UC Davis EV Charging Infrastructure Evaluation

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Background

Following an executive order by Governor Gavin Newsom, the California Air Resources Board (CARB) is tasked with mandating all sales of new vehicles in the state of California to be zero-emission vehicles (ZEVs) by the year 2035 (Newsom, 2020). In addition to the CARB mandate, UC Davis remains committed to achieving ambitious sustainability goals. Notably, UC Davis aims to transition its commuter fleet to 4.5% ZEVs by 2025 and 30% by 2050. Sustainability goals such as these support larger university goals such as achieving carbon neutrality by 2025 (Corkery, 2021). With these outlined goals, it is clear there will be an increase in electric vehicles (EVs) commuting to campus and an increasing demand for EV charging infrastructure on campus. However, the best strategy to meet the increasing demand of EV charging capacity is debated amongst stakeholders within the UC Davis community. Considering this, UC Davis hired Affiliated Engineers and DKS Associates as consultants in order to devise a plan and framework for expansion. An electric vehicle study (AEI/DKS Report) was then submitted to UC Davis on May 25th, 2021 (Affiliated Engineers & DKS Associates, 2021).

According to the AEI/DKS Report, UC Davis campus is recommended to increase charging capacity to 304 chargers by 2025, 795 by 2030, and 1,109 by 2035 as outlined in Figure 1 based on a recommended five commuters per charger (Affiliated Engineers & DKS Associates, 2021). Currently, UC Davis has 80 chargers on campus according to an inventory assessment from February, 2022 (Transportation Services, 2022). According to these recommendations, UC Davis needs to install an additional 224 chargers prior to 2025 in order to stay on pace with this expansion framework. The AEI/DKS Report highlights a plan to achieve this expansion, however, this plan has not been widely accepted by involved UC Davis departments. Our client, Ramon Zavala at Transportation Services, noted the AEI/DKS Report was too broad and did not specifically outline the best strategy for expansion. With this, Ramon tasked our team with developing an updated report. The report is divided into two main sections: Part I (Evaluation of Campus EV Infrastructure) and Part II (Our Recommendations).

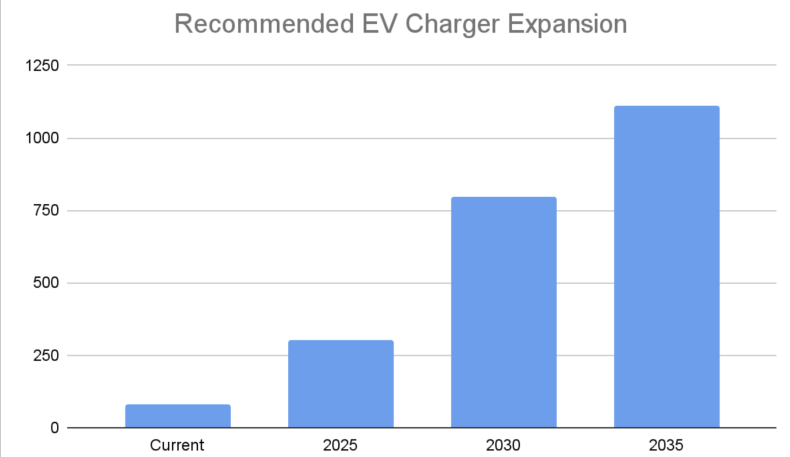

Figure 1. Number of chargers recommended by AEI/DKS Report in the years 2025 (304), 2030 (795), and 2035 (1,109). Currently UC Davis has 80 chargers on campus.

Within Part I of the report, we highlighted department concerns, limitations, needs, preferences and current/future EV charger projects. In Part II, we make our personal recommendations based on the information we gathered from departments as well as our own personal research. With this report, we ultimately present an updated plan and framework for UC Davis to strategically expand EV charging infrastructure on campus. Campus management may utilize this plan to expand on current efforts and allocate resources effectively in order to achieve sustainability goals and meet the increasing demand for EV charging infrastructure on campus.

Methodology

Informational Interviews

In order to gather information from departments, we conducted informational interviews. This included interviews with management from Transportation Services, Utilities, Design and Construction Management (DCM), Institute of Transportation Studies (ITS), and Fleet Services. Through this process, we were able to gain insight into each department's view on the EV charging infrastructure expansion. During each interview, we learned department preferences regarding charger models, pricing policy, and payment methods. Additionally, we gathered information involving previous plans for EV charger expansion within departments and whether or not future plans existed. Depending on current plans in place, we also learned of optimal locations for new chargers based on previous work. Our informational interviews also provided a platform to learn department concerns and limitations with regards to the EV charger expansion. Information gathered from the interviews was then synthesized and included in Part I of our report, and was also considered by our team when providing recommendations in Part II of the report.

Synthesis of Previous Reports

One of the main considerations while conducting interviews for the project was to determine optimal locations based on previous research. This is highly determined by available power and proximity to transformers on campus. Information regarding locations and charger models is included in the AEI/DKS Report, however, our team worked to identify additional previous research conducted by UC Davis departments. To gather information regarding this, we referred to a previous project report created by UC Davis DCM. This report provided detailed data including locations and current charger models available on campus. It also provided us with extensive details on the high intensity usage locations of the chargers on campus, and pricing policy for EV charging. The DCM report highlights 11 optimal locations based on cost-effectiveness and demand for additional chargers. More information about these locations identified by DCM can be found later in the results section of this report. Previous reports additionally emphasize the importance of a positive return on investment (ROI). For the purposes

of this study, ROI refers solely to the initial cost of investment for the project and the length of time required to offset this cost. Our team utilized previous reports to identify projects that would support the fastest ROI.

Analysis of Charger Models

After charger locations were identified, we aimed to determine the best charger model for future expansion projects. Interviews held with stakeholders helped us identify chargers that would fit the minimum requirements for the departments. An initial barrier for charging infrastructure lies in the capabilities of level 2 "smart" vs "dumb" chargers. Current campus charging infrastructure relies on ClipperCreek HCS-40 "dumb" chargers which are incapable of charging per kWh (kilowatt hour) or tracking precise usage histories necessary for our client, Transportation Services. Alternatively, "smart" level 2 chargers allow Transportation Services to charge for electricity per kWh and record usage history allowing them to claim Low Carbon Fuel Standard (LCFS) credits. LCFS credits are awarded by the California Air Resources Board and provide owners of chargers with a funding grant based on charger usage and reduction of carbon emissions (CARB, 2022). We completed a literature review to determine EV chargers that satisfied American Disabilities Act (ADA) compliance, can charge per kWh, and can track usage.

A primary motivation for this project is utilization of funding available from the California Electric Vehicle Infrastructure Project (CALeVIP). CALeVIP provides a short list of charger models, both AC (alternating current) Level 2 and DC (direct current) fast chargers, which satisfy the UC Davis department requirements and qualify for additional rebate funding through CALeVIP (CALeVIP, 2022). On further analysis, we found that the ChargePoint chargers CT4000 series, Blink's IQ 200, Enel's Juicebox 32, and Powerflex Webasto Turbo DX from the rebate eligibility list satisfied UC Davis requirements.

Figure 2. ChargePoint CT4000 (Dual Connector)

Figure 3. Blink's IQ 200

The final step after analyzing charger models was to check ADA compliance. As an employer, installing electric vehicle supply equipment (EVSE) requires construction updates to follow special design guidelines to accommodate people with disabilities, as required by the ADA. Although the ADA does not provide design standards for charging station-equipped parking spots, the US Department of Energy does (DOE, 2022). Some of the important ADA requirements are having accessible card reading devices, facility accessibility, and cable reach range. The charger models previously mentioned are ADA compliant, and hence can be considered for installation by UC Davis.

Results

Needs

There is a clear need to expand UC Davis EV infrastructure to meet increasing demand and achieve campus' sustainability goals. While this expansion is important, it's just as important to upgrade the existing "dumb" chargers to "smart" chargers, so users are billed by their kWh usage. The existing "dumb" chargers do not track charging usage, resulting in a missed opportunity for Transportation Services to be able to collect LCFS credits and charge users for charging. We also found it important to consider using multiple payment methods, as most "smart" chargers can easily be set-up to accept app-based payment, but this assumes everyone has access to a smartphone. So, it would be best to accept both an app-based payment, and a more traditional payment method like a debit or credit card kiosk at these charging locations.

Figure 4 and Table 1, on the following page, highlight and outline the identified most cost-effective locations to install new EV chargers across campus, as identified by UC Davis DCM. Additional charger ports could be added to each of these locations (as compared to the values in the table) to help UC Davis reach the goal of ~300 charging ports by 2025. These locations are also distributed well across campus, making them accessible for users no matter where they are coming from. Additionally, considering the high demand for EV infrastructure in these lots, the ROI for the cost per capita of new chargers will be higher than other locations. Financial constraints prevented DCM from moving forward with this project, however, it may be utilized as a framework for future projects.

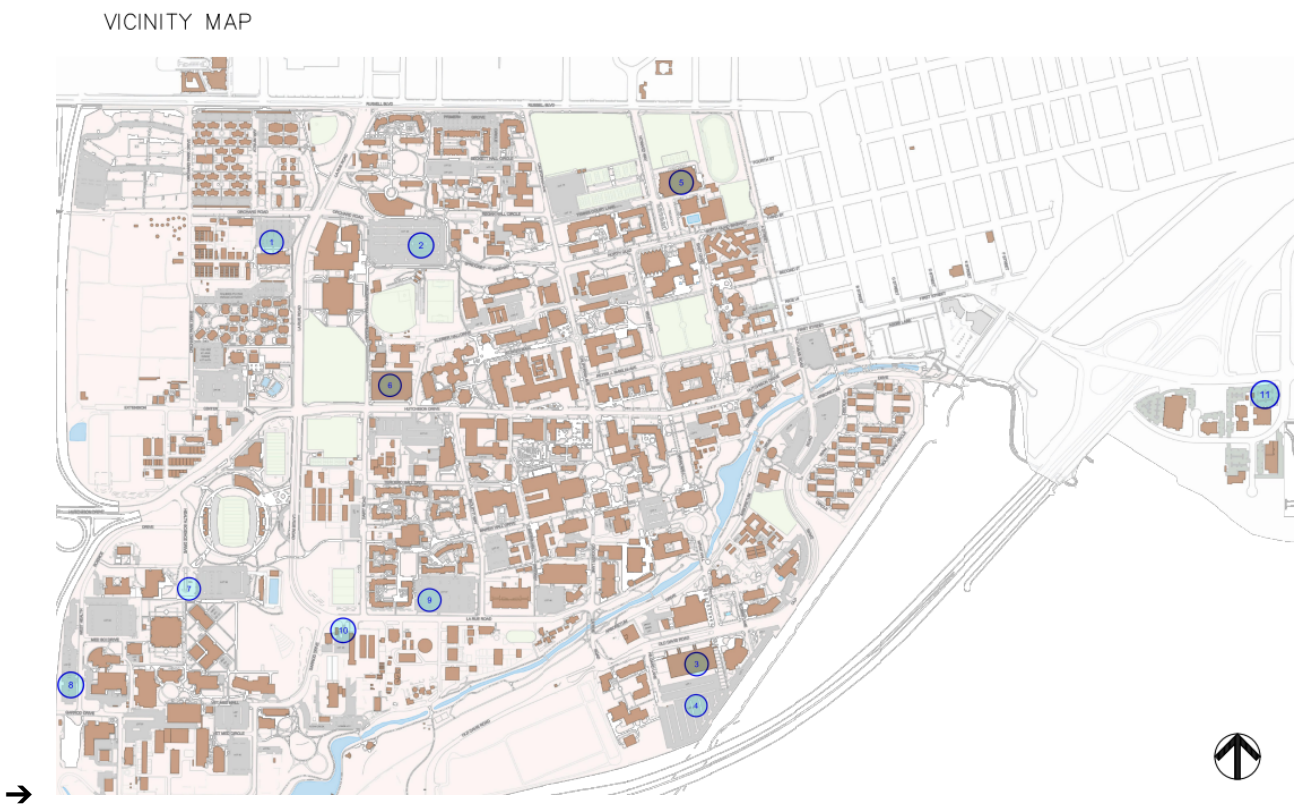

Figure 4. Optimal Locations for new EV charging stations as determined by the Design and Construction Management Report.

DCM Project: EV Charger Locations			
Map Index #	Parking Facility	Address	# of Charger Ports
1	Lot 35	1050 Orchard Rd.	2
2	Lot 25	760 Orchard Rd.	10
3	Gateway Structure	600 Hilgard Ln.	10
4	Lot 1	254 Old Davis Rd.	10
5	Quad Structure	400 Howard Way	4
6	Pavilion Structure	685 Klieberhall Dr.	6
7	Lot 56A	426 Health Science Dr.	2
8	Lot 57	620 W. Health Science Dr.	10
9	Lot 47	375 Bioletti Way	10

10	Lot 49	740 La Rue Rd.	6
11	Lot 80	1333 Research Park Dr.	4

Table 1. Location identification for new EV charging stations as determined by the Design and Construction Management Report.

Concerns

As UC Davis continues to expand and plan future projects it will be important to consider the installation of additional transformers to support future EV infrastructure. UC Davis is a commuting destination, and located at the conjunction of two major transportation corridors - Interstate 80 and Highway 113 - UC Davis could utilize future EV infrastructure to cater to other EV travelers/commuters along these corridors for increased charger use and profits.

After conducting our informational interviews, we also found a lack of interdepartmental coordination across the UC Davis campus and lack of consensus on how best to expand UC Davis' EV infrastructure. We also found it concerning that UC Davis is not collecting the LCFS credits for the few "smart" chargers that are already installed on campus, however we did discover that there is a pathway to correct this, so UC Davis can collect these LCFS credits. Some campus stakeholders also highlighted concerns around the current lack of access restrictions/time limits for using EV chargers on campus - meaning that Davis residents can exploit the current charging price scheme. Additionally, the maintenance of EV chargers on campus is currently being contracted out, but in the future UC Davis Utilities or other departments may become responsible for the ongoing maintenance of these chargers.

Limitations

There are two main limitations that were identified through the process of this project - the availability of power and funding. The UC Davis campus runs off its own power grid, so it is critical to understand the power demand and power availability around and near parking facilities on campus, as installing EV chargers where there is no available power would not be cost-effective. As previously mentioned, the DCM project was not completed due to funding constraints around upgrading parking facilities to meet ADA requirements, which was a common theme we found throughout our research and informational interviews among multiple departments.

Equity Considerations

Throughout this report we have included equity concerns and constraints. Within this section, we aim to provide additional recommendations highlighting our concerns, and the way in which these may be addressed and applied as the EV charging infrastructure expansion proceeds.

- ➔ *Leakage of current billing system:* The current billing scheme on UC Davis campus charges a flat fee for the day rather than charging per kWh. This means newer cars and batteries charge significantly faster and get more energy for the same price. Additionally, the non-market rates incentivizes non-commuters to exploit cheap charging rates on weekends and off-hours. By charging per kWh, UC Davis may address current issues with disproportional benefits resulting from the current billing scheme.
- ➔ *ADA compliance barriers:* Meeting ADA compliance has historically been a cost barrier for EVSE infrastructure. Electrifying the commuting fleet is essential in reaching sustainability goals for many years to come. It should be expected that such a large capital investment includes ADA compliance for the coming decades. Commuters with disabilities are far more likely to rely on a car for commuting than alternative transportation like bikes or buses. Additional UC Davis funding will be required to ensure projects meet ADA compliance and support EV infrastructure expansion.
- ➔ *Comparing needs of UC Davis fleet and commuters:* Future charging installations need to meet a diverse set of needs between the UC Davis EV fleet and commuters. Fleet vehicles are essential to operations of UC Davis departments but any new infrastructure must also ensure that commuters have suitable locations to charge for their commute. Policies which increase the transparency of charging priority are necessary to navigate this issue.
- ➔ *Payment options:* As various payment mechanisms are considered, it is important to consider accessibility amongst users. ParkMobile currently provides a platform for charging users for parking, and may be utilized for EV charging as well. However, not all users may have access to a smartphone to utilize app-based payments, so including other forms of payment mechanisms such as a kiosk positioned at the stations should be considered. Additionally, a tiered payment system based on employee or student status of commuters will increase charging access to a wider range of users.

Recommendations & Discussion

Addressing Short Term Needs (2020-2025)

The focus currently should be on rapid expansion of level 2 *smart charging* infrastructure. The ClipperCreek HCS-40 level 2 chargers currently installed around campus lack key features including billing per kWh, and usage tracking required to claim LCFS credits, which have been identified as a funding mechanism to increase ROI of campus chargers. Smart charging

infrastructure is required to meet the legal billing needs of UC Davis's Transportation Services and will increase revenues by charging per kWh rather than the current non-market rate of $0.50 per day for unlimited charging. While funding mechanisms exist for charging infrastructure, none exist for updating ADA requirements (restriping, widening spots, wheelchair access to chargers, etc.) which have proved to be a limiting barrier causing recent projects to fall through. Whether ADA compliance funding comes from UC Davis or a current department it is beneficial to act quickly as ROI may diminish due to limited CALeVIP funding, and the unpredictability of future LCFS credit value. It would be beneficial for UC Davis to take advantage of CALeVIP funding and begin claiming LCFS credits as soon as possible, particularly because these funding mechanisms are time limited, whereas ADA compliance is a necessary capital investment regardless of timing window.

As mentioned in our discussion of charging brands, we are recommending chargers in the ChargePoint CT4000 Series (all level 2 smart chargers), particularly the ChargePoint CT4021, their most economical dual port charger (Figure 2). These chargers would be capable of charging two vehicles simultaneously, bill per kWh, and provide trackable electricity usage to claim LCFS credits, and better monitor UCD customer usage for future billing adjustments. UC Davis also has an existing relationship with ChargePoint, who are willing to complete paperwork and submissions for CALeVIP grants. Additionally, ChargePoint is capable of transitioning ownership of LCFS credits to individual UC Davis departments alongside a monthly maintenance and usage fee. This could provide both a revenue source for individual departments and reduce maintenance costs and training times for UC Davis employees not familiar with charging infrastructure maintenance needs.

Cost-effective installation locations have previously been identified by UC DCM (previously mentioned in this report). We recommend UC Davis proceed with installations at these locations including the replacement of ClipperCreek HCS-40 chargers. UCD is unlikely to receive funding as generous as CALeVIP and ChargePoint can provide, and most funding barriers are due to construction costs and facility updates rather than the costs associated with the chargers themselves. There are currently no grants or available funding mechanisms for ADA compliance updates and construction associated with EV charger installation.

Once chargers are in place, a new billing method for electricity use can be put in place. We recommend replacing ClipperCreek HCS-40s prior to a campus-wide billing method overhaul due to equity concerns of different charging rates around campus: $0.50 for the day at ClipperCreek charging sites compared to the recommended $0.28-$0.38 per kWh at updated charging sites (AEI & DKS, 2021). Currently, commuting customers use the ParkMobile app to pay for parking and charger usage on campus. Ideally, this mechanism would remain but allow customers to make a second payment for charging. Payments for electricity must be paid separately to qualify for LCFS credits and meet federal fuel payment guidelines. Alternatively, pay-by-card mechanisms

are easy to apply to the ChargePoint CT4021 and would work well with UC Davis Fleet Vehicles needs and be a familiar and accessible process for commuters and opportunity parkers. Billing restructure can be a motivating factor for smart charging infrastructure as ROI of the new billing mechanisms and LCFS credits will quickly eclipse the price difference between the ClipperCreek HCS-40 and the ChargePoint CT4021.

Identifying Future Infrastructure Gaps and Needs 2025+

Reaching the recommended goals of 304 chargers by 2025, 795 chargers by 2030, and 1,109 chargers by 2035 is currently not attainable or on pace with the current strategy of lowest cost-effectiveness and lack of capital investment in additional transformers or construction costs in parking lots. Current transformer capacity is incredibly limited for installation of new chargers. Additional capital investment from UC Davis is necessary to expand capacity and complete costly construction updates and trenching required in concrete lots. As previously recommended to UC Davis in the AEI/DKS report, higher priced charging for opportunity parkers may be a suitable revenue stream in lots that require high-investments like an additional transformer. Opportunity charging refers to short-term usage of chargers during a commute, such as health clinic visits, or a stop at the gym. We recommend that additional high investment chargers be placed in locations with high opportunity charging usage such as: the Mondavi Center, Memorial Union, Aggie Stadium, Activities and Recreation Center, Manetti Shrem Art Museum, Medical Center, and the Quad and Pavilion parking structures. These locations are likely to be utilized heavily by staff and students during the work day, and by commuters and opportunity parkers on weekends and evenings, which will increase charging usage and provide a faster ROI for high cost projects.

UC Davis Fleet Vehicles are also hoping to rapidly expand their EV fleet. Charging needs of the EV fleet will overlap heavily with commuter charging needs and locations. Efficient allocation of charging capacity between commuters and fleet vehicles will require a combination of infrastructure and policy solutions. Infrastructure solutions include increased DC fast charging capacity for fleet vehicles and repurposing of retired ClipperCreek HCS-40s for “behind the fence” (not accessible to public) charging capacity. Note that public availability is required for LCFS credit qualification. As our commuting EV population increases, it is necessary to ensure Fleet Services has access to at least one DC fast charger for quick refuels, reducing lag-time for rental customers. Should supply of chargers continue to fall behind, we recommend keeping ClipperCreek HCS-40s on hand to fix an emergency shortfall of EV charging infrastructure on campus. It is unlikely these would be cost-effective due to installation costs and a lack of revenue stream. Policy changes are likely needed should charging competition increase between the EV fleet and EV commuters. Stricter enforcement of charging time limits (currently 4 hours) will be needed if demand for chargers drastically eclipses supply. Higher overnight charging fees could be applied to commuter and opportunity chargers compared to fleet needs. Fleet vehicles may be

able to capitalize on overnight charging to refuel cars each day whereas commuters rely heavily on daytime charging. Charging costs may be able to incentivize this behavior among users.

Next Steps and Continued Research

A complete ROI report is the logical next step in expanding EV charging infrastructure on campus. Given predicted growth of electric vehicles in California, it is necessary to create an outline of expected capital investments and revenue over the next decade(s) of electric infrastructure expansion. Aside from cost-effective locations, large capital investments like transformer installation will require more thorough research into ROI. Currently we recommend any future ROI study must include: current and projected charging capacity, stability and projection of LCFS credits, availability of CALeVIP funding, kWh pricing, capital investment costs, operation costs, maintenance costs and product lifetime, ADA compliance costs, and the rapidly developing EVSE market.

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