disadvantaged Communities (DACs)?

If no DACs: Could you share any experiences related to expanding, planning or considering EV charger installations in DACs?

Equity

16) As a customer in a DAC, were there any unique aspects to installing charging infrastructure?

Future Outlook

17) Are there areas in your EV charging infrastructure project or operations that you think could be improved?

18) Given your experience, what should others know when considering CaaS solutions for their EV charging project? What advice or lessons learned would you share?

Appendix C: Policy Comparison Chart

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
AB 1236	Introduced: 27 February 2015 Approved: 8 October 2015 Each city, county, or city and county with a population of 200,000 or more need to adopt and implement an ordinance, “with an expedited, streamline permitting process,” by September 30, 2016. If a city, county, or city and county house less than 200,000 residents, they need to adopt by September 30, 2017.	California	Local agencies to limit barriers and restrictions for the installation of electric vehicle chargers To encourage the installation of electric vehicle charging by eliminating obstacles and making them cost effective Require a city/county/city and county to approve an application for the installation of electric vehicle charging stations through non-discretionary permits	Includes public charging and chargers in the home.	Hesitancy to approve this bill due to beliefs that electric vehicle charging did not protect the health and safety of citizens, however, if adverse impacts were found with no solution to mitigate the effects, a city, county, or city and county may deny the application—each charging station must meet safety and performance standards.	Chu, David. Assembly California Legislature Letter. (2018). https://www.calbo.org/sites/main/files/ab_1236_letter_asm_david_chiu_.pdf Electrical vehicle charging stations for Multi-Family & Commercial. (2023). City of Santa Ana. https://www.santa-ana.org/electrical-vehicle-charging-stations/ Plug-in readiness - California governor’s Office of Business and Economic Development. (n.d.). California Governors Office of Business and Economic Development. https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/ Matkins, Allen. (n.d.). California laws related to permitting electric vehicle charging stations and electric infrastructure projects. California Laws Related to Permitting Electric Vehicle Charging Stations and Electric Infrastructure Projects Legal Alerts. https://www.allenmatkins.com/real-ideas/california-laws-related-to-permitting-electric-vehicle-charging-stations-and-electric-infrastructure-projects.html

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
AB 970	Introduced: 18 February 2021 Approved: 8 October 2021	California	Clarifies that provisions rooted from AB 1236 apply to all cities, including charter cities A city, county, or city and county must submit their application in five business days, if the application's electric vehicle charging proposal is for at least one and no more than twenty-five charging stations at one site, or ten business days, if the application's electric vehicle proposal is for more than twenty-five charging stations at one site, in order to be considered complete. In installing the electric vehicle charging stations, a city, county, or city and county must reduce parking spaces to allow for installation	Policy applies to all counties, cities, and charter cities.	AB 970's provisions were effective for cities, counties, or cities and counties with populations of more than 200,000 on January 1, 2022. If a city, county, or city and county had a population of less than 200,000, provisions were effective January 1, 2023.	Plug-in readiness - California governor's Office of Business and Economic Development. (n.d.). California Governor's Office of Business and Economic Development. https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
AB 2565	Introduced: 21 February 2014 Approved: 21 September 2014	California	Tenants have the right to install EVCS and landlords must grant permission under certain circumstances. Residential: The lessee is required to pay, as part of rent, for the costs associated with the electrical usage of the charging station, and any costs for damage, maintenance, repair, removal, and replacement of the charging station, and modifications or improvements made to the property associated with the charging station. Commercial: A lessor may create a new parking space where one did not previously exist to facilitate the installation of an EVCS. The lessee is responsible for: (a) costs for damage to property and the EVCS resulting from the installation, maintenance, repair, removal, or replacement of the EVCS; (b) costs for the maintenance, repair, and replacement of the EVCS; and (c) the cost of electricity associated with the EVCS.	Renters Apply to residential and commercial.		California Governor's Office of Business. (n.d.). Electric Vehicle Charging Station Permit Streamlining Fact Sheet. https://business.ca.gov/wp-content/uploads/2023/03/AB-2565-Installing-EVCS-on-Rental-Properties.pdf

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Clean Transportation Program	California Energy Commission (CEC)	California	Program seeks to invest more than 50% program funding in light-duty EV charging infrastructure and fleet EV infrastructure projects in low-income and disadvantaged communities.	Majority of funding for disadvantaged communities.	AB 126 (passed 2024) requires the CEC to spend at least 50% of programmatic money on low-income and disadvantaged communities starting 01/01/2025.	California Energy Commission, (2024). 2024-2025 Investment Plan Update for the Clean Transportation Program. https://www.energy.ca.gov/publications/2024/2024-2025-investment-plan-update-clean-transportation-program
Clean Vehicle Rebate Program (CVRP)	Operates on first-come, first-serve basis for applications Only has certain amount of funds (by the California Air Resources Board) depending on budget allocation and demand	California	Each resident can earn from \$1,000-7,500 for purchasing/leasing an EV. Each applicant has to provide info on income, household size, type of vehicle, ownership. - Rebate will reflect info above and be based on funding availability.	Supports lower income residents by providing rebates for EV charging.	Also includes funding for hydrogen fuel cells. Even when funding for CVRP is exhausted, there are other rebates listed on the website that residents can apply for.	CVRP Home: Clean Vehicle Rebate Project. (n.d.). CVRP Home Clean Vehicle Rebate Project. https://cleanvehiclerbate.org/en

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Low Income Home Energy Assistance Program (LIHEAP)	Funded by U.S. Department of Health and Human Services, Administration for Children and Families, Office of Community Services	United States	Federally funded program that assists low-income households that pay a high portion of their income to meet energy needs. This can be used to fund EV charging costs, as well as other utilities.			California Department of Community Services and Development. (n.d.). Low Income Home Energy Assistance Program. https://www.csd.ca.gov/Pages/LIHEAPProgram.aspx Low Income Home Energy Assistance Program. LIHEAP. (n.d.). https://www.liheap.org/
California Alternate Rates for Energy (CARE)		Areas supported by participating utility companies	Low-income customers can receive a 30-35% discount on electric bill and 20 percent on natural gas. Eligibility depends on household size and income. Similar to LIHEAP, this can aid in EV charging costs, as well as other utilities.	Supports lower income customers.		Care/FERA program. (n.d.). California Public Utilities Commission. https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/care-fera-program

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
AB 32 / Low Carbon Fuel Standard (LCFS)	California Air Resources Board (CARB) Approved 2009, implementation began Jan 1, 2011, has been amended every few years since	California (expanding to Pacific Coast Collaborative - regional agreement between CA, Oregon, Washington, British Columbia. Also engaging with reps from Canada and Brazil)	By the California Air Resources Board, 12 years ago, 96% of CA's transportation ran on petroleum, with about 30 million vehicles on the road. 20 lbs of CO2 emissions per gallon burned, around 5 tons/year per car. LCFS requires fuel with less carbon. Declining standard of carbon intensity - give fuel suppliers emission cutting flexibility, answering consumer demand, they negotiate within their own markets buy and sell emission credits to develop profitable products. Planned to have cut global warming pollution by 10% by 2020, up to 20% gasoline/diesel replaced with cleaner fuels, low carbon biofuels quadrupled by 2020, more than 20 times alternative and hybrid vehicles. To stimulate the economy, CA must diversify fuel sources and reduce reliance on oil.	Supports renewable fuel producers. Decreases carbon emissions and creates better environments to those that endure bad environmental conditions. Consumers can have access to lower priced and more accessible alternative energy sources.		California Air Resources Board. Low Carbon Fuel Standard California Air Resources Board. (n.d.). https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about California Air Resources Board. (2011). Low Carbon Fuel Standard. YouTube. https://www.youtube.com/watch?v=oluLMKkUCwY

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Advance Clean Fleets	California Air Resources Board (CARB) April 2023	California	Plan to accelerate deployment of zero emission technologies for medium and heavy-duty vehicles. Already early successes, manufacturers are 2 years ahead of their targets for zero emission sales. Work alongside Advanced Clean Truck regulations. Bus fleets that are well suited for electrification need to reduce emissions. Manufacturers only manufacture zero emission vehicles (ZEV) starting 2036 model year. Expected to introduce 1.69 mil ZEVs by 2050. Expected to result in \$26.5 billion in statewide health benefits and save fleet owners \$48 billion through 2050.	Aims to protect the health and welfare of CA residents by improving air quality and mitigating harmful effects of GHG.	Contributes to meeting the goals of Newsom's Executive Order N-79-20. ACF currently paused.	Advanced Clean Fleets. California Air Resources Board. (n.d.). https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Informatio n	Source
Electric Vehicle Charging Infrastructure	California Air Resources Board (CARB)	California	All new cars sold in 2025 must be zero emission, from the adoption of the Advanced Clean Cars II regulations. CARB is working towards making fueling easy for all. When a driver needs to use a public EV charger, all locations can be found through mapping tools, all the costs associated with charging and parking are posted, a membership to use the station is not required, and drivers can easily pay with what is in their wallet (regulations by EV Standard regulations developed to implement SB 454 EV Charging Stations Open Access Act which builds driver confidence).	Support confidence of consumers owning a renewable resource vehicle.		Electric Vehicle Charging Infrastructure. California Air Resources Board. (n.d.). https://ww2.arb.ca.gov/our-work/programs/electric-vehicle-charging-infrastructure/about
Pollution Reduction Committee and South Coast Air Quality Management District	Effective September 5, 2023	4 counties under jurisdiction	EV charging rebates (as of April 2, 2023) only level 2 chargers are eligible. Available within the South Coast AQMD four county jurisdiction (LA county, Orange County, Riverside County, San Bernardino County).	Only low-income residents are eligible.		Residential EV Charging Incentive Program. (n.d.). South Coast AQMD. https://www.aqmd.gov/home/programs/community/community-detail?title=ev-charging-incentive

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Charge Up! (San Joaquin Valley Air Pollution Control District)		San Joaquin Valley	Provides funding for public agencies, businesses, and property owners of multi-unit dwellings (apartment complexes, condominiums, etc.) in the San Joaquin Valley to install EV chargers.	The chargers support existing EV owners and encourage the growth of clean technology in the Valley.	Private at home use of EV chargers in single family residences are not eligible. Not a rebate (need a voucher before buying a charger). -in 2014 San Joaquin created a readiness siting analysis which displays the most optimal locations for chargers.	Charge up!: Electric Vehicle Charger Incentive Program. (n.d.). San Joaquin Valley Air Pollution Control District. https://ww2.valleyair.org/grants/charge-up/
CALeVIP		California	Rebates for EV charging. Supports the requirement of only zero emission vehicles sold 2035.	Could sign up for the rebate email list, a variety that could benefit most.		Rebate Statistics Dashboard. (n.d.). CALeVIP. https://calevip.org/rebate-statistics

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
AB 841	Approved: September 30, 2020	California	Requires CPUC to approve a new tariff or rule that authorizes each electrical corporation to design and deploy all electrical distribution infrastructure on the utility side of the customer's meter for all customers installing separately metered infrastructure to support charging stations, other than those in single-family residences.	CPUC's Rule 29, which complies with AB841, does not apply to public entities/agencies/authorities that have EV charging infrastructure on public lands. AB 841 includes provisions to accelerate the deployment of EV charging infrastructure in California. Specifically, the bill authorizes the use of funds from the California Clean Energy Jobs Act (prop 39) for the installation of EV charging stations at schools, including K-12 schools and community colleges. -not less than 35% of the investments (sentence above) to be in underserved communities.		AB 841. (2020). California State Legislature. https://legiscan.com/CA/text/AB841/id/2211049

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
CPUC's Rule 29		California	CPUC Rule 29 allows those who are installing EVCS to not pay the cost of utility-side infrastructure upgrades. Instead, those costs are distributed to all ratepayers. Does not apply to public entities/agencies/authorities that have EV charging infrastructure on public lands. This rule complies with AB841. Applies to commercial, industrial, and/or multi-family EV charging station projects.	Does not apply to single family homes.		Electric Vehicle Infrastructure Rule 29. (n.d.). PG&E. https://www.pge.com/assets/pge/docs/clean-energy/electric-vehicles/electric-rule-29-fact-sheet.pdf Electric Vehicle (EV) Infrastructure Rule 29. (n.d.). Southern California Edison. https://www.sce.com/sites/default/files/2022-07/EV%20Rule%2029%20Fact%20Sheet%200622_WCAG%20(V2).pdf Draft Resolution E-5167. (2021). Public Utilities Commission of the State of California. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M413/K061/413061495.PDF
SF Building Ordinance	San Francisco: Local Government 2017	San Francisco	San Francisco's EV Ready Ordinance (2017) requires all NEW residential and commercial buildings to configure 10% of parking spaces to be “turnkey ready” for an EV charger installation, and an additional 10% to be “EV flexible” for potential charger installations and other upgrades.	San Francisco is a condense city with lacking garage space and lots of apartments, townhouses, etc. With the SF EV building ordinance, residents can have security and confidence that they will have space to fuel their vehicle.		San Francisco's EV Ready Ordinance. (n.d.). LPDD. https://lpdd.org/resources/san-franciscos-ev-ready-ordinance/#:~:text=San%20Francisco's%20EV%20Ready%20Ordinance%20(2017)%20requires%20all%20new%20residential,charger%20installations%20and%20other%20upgrades.

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Mandatory Electric Vehicle (EV) Charging Station Building Standards	California Building Standards Commission (CBSC) 2023	Californi a	New one- and two-unit single family dwellings or townhouses with attached private garages must have electrical conduit installed that is capable of supporting a Level 2 EV charging station. For new multifamily dwellings and hotels, 10% of parking spaces must be EV-capable and 25% of parking spaces must be EV-ready. New multifamily dwellings and hotels with more than 20 units must install Level 2 EV charging stations at 5% of all parking spaces.	Website includes diagrams for public parking facilities. Also good for those without space or access to charging in their home.		Akerblom, M., Epstein, B., Fogt, M., Palmer, D., and Matkins, A. (2023). California Laws Related to Permitting Electric Vehicle Charging Stations and Electric Infrastructure Projects. JDSUPRA. https://www.jdsupra.com/legalnews/california-laws-related-to-permitting-8087713/ U.S. Department of Energy. (n.d.). Mandatory Electric Vehicle (EV) Charging Station Building Standards. U.S. Department of Energy: Energy Efficiency and Renewable Energy. https://afdc.energy.gov/laws/11068#:~:text=For%20new%20multifamily%20dwellings%20and,5%25%20of%20all%20parking%20spaces. Welch, Gary. (2022). The 2022 CalGreen Tier 1 and 2 EV Requirements. CalGreen Energy Services Inc. https://calgreenenergyservices.com/2022/08/24/2022-calgreen-tier-1-and-2-ev-requirements/

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
SB 1275: Charge Ahead California Initiative	Approved: September 21, 2014	California	Goal setting initiative. The bill would state that the goals of the initiative are to, among other things, place in service at least 1,000,000 zero-emission and near-zero-emission vehicles by January 1, 2023, and to increase access for disadvantaged, low-income, and moderate-income communities and consumers to zero-emission and near-zero-emission vehicles. The bill would require the state board to include, commencing with the Air Quality Improvement Program funding plan for the 2016–17 fiscal year, a specified funding plan that includes the immediate fiscal year and a forecast of estimated funding needs for the subsequent 2 years commensurate with meeting the goals of the Charge Ahead California Initiative; to update the plan at least every 3 years through January 1, 2023; to adopt, no later than June 30, 2015, specified revisions to the criteria and other requirements for the Clean Vehicle Rebate Project; and to establish programs that further increase access to and direct benefits for disadvantaged, low-income, and moderate-income communities and consumers from electric transportation.			SB 1275. (2014). California State Legislature. https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201320140SB1275

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Application for Approval of Pacific Gas and Electric Company's (U39-E) Electric Vehicle Charging Pilots for Schools and Parks Pursuant to Assembly Bills 1082 and 1083	CPUC	California	(Charge Ahead California Initiative): CPUC funded 8 pilots proposed by 4 IOUs (PG&E, SCE, SDGE, and Liberty Utilities) to install over 900 public charging ports at "under-served sites" (CPUC). Each utility will have a pilot for public schools and the other for public recreational locations (state parks and beaches). "In locating the charging stations, the utilities will prioritize sites that serve disadvantaged communities most exposed to dangerous air pollution. The final decision directs the utilities to ensure 40 percent of the sites in the schools pilots are located in disadvantaged communities, while requiring that 25 percent of the sites selected for the state parks and beaches pilots serve disadvantaged communities. San Diego Gas & Electric will also deploy charging stations at city and county parks, and plans to locate 100 percent of those installations within disadvantaged communities."	Focus on the disadvantaged communities.	Allows the utility to "choose 'turn-key' solutions in which the utilities will own-and-operate the charging stations, while recovering electricity costs from the participants and drivers who use them".	Proposed Decision on the Transportation Electrification Pilots for Schools and Parks Pursuant to Assembly Bills 1082 and 1083. (2017). Public Utilities Commission of the State of California. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M319/K350/319350862.PDF
AB 1082		California	Authorizes each of the electric utilities subject to Commission jurisdiction to file an application to propose a pilot for the installation of electric vehicle charging stations at school facilities and other educational institutions. The legislation envisions that these charging stations could provide support for electrified school buses. The participating school or educational facility shall have the authority to establish guidelines for the use of charging stations installed through the pilot.			Muller, M. and Baumhefner, M. (2019). CA Approves \$55M for EV Charging at Parks, Beaches & Schools. NRDC. https://www.nrdc.org/bio/miles-muller/ca-approves-55m-ev-charging-parks-beaches-schools

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
AB 1083		California	Authorizes each of the electric utilities subject to Commission jurisdiction to file an application to propose a pilot for the installation of electric vehicle charging stations at state parks and beaches. Additionally, AB 1083 requires that the utilities consult with the Department of Parks and Recreation (Parks), the Commission, CEC, and CARB if they file an application. Consistent with the legislation, Parks shall determine which parks or beaches are suitable locations for electric vehicle (EV) charging.			AB 1083. (2017). California State Legislature. https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1083
Hybrid and Zero-emission Truck and Bus Voucher Incentive Project (HVIP)	California Air Resources Board (CARB)	California	HVIP continues to accelerate market transformation by incentivizing the purchase of zero-emission heavy-duty trucks and buses for California fleets. HVIP is the cornerstone of advanced technology heavy-duty incentives, providing funding since 2010 to support the long-term transition to ZEVs in the heavy-duty market, as well as supporting investments in other emerging technologies to achieve substantial GHG reductions and help meet health-based ambient air quality standards. Investments made through HVIP provide both broad purchase incentives for fleets, and more targeted measures to address air quality needs in California's priority populations. Voucher incentives complement other programs in CARB's heavy-duty funding portfolio by providing a streamlined application process without requiring the scrapping an existing vehicle.	Supports purchasers to switch to renewable energy buses and trucks.		California Air Resources Board. (n.d.). Clean Truck & Bus Vouchers (HVIP). https://ww2.arb.ca.gov/our-work/programs/clean-truck-bus-vouchers-hvip

Policy/ Program	Agency & Timeframe	Location	Description	Policy/ Program Recipient(s)	Additional Information	Source
Innovative small electric fleet (ISEF)	California Air Resources Board (CARB)	California	Vouchers for Class 2b through 8 zero-emission vehicles. Fleets have the option to request increased vouchers for innovative solutions such as all-inclusive leases, peer-to-peer truck sharing, truck-as-a-service, assistance with infrastructure, and individual owner planning assistance. Eligibility: Small fleet owners with 20 or fewer vehicles with a gross vehicle weight rating (GVWR) greater than 8,500 lbs. under common ownership or control and domiciled in California and less than \$15 million in annual revenue. Nonprofits are exempt from revenue requirements.	Similar to HVIP.		California Air Resources Board. (n.d.). Innovative Small e-Fleet Pilot Program. https://ww2.arb.ca.gov/resources/fact-sheets/innovative-small-e-fleet-pilot-program

