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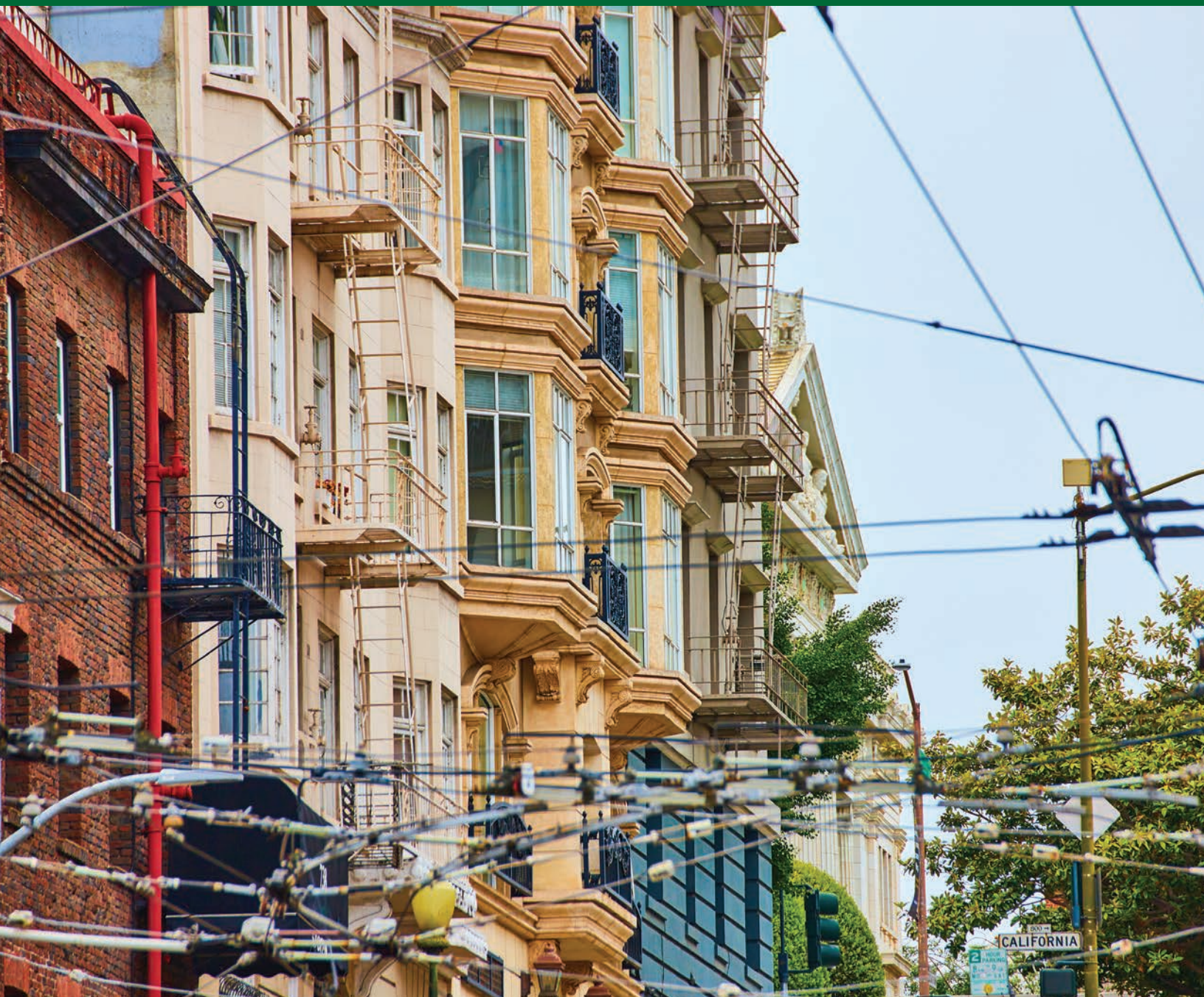
Policy Brief

EV Equity Initiative

POLICY STRATEGIES TO PROMOTE EQUITABLE EV CHARGING ACCESS FOR *Multi-Family Housing Residents*



AUGUST 2024 | **POLICY BRIEF**

POLICY STRATEGIES TO PROMOTE EQUITABLE EV CHARGING ACCESS FOR MULTI-FAMILY HOUSING RESIDENTS

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ABOUT THIS REPORT

To prepare this report, the Center for Law, Energy & the Environment (CLEE) researched city programs and existing case studies about efforts to install and operate electric vehicle charging equipment at multifamily residences. The authors conducted interviews with several program officials and multifamily residential charging experts. This brief is intended to guide local government leaders, building managers, and other stakeholders involved in the planning and installation of charging infrastructure at and near multifamily residences.

CLEE developed this policy brief as part of its EV Equity Initiative, which seeks to build locally tailored, community driven, and replicable approaches to the development of electric vehicle and mobility infrastructure in underserved communities in California and US cities.

ABOUT THE CENTER FOR LAW, ENERGY & THE ENVIRONMENT

CLEE channels the expertise and creativity of the Berkeley Law community into pragmatic policy solutions to environmental and energy challenges. CLEE works with government, business, and the nonprofit sector to help solve urgent problems requiring innovative, often interdisciplinary approaches. Drawing on the combined expertise of faculty, staff, and students across the University of California, Berkeley, CLEE strives to translate empirical findings into smart public policy solutions to better environmental and energy governance systems.

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I. INTRODUCTION AND EXECUTIVE SUMMARY

A. CHARGING ACCESS FOR MULTIFAMILY HOUSING RESIDENTS IS NEEDED FOR AN EQUITABLE EV TRANSITION

Leaders in California and 12 other states that are adopting the Advanced Clean Cars II regulation[a] have set a target of completely phasing out new internal combustion engine vehicle sales for passenger cars by 2035, as part of the effort to reduce greenhouse gas emissions and other harmful air pollution.[1] The transition to 100 percent zero-emission automobile sales by 2035 will require significant expansion of electrical vehicle (EV) charging infrastructure. In California alone, for example, the California Energy Commission projects that 2.11 million public and "shared private" (i.e., publicly accessible on private property) chargers will be needed "across a range of power levels and location types"[b] to support roughly 15.2 million statewide plug-in electric light-duty vehicles in 2035;[2] this figure far exceeds the roughly 105,000 chargers of this type available statewide as of August 2024.[3]

California's current charging shortage reflects the broader need to install many millions of new EV chargers nationwide to secure a timely clean mobility transition. Homes

a The Federal Clean Air Act allows other states to adopt California's motor vehicle emission standards under Section 177. See e.g., United States Environmental Protection Agency, "Vehicle Emissions California Waivers and Authorizations" (webpage), available at https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations; for the list of 12 states that have adopted California's vehicle sales regulation, see e.g., California Air Resources Board, "States that have Adopted California's Vehicle Standards under Section 177 of the Federal Clean Air Act," available at https://ww2.arb.ca.gov/sites/default/files/2019-03/177-states.pdf.

b The California Energy Commission states that 83,000 of the 2.11 million total required public and shared private chargers should be direct-current fast chargers; *California Energy Commission, Assembly Bill 2127 Second Electric Vehicle Charging Infrastructure Assessment*, supra, pp. 2-4.

constitute the core of a convenient and reliable charging network, and EV charging infrastructure in multi-unit dwellings and multifamily housing (MUDs and MFH[c]) in particular will serve a vital role in ensuring an equitable clean mobility transition.[4]

The rapidly approaching EV transition combined with the scarcity of EV charging availability in MUDs unfavorably positions "lower-income households and those in dense metropolitan areas who disproportionately rent their residence." [5] The ability to fuel vehicles at home represents one of the clean mobility transition's most significant, practical enhancements to passenger vehicle driving and mobility. Charging availability in residential locations delivers EV drivers a major cost and convenience advantage over traditional internal combustion engine vehicles that rely on fossil fuel from gas stations.[6] Most EV drivers fully exploit the new benefit; more than 80 percent of EV charging occurs at drivers' homes.[7] While each driver's charging preferences match their individual circumstances, the ease and practicality of residential charging leads the majority of EV drivers to characterize their residence as the most important location for charging needs – followed by work, then public locations.[8] Among these options, residential charging (Level 1 and Level 2) is typically the least expensive; average public charging prices vary between $0.30 and $0.60 per kilowatt-hour (kWh) – significantly greater than the residential average of $0.16 per kWh.[9]

However, the current residential reach of EV charging infrastructure has left the cost and convenience benefits of at-home charging inaccessible for the large number of US residents living in MUDs. Household charger utilization overwhelmingly skews toward owner-occupied single-family residences; while MUDs constitute almost a third of US households, less than five percent of at-home charging occurs in MUDs.[10] This residential charging disparity is likely not a product of differential driving behavior between these two housing types; 75 percent of MUD households contain at least one vehicle.[11]

Instead, MUDs lack the volume of charging equipment that is currently expanding among single-family properties. Although state and local governments around the country are instituting EV readiness standards (for example, California's Title 24 Green Building Code requires charging infrastructure or host capacity in newly constructed buildings), the median age of rental buildings nationwide is 44 years – significantly predating the recent period of growing Electric Vehicle Supply Equipment (EVSE) needs, infrastructural considerations, and standards.[12] Because MUDs disproportionately house lower-income residents,[13] rental units' limited EV readiness could exacerbate mobility disadvantage among priority populations.[d]

Without equitable access to charging at or near their homes, MUD residents are at risk of paying significantly more for less convenient charging than single-family home residents. This pricing inequity scales to broader economic disadvantage; according

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c For simplicity, this report uses the term MUD to refer to all multi-unit housing arrangements.

d "Priority populations" is a definition used by California climate policymakers to describe households and communities that are both Disadvantaged Communities (as defined by the CalEnviroScreen 4.0 set of environmental burden and demographic indicators) and low-income communities and households (at or below 80 percent of statewide median income). These households and communities are prioritized in many state and local climate planning and investment programs, such as the California Climate Investments program. This report uses "priority populations" generally to encompass lower-income, environmentally vulnerable, and transportation-disinvested communities most in need of policy support in the EV transition.

to recent census data, nearly 92 percent of American households own at least one car, and the majority of American workers use single-occupancy or pooled vehicles for their work commute instead of other travel methods.[14]

Given the financial and structural barriers facing MUD charging investment, an equitable clean mobility transition that adequately serves priority populations will require proactive policies to rapidly expand access. This policy brief highlights equity-focused strategies to overcome those barriers, based on an analysis of charging programs and existing case studies of EV charging at MUDs.[e]

B. MUDS FACE HEIGHTENED BARRIERS TO CHARGING INVESTMENT

The disparity in charging availability between single- and multi-unit residences results from a range of factors that make EVSE installations significantly more challenging for MUDs. Landlord-tenant and shared ownership arrangements that govern MUDs require installation and operational decisions to align incentives among a broad range of stakeholders – a challenge that single-unit homeowners avoid.[15] Additionally, lower-income MUD residents and building owners generally have less access to capital for installation and electrical upgrades, relative to upper-income MUDs and single-family households. And MUDs can present basic infrastructural challenges to charging installation such as shared parking spaces and common electrical infrastructure. The collective challenges to EVSE installation in MUDs closely reflect the findings of the California Air Resource Board's (CARB) Low-Income Barriers Study – which highlights key affordability, awareness and coordination barriers to ensuring clean transportation access in low-income areas.[16] Based on case study analysis, interviews with MUD charging infrastructure experts, and review of existing reports, this brief evaluates the following three central barriers to securing EV charging in MUDs:

- **High installation and operational costs** required for EV charging in MUD parking areas (and in public spaces for MUDs that lack onsite parking)
- **Low EV demand and awareness** among MUD residents and building managers[17]
- **Limited electrical and network capacity**, particularly in older MUD buildings

Beyond the direct barriers to charging installation in MUDs, there is substantial concern about green gentrification associated with charging infrastructure development.[18] The potential for rent-induced housing displacement following EVSE installations and other clean infrastructure enhancements poses a critical equity challenge to communities and building owners seeking to participate in the clean mobility transition.[19] While there is extensive precedent for effective anti-displacement policies implemented on community and city levels, few anti-displacement strategies have been documented in the EV charging context to date. This is a key area for further policy development alongside the charging access solutions featured in this report.

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e The analyses in this report relied primarily on a review of existing case studies alongside select expert interviews. A full list of case studies can be found on page 38.

BUILDING TYPES AND ARRANGEMENTS

MUDs encompass a diverse group of buildings, living situations, and technical arrangements (e.g., different parking and electrical infrastructure layouts) that will determine which strategies or investments are most suitable for a specific building. Key distinctions among MUDs for policymakers and program managers to consider include:

- **Owner-occupied (e.g., condominium and co-op) vs. rental**: Rental buildings will face split incentives between building owners and tenants, but may also benefit from single-owner management and financing; co-op and condo owners may have more challenges coordinating their interests.
- **Old vs. new construction**: Older buildings are more likely to require expensive electrical system upgrades to accommodate chargers but may also be ready for comprehensive energy retrofit projects.
- **Affordable (deed-restricted and "naturally occurring") vs. market-rate**: Affordable properties are more likely to have limited capital and face financing-related restrictions on new investments but may also qualify for more incentive programs.
- **Large vs. small buildings**: The needs and management capacity of a building with 100 or more units will differ greatly from those of a small building with four or five units.
- **Dedicated on-site parking vs. off-street parking**: Charging infrastructure will present different ownership possibilities, charging rates, and legal obligations depending on its location on- or- off-site.
- **Assigned parking vs. unassigned parking**: Buildings without assigned parking spaces will face charging access and coordination challenges among users.

While the findings and recommendations in this report do not distinguish among these building characteristics in each case, program and building managers will need to shape investments to meet the context.

C. MUD CHARGING PROGRAMS CAN AND SHOULD CENTER EQUITY

Analysis of 31 case studies of MUD charging projects and programs identified a wide range of strategies to address the barriers to MUD charging investment. The effectiveness and appropriateness of a solution will depend on the infrastructure and financial capacity of an MUD and the needs of its residents and community. This brief elevates existing applications of key strategies to address barriers to EVSE development at MUDs. The case study analyses focus on strategies with the greatest potential to advance the goals of equitable implementation and access for priority populations. In some instances, this brief proposes additional elements to enhance strategies' equitable reach and implementation. Key findings include:

Barrier A: High Installation and Operational Costs

1	Grants, rebates, and other incentive programs require **equity-focused allocation methods** to reach all residents and deliver equitable outcomes.	Primary Actors: **Electric Utilities/Community Choice Aggregators (CCAs)** **Local Governments**
2.	**MUD-specific electricity rates** can address inequities in charging prices by more closely matching residential rates that single-family households face.	Primary Actors: **Electric Utilities/CCAs** **EVSE Companies** **Local Governments**
3.	**Power management products and services** can reduce costs and support charger utilization from installation through ongoing operation.	Primary Actors: **Building Owners/Managers** **Electric Utilities/CCAs** **Local Governments**
4.	**Cost-sharing among residents** can reduce unit costs for charging equipment if EVSE demand is sufficiently high among residents.	Primary Actors: **Building Owners/Managers** **Building Residents**

Barrier B: Low Demand and Awareness

1.	**Targeted stakeholder outreach** is crucial for equitable participation in incentive programs.	Primary Actors: **Advocates and Educators** **Local Governments**
2.	**EV ownership incentives and accommodations** for MUDs with low near-term charging demand can improve charger accessibility and help jumpstart EV adoption.	Primary Actors: **Building Owners/Managers** **Local Governments**
3.	**Educational campaigns** can broaden awareness and adoption and should be led by community-aligned public agencies and/or trusted organizations.	Primary Actors: **Community-Based Organizations** **Advocates and Educators** **Local Governments**
4.	**Opening chargers for public use** can provide utilization support when residential charging demand is low.	Primary Actors: **Building Owners/Managers** **Electric Utilities/CCAs** **Local Governments**

Barrier C: Electrical Capacity Limitations

1. **Load-balancing charging equipment** can help minimize electrical upgrades but also reduces user convenience. Potential inconveniences associated with load-management technology should be offset by lower prices and/or supplemental charging and mobility options beyond the MUD.

Primary Actors:
Building Owners/Managers
Electric Utilities/CCAs
Local Governments

2. **Level 1 charging** can reduce the need for electrical upgrades at the expense of charging speed. In some instances, Level 1 charging provides a feasible alternative to Level 2, but it should only be considered in limited cases and is ideally supplemented by nearby Level 2 and fast-charging options to avoid systematic inconvenience for MUD residents.

Primary Actors:
Building Owners/Managers
Local Governments

3. **Mobile charging systems** can substitute for fixed installations in very limited use cases.

Primary Actors:
Building Owners/Managers
EVSE Companies

Section D: Community Mobility Strategies

1. **Community ownership and investment models** should accompany EV charging installations to address displacement concerns.

Primary Actors:
Building Residents
Community-Based Organizations
Local Governments

2. **Offsite, public charging options and carshare services** can provide valuable supplements to (or in some cases, replacements for) onsite MUD resources. Charging centers, mobility hubs, and carshare programs that are co-managed by partnered public agencies and/or private organizations (including utilities and CCAs) can support MUDs that lack dedicated parking and EV ownership or are unable to privately fund EV infrastructure in their own parking areas.

Primary Actors:
Building Owners/Managers
Community-Based Organizations
EVSE Companies
Local Governments
Building Residents

3. **Curbside and public right-of-way charging** can complement or serve as residential options to support a comprehensive and reliable charging network for building residents.

Primary Actors:
EVSE Companies
Local Governments

II. BARRIERS TO EQUITABLE MULTIFAMILY CHARGING ACCESS AND STRATEGIES TO OVERCOME THEM

A. EQUITY BARRIER: HIGH INSTALLATION AND OPERATIONAL COSTS

High installation and operational costs are frequently cited as strong deterrents to EVSE deployment at MUDs.[20] In higher-income buildings, residents may willingly incur these costs through elevated charging prices or rent payments and are more likely to be near-term EV adopters. But middle- and lower-income MUD residents largely lack the financial resources to pay these additional costs, and lower-income MUDs often lack flexibility to take on new capital investments. As a result, building owners and managers rely heavily on cost-mitigating strategies that avoid financially debilitating price- or rent-offsets – if they are able to take on a charging project at all. Several strategies can help reduce the cost of EVSE installation and the rates that drivers pay to charge; the case study analysis highlights mechanisms to help these strategies meet the needs of priority populations.

1. Grants, rebates, and other incentive programs require equity-focused allocation methods

Primary Actors:
Electric Utilities/CCAs
Local Governments

Incentive programs (e.g., state and local government EVSE grants and rebates, or utility make-ready programs) are a standard component of many charging investments; the MUD case studies included in this analysis drew heavily from grant and rebate funding opportunities to assist installation costs. These incentives are needed for charging equipment and for electrical service upgrades,

especially in older buildings without adequate on-site power and where near-term charger utilization is likely lower.[f]

However, depending on program structure and allocation methods, financial incentives do not necessarily promote equitable outcomes. Program evaluators and participants have found that equitable distribution of funds requires more deliberate allocation than the simple "first come, first served" mechanisms that rebate programs often employ. Funding allocations that reward application submission speed can favor higher-income applicants with sufficient capacity to act under tight time constraints, as do traditional grant processes with highly complex submission and reporting requirements. Tiered grants and rebates that consider applicants' income levels and actively support disadvantaged candidates can afford the distributor greater flexibility to align distribution with planned equity goals.[21]

UNTARGETED DISTRIBUTION

In Columbus, Ohio's Smart Columbus standard rebate-structured MUD charging program, only two of six ZIP codes of winning applications exhibited average household income levels below the regional median. Additionally, winning applicants also largely came from ZIP codes with higher average educational attainment than the regional population. Program administrators concluded that future program funds could be distributed more equitably and serve community needs more effectively by using a grant allocation system that accounts for equity-based applicant characteristics such as location, income, and educational attainment.[22]

- **Case Study – Tiered Rebate Alternative,** *Los Angeles, CA; Southern CA:* An analysis of MUDs in the Westside Cities area of Los Angeles recommends tiered rebates that account for "consumer income levels" and "locational attributes" in their distribution of funds. This progressive rebate mechanism, the report argues, "ha[s] proven to be more cost-effective, ha[s] lower total policy costs, and result[s] in greater allocative equity" [23] relative to standard rebates. These findings are drawn from CARB research that identifies enhanced cost-effectiveness and equity outcomes in several programs that were modified by tiered rebate mechanisms – including the Clean Vehicle Rebate Project, the Enhanced Fleet Modernization Program (EFMP), and the EFMP Plus-up Pilot Program.[24] Southern California Edison's Charge

f An EVSE project at Muir Commons in Davis, CA demonstrates middle- to upper-income MUDs' reliance on incentive programs to make EV charging installations financially feasible. With an aim to install one Level 2 charger for each of 26 residential units, Muir Commons residents leading the building's grant application estimated extensive retrofitting costs that exceeded $20,000 per charger. Collective tenant participation and grant support ultimately reduced costs to $550 per resident – with an additional $800 grant available for residents who would later buy an EV. The resident leading the project noted that the funding opportunities were instrumental in securing residential support and basic feasibility; see e.g., Charles Morris, "Muir Commons: A case study in MUD EV infrastructure" (March 3, 2019), available at https://chargedevs.com/features/muir-commons-a-case-study-in-mud-ev-infrastructure/; Eugen Dunlap, Interview (March 8, 2024).

Ready rebate program also uses a tiered funding allocation model, with the top quartile disadvantaged community sites qualifying for the highest-level rebate, and "lower rebates offered to non-DAC Multi-family and other non-residential entities." [25]

- **Case Study – Target Application Ratio,** *California (Central/ Northern):* The Pacific Gas and Electric (PG&E) / Ecology Action Multifamily Housing and Small Businesses EV Charger Program sets a funding ratio of 75 percent priority population recipients to 25 percent non-priority population recipients. The Ecology Action program outreach team identifies funding recipients using both targeted outreach efforts and deliberate waitlist prioritization. Ecology Action program staff have found that the outreach and waitlist dual-management strategy serves as a highly effective measure to maintain the program's desired applicant ratio.[26]

Incentive programs offer a crucial pathway to ease the cost barriers to EV charging installations in MUDs. By incorporating targeted allocation methods, program managers can maximize their ability to serve priority populations.

2. MUD-specific electricity rates can address inequities in charging prices

Primary Actors:
Electric Utilities/CCAs
EVSE Companies
Local Governments

For a variety of reasons, MUD residents typically face significantly higher charging rates compared to EVSE users in single-family households.[g] Most EV drivers in single-family homes can use electrical circuits that connect owned equipment directly to the electric utility; no third-party EVSE service provider operates in between chargers and the electricity provider.[27] By contrast, MUD charging is typically provided by a building owner or third-party service provider (sometimes thinly capitalized), so charging prices reflect provider fees and markups on top of basic utility rates, with additional fees that building managers charge to compensate for installation costs, ongoing operation, and other services like EV parking.[28] MUD chargers also often lack access to utilities' discounted EV charging rates, since chargers are frequently connected to common area meters.[29] And in instances where MUD charging retrofits are infeasible and EV-driving residents must rely on public charging alternatives, these drivers must pay unregulated, EVSE-determined charging prices that single-family residents can largely avoid.[30] As a result, the drivers who most need low-cost charging may be least likely to access it.

Multiple entities play a role in setting charging rates and thus have the potential to help address cost disparities for MUD charging:

g One Sacramento multi-unit complex served by Loop, an EVSE company, posted a charging rate of $0.35/kWh. Additionally, the apartment management assesses a $100 connection fee for each plug-in and a $25/month fee for EV drivers to use the charging station parking space. Another MUD complex served by Loop in Sacramento posted a $0.45/kWh charging rate but did not assess additional fees. These two charging rates (accounting for additional fees) culminate in annual charging fees that surpass single-family household rates' ($0.105/kWh) annual fees by about five times. These findings were drawn from an EV Charging Coalition for All Presentation (on file with authors) and an interview with Dwight MacCurdy and Diya Kandhra.

- **EVSE companies** that own MUD chargers directly set charging rates and could offer discounted or tiered rates based on household/building income levels or geography.

- **Electric utilities** set electricity rates and could appeal to utility regulators to secure per-kWh charging rates or rebates for MUD chargers (regardless of panel arrangement) to equalize costs relative to single-family home discounted charging rates.

- **Utility regulators** can approve MUD charging rates and could require public EV charging prices (particularly those frequently used by nearby MUD residents) to more closely reflect prices in single-family households or require utilities to help offset costs for lower-income public charging users.[31]

However, variation among MUDs' electrical infrastructure, utility services and other localized considerations as well as revenue requirements can limit these actors' ability to pursue more equitable charging rates; for example, lower prices for residents may have to be offered in tandem with subsidies for building owners to sufficiently incentivize their charger investments. The following case studies highlight applications of targeted pricing strategies.

PANEL CONNECTIONS AND CHARGING RATES

Multifamily residents' access to discounted residential electricity rates for charging often depends on the EV charging circuit's placement.[h] When a charger connects to the MUD's common power source through an EVSE company, it may be impossible to charge at the reduced rates utilities make available for dedicated residential chargers, and charging prices can reflect unregulated markups from the company and building owner. Common meter-connected charging can also activate demand charges, increasing utility costs for all of the building's residents. However, a charging circuit's direct connection to the tenant's individual electrical panel allows the resident to choose among the lowest-cost, regulated rates available to any single- or multi-unit household. Markup-differentiated charging rates reveal a potential tradeoff between incentivizing installations for building owners and securing fair prices for MUD residents.

- **Case Study – Location-Based Pricing**, *San Francisco Bay Area and Southern CA*: EVgo, an EVSE company, initiated a pilot program that determined per-kWh charging rates according to a variety of location-dependent factors. The program designated each charger one of three possible price levels according to local income levels, an environmental justice index (based on California's CalEnviroScreen[32]), and other market dynamics such as property costs, traffic congestion and local EV considerations.[33]

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h A program official for the PG&E / Ecology Action Multifamily Housing and Small Business EV Charger Program noted that many of the program's charger retrofits were connected to the building's common panel (as opposed to a dedicated EV charging panel or individual housing units) – preventing residents from accessing specialized EV charging rates. In most older buildings, securing EV charging discounts offered by the utility through an EV-dedicated panel requires additional electrical upgrades that add to program costs. To ensure equitable outcomes, programs should include support for these upgrade costs in older lower-income buildings.

- **Case Study – Utility Engagement**, *Davis, CA*: A resident leading the building's charger installations noted that MUDs are unfairly subject to higher rates for charging relative to individual homeowners in addition to MUDs' higher installation costs. PG&E applied to the California Public Utilities Commission for approval of a special rate offer for MUDs.[34]

3. Power management products and services can reduce costs and support charger utilization from installation through ongoing operation

Primary Actors:
Building Owners/Managers
Electric Utilities/CCAs
Local Governments

A growing market of products and services that reduce installation costs and simplify operational procedures for residents and building owners can help minimize the burdens (financial or other) associated with installing and operating charging infrastructure. The numerous costs associated with MUD charging development – including electrical permitting, setup and installation, annual service fees, and EVSE management and support – also present numerous opportunities for cost-saving technical and process innovations.[35] A variety of EVSE software platforms also include features that can help building owners optimize their management and maximize charger utilization and/or revenue generation among tenants.

Chargers with reservation capabilities can allow residents to schedule and coordinate sessions and ensure charging accessibility in instances of limited equipment. Flexible control systems can empower building owners to adjust charger profiles (e.g., pricing, power level, access) along a variety of parameters – including time of day, day of the week, renewable energy availability, and user type (e.g., tenants and public). If available, EVSE company staff can work with building owners to interpret chargers' data collection and help calibrate chargers to an MUD's needs – with particular attention to periods where tenants rely on moderate- to high-level power.

Public agencies and utilities can support lower-income MUDs by facilitating connections between building owners and products/services that reliably reduce EVSE installation and operational costs while enhancing charger utilization. Targeted subsidies, educational campaigns, and public-private partnerships can enhance both MUD building owners' awareness of useful products/services and EVSE companies' ability to deploy their resources in lower-income areas – especially given that some systems with reservation capabilities are "premium priced" products. If near-term low costs are achieved at the expense of equipment quality and long-term viability, building owners should be made highly aware of such tradeoffs (discussed further in Section C). An equitable application of adjustable equipment features would see building owners balance their own revenue generation needs with tenants' financial constraints.

- **Case Study – Driver Brings Own Charging Cable**, *National:* A number of EVSE companies offer products that transfer charging cable ownership and management responsibility to the EV driver, a practice that is common throughout Europe but mostly rare in the US. For example, Orange's Level 1 and Level 2 charging outlets exclude cables. (Drivers use their own cables that are often included with their

EV purchase.) It's Electric, an EVSE company focused on public and curbside installations, similarly excludes cables from their charging devices and instead provides detachable individual charging cables to customers. The exclusion of connection cables in fixed charging equipment circumvents significant cord-related maintenance issues that typically accompany ongoing operation, reducing building-side costs (although somewhat increasing user costs).[36]

- **Case Study – Planning Support**, *Toronto, Canada:* SWTCH, an EV charging management company based in Canada, supports building owners in their selection, setup and monitoring of shared charging equipment. The company guided the building owners of New Times Square – a 375-unit building in Toronto – in their selection of EVSE software profiles that would help avoid costly demand surges and electrical upgrades.[37]

- **Case Study – Reservation Software**, *Campbell, CA*: The Revere Campbell Apartments works with EVmatch, a software development company that coordinates charger use with a reservation system. EVmatch's low-fee software supplements Enel X Juicebox Level 2 chargers and offers reservation services to drivers via a mobile app. The app allows for users to locate stations and reserve or extend charging sessions. EVmatch also includes a management portal that allows for building owners to set pricing, idle fees, and availability for different user groups. The equipment manages user billing and reimburses the building owners on a set schedule.[38]

- **Case Study – Support Staff and Flexible Charger Profiles**, *Honolulu, HI; San Francisco, CA:* The Ko'olani selected OpConnect chargers largely on the basis of the EVSE company's "locally authorized repair staff and response time to service requests." [39] The OpConnect system uses a cloud-based platform to collect and analyze data, process payments, manage scheduling and ticketing, and provide support services for customers. The MUD can manage charger settings (e.g., pricing, accessibility) for up to nine periods throughout the day using the OpConnect portal. Similarly, the Madrone uses PowerFlex software, a cloud-based platform with price-setting, data analysis and customer support features. PowerFlex staff work with building managers to align charger profiles with MUD needs.[40]

The cost and convenience of residential charging in MUDs can depend on the building's charger profile and scheduling capabilities. MUDs' diverse structural qualities differentiate their optimal charging systems, and various assisting technologies and services can help building owners navigate this variety.[41]

4. Cost-sharing among residents can reduce unit costs for charging equipment if EVSE demand is sufficiently high

Primary Actors:

Building Owners/Managers

Building Residents

In MUDs where charging demand is sufficiently high, group investments in charger installations among willing tenants can substantially reduce chargers'

upfront unit installation costs.[42] Collective tenant engagement in EVSE installations is particularly relevant for multi-owner MUD types such as condominiums and co-ops and may have limited applicability for lower-income MUDs that are less likely to have high EV use in the near term. Limited incentive for lower-income tenants to collectively mobilize toward charger installations obligates public and private incentive programs and educational campaigns to accommodate scarce tenant demand and support EVSE coalition-building where necessary.

- **Case Study – Collective Participation**, *Davis, CA:* The Muir Commons co-op leveraged a substantial PG&E grant in its installation of 26 Level 2 chargers – one for each unit. The MUD's cooperative management structure warranted collective approval and cost-sharing among tenants for program participation and sufficient cost reduction. Muir Commons was able to overcome this barrier through coalition-building efforts from a few determined residents and a receptive culture among an environmentally concerned, highly informed resident base. (Some residents were CARB employees.)[43]

B. EQUITY BARRIER: LOW DEMAND AND AWARENESS

Limited awareness of EVs and their associated infrastructure remains a key barrier to adoption among residents of lower-income and priority communities; a general lack of knowledge about new EV infrastructure, potential long-term cost savings, and incentive opportunities produces reluctance toward clean vehicles and EVSE installations.[44] Insufficient advertisement and guidance for complex grant solicitations (and limited broadband internet access) can prevent many community organizations, local transportation agencies and residents from navigating clean mobility options.[45] Low near-term adoption in turn limits building managers' and EVSE companies' interest in installing charging in these communities. These barriers may be most significant for MUD residents who do not typically manage their building infrastructure.

Education and/or stakeholder outreach campaigns can help resolve uncertainties and EV knowledge gaps that can otherwise deter charging installations in MUDs. Similarly, various software platforms, program designs, and infrastructural decisions can ease building owners' operational burdens and maximize charger utilization to ensure sufficient return on investment. Securing equitable distribution of residential EV charging will require concerted efforts to educate residents and building owners and significantly boost charging demand (or temporarily accommodate low near-term demand). The following section highlights existing strategies to help resolve awareness and demand gaps in MUDs alongside additional equity considerations.

1. Targeted stakeholder outreach is crucial for equitable participation in incentive programs

Primary Actors:
Advocates and Educators
Local Governments

Public agencies and private organizations can conduct stakeholder outreach (to building owners, charging providers and residents) at the onset of MUD

charging expansion programs to broaden program uptake and increase charger utilization. Several organizations that have incorporated stakeholder outreach into their grant and rebate programs attribute a meaningful portion of program success to this preliminary component.

Stakeholder outreach serves a particularly significant role in ensuring the equitable distribution of EVSE program funds; MUDs whose residents currently have low demand for EV charging and greater financial barriers to adoption are likely to require targeted support to learn about and take advantage of program opportunities. Grant and rebate program officials dedicated to engaging with MUDs in priority areas can help spread awareness and build a compelling case for program participation that moderates building owners' financial concerns with the long-term benefits of installation. Program officials can promote equity in program participation using a range of equity-focused outreach selection criteria including income levels and other priority population indicators.[i] Officials can also leverage partnerships with local organizations to assist outreach efforts and increase community trust.

- **Case Study – Dedicated Engagement,** *California (Central/Northern):* The PG&E-Ecology Action Multifamily Housing and Small Business EV Charger Program includes a dedicated research team that conducts outreach to property owners and public housing authorities to identify and engage with prospective program participants. The team uses a PG&E mapping tool overlaid with demographic data (indicating CalEnviroScreen disadvantaged communities, tribal areas, lower-income communities, and rural areas) to identify priority populations and guide outreach to prospective applicants. Program officials also incorporate buildings' EV readiness into outreach selection criteria to increase the likelihood and ease of program uptake.[46]

- **Case Study – Local Partnerships and Educational Outreach***, Columbus, OH:* In the Smart Columbus Rebate Program, the city contracted with CFO, a clean transportation nonprofit based in Ohio, to conduct outreach throughout the program's planning and implementation. The City and CFO contacted EVSE providers and apartment developers to gauge program interest and initiate informative conversations with building managers about charging infrastructure. Program applications were found to directly reflect the city's and CFO's outreach efforts, and program evaluators emphasized the outreach component's significant contribution to the program's success. Evaluators also recommended broader outreach in future iterations to diversify the applicant pool.[47]

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i A full range of equity-focused selection criteria may also include educational attainment, air quality, employment status, and linguistic isolation (as used in CalEnviroScreen 4.0), among others. California Office of Environmental Health Hazard Assessment, *CalEnviroScreen 4.0* (October 2021), pp. 167-198, available at https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf.

2. EV ownership incentives and accommodations for MUDs with low near-term charging demand can promote equity in program participation and jumpstart EV adoption

Primary Actors:
Building Owners/Managers
Local Governments

Charging demand among residents is often a prerequisite to MUD charger installations; some EVSE incentive programs include residential EV ownership as an eligibility requirement, and many building owners are unlikely to invest in advance of high utilization by tenants. Building managers are more incentivized to purchase and maintain charging equipment if they view chargers as desired amenities that can attract and retain tenants. However, EV adoption to date has been disproportionately low among lower-income drivers, due to a combination of higher upfront prices, slower vehicle turnover, and informational/marketing limitations.

Building owners and program leaders can pursue strategies that directly address or temporarily circumvent the need for immediate EV charging demand among tenants. Building managers and EVSE programs can stimulate residential charging demand by offering EV use/ownership incentives that complement charger installations – including parking discounts for EV drivers, EV purchase credits, and free charging. Such incentives may help MUDs meet some EVSE financial support programs' eligibility requirement that recipients demonstrate meaningful charging demand.

Building-sponsored incentive strategies can require additional funding beyond EVSE installation and may therefore lack feasibility among lower-income MUDs. To ensure that EVSE support programs sufficiently reach lower-income residents, program leaders should consider omitting requirements that tenants currently drive EVs and demonstrate near-term charging demand for targeted MUDs. Additionally, program leaders can seek and elevate partnerships with EVSE companies that offer fee structures that are proportional to the level of equipment use among residents.

- **Case Study – EV Use/Ownership Incentives**, *Minneapolis, MN:* Green Rock Apartments supplemented its EVSE installations (between one and four Level 2 non-networked chargers for each of its four buildings) with incentives for EV use. Any resident who uses an EV is offered free parking, and all tenants are eligible for a $2,000 credit toward PEV purchases. In lieu of direct payments for each charging session, EV charging costs are included in residents' rent.[48]

- **Case Study – No Requirement of Current EV Use on Site,** *California* (*Central/Northern*): The PG&E/Ecology Action incentive program excludes the frequently-adopted application requirement for MUDs to demonstrate that tenants currently drive EVs. A program official reported that in many instances, the MUDs served by the program lack existing EV use; the program aims to support future EV adoption and accommodates a near-term lag in demand for the installed chargers.[49]

- **Case Study – Utilization-dependent Equipment Fees**, *Mebane, NC*: A 100-unit property in Mebane selected Orange's low-power

charging outlets partially on the basis of the company's usage-based equipment fee; properties are only charged for products when tenants use the equipment.[50]

A range of ownership incentives or accommodations can account for the likely prospect that extensive EV demand may not exist among lower-income MUD residents until convenient charging options emerge in tenants' residential parking areas.

3. Educational campaigns can broaden awareness and adoption and should be led by community-aligned public agencies and/or trusted organizations

Primary Actors:
Community-Based Organizations
Advocates and Educators
Local Governments

Adding an educational component to MUD-focused charging programs can help clarify technological considerations and procedures for building managers (such as maintenance requirements, lease costs, rebate opportunities, and panel evaluations, among others), encourage EV adoption, and stimulate charging demand among residents.[51] The cost-effectiveness imperative among lower-income MUDs elevates the need for trusted and impartial experts with close community ties (ideally local businesses and community-based organizations) to lead educational efforts. Workshops and information sessions led by representatives from for-profit vehicle or EV charging companies may steer tenants and building managers toward products or services that fail to maximize cost-effectiveness and convenience in their EVSE development, leading to inequitable outcomes for lower-income communities. EVSE programs led by for-profit companies or public agencies can enhance program-recipient alignment by funding community-based organizations to execute the programs' educational components.

Building managers can seek EVSE education in places beyond incentive programs. Some local EV advocacy organizations (led by trusted community members) conduct education and awareness campaigns to help familiarize citizens with EVs and their associated infrastructure. City governments can help maximize these organizations' community services by enhancing their capacity and facilitating their connection with MUD residents or building owners/managers.

This education can occur in a variety of venues and formats – including community workshops, ride and drive events, flyers, or on-demand support experts, among others. Educators and program leaders can enhance prospective EV adopters' engagement by embedding their efforts in social settings; community-based EV instruction adds layers of familiarity and comfort to the learning process and leverages an empirically validated tendency for individuals to adopt the attitudes and behaviors that are prevalent in their social networks.[52] Educators can also enhance campaigns' productivity by tailoring their content to the knowledge gaps and logistical needs of local communities, including communications in multiple languages as appropriate. However, the merits and formats of preliminary needs assessments should be reconciled with the potential burdens of information-gathering (e.g., time, commuting) imposed upon MUD residents and building owners.

- **Case Study – Local Organization-Led Education**, *California (Central/Northern); Bay Area, CA:* The PG&E-Ecology Action Multifamily Housing and Small Business EV Charger Program includes an education and awareness campaign that familiarizes tenants and building managers with charger installation and EV benefits and incentives. The Ecology Action team conducts two education processes at the MUD building site – one after the applicant submits final design and permitting materials with contract signature, and the other after the chargers are installed and activated.[53] Similarly, the Metropolitan Transportation Commission's (MTC) Bay Area nonprofit partner, TransForm, leads an educational component in the project team's Mobility Pilot Project.[54]

- **Case Study – Socially Embedded Awareness and Adoption**, *Columbus, OH; Oakland, CA:* The Smart Columbus Rebate Program is part of a broader Smart Columbus Initiative that includes a "Ride and Drive Roadshow" – which primarily hosts events at local company sites in Columbus. The initiative's employee-based approach introduces prospective drivers to EVs and their associated infrastructure alongside familiar colleagues.[55] The Oakland Eco-Block pilot project similarly encourages communal adoption by executing a whole-energy system retrofit (including shared charger installations) across a single residential block area. The project aims to leverage "the advantages of collective engagement and the neighbor effect, where community members inspire one another to embrace [the pilot's] innovative technologies." [56]

- **Case Study – Community-Based Organization Leadership**, *Sacramento, CA:* SAC EV is a community-based organization in Sacramento that educates local residents about EVs and their supporting infrastructure. The organization introduces community members to EVs through bimonthly informational workshops, exhibits, and ride and drive events, alongside flyers, displays and other program efforts. SAC EV seeks to "act as a centralized information source" [57] and advocate for EV adoption and availability. A board member at the organization attributes some of the program's effectiveness to its members' lack of profit motives, and he expressed interest in connecting with local building owners to help inform EVSE investment strategies for MUDs.[58]

- **Case Study – Varied Formats and Venues**, *Columbus, OH*: In the Smart Columbus Rebate Program, applicants submitted education and outreach plans to demonstrate their ability to secure charger utilization among tenants. The following strategy proposals were documented in the program analysis:

    - Coordinate with garage owners at properties to educate residents about charging equipment and distribute guidance and rules for their use
    - Have an EVSE expert available at the site
    - Provide informative, continually updated written and digital materials via flyers and/or email announcements
    - Host an EV driving demo or a ride and drive event
    - Work with EVSE companies to prepare educational materials

  In addition to the building developers' own educational efforts, the program's partnered nonprofit organization, CFO, continued coordination with the developers following rebate distribution.[59]

- **Case Study – Need-Based Education**, *Bay Area, CA:* The MTC-TransForm mobility options project included a comprehensive needs assessment that identified significant awareness gaps about EVs and their associated charging infrastructure. The assessment substantiated the need for a robust educational component in the program and in the broader EV transition, and specific needs varied significantly by program site.[60]

Heightened familiarity with new clean mobility technologies can help bolster EV adoption and charging demand among MUD residents. Various forms of community education can provide this familiarity, if paired with trusted local leadership and effective needs assessment.

4. Opening chargers for public use can provide utilization support when residential charging demand is low

Primary Actors:
Building Owners/Managers
Electric Utilities/CCAs
Local Governments

When EVSE financial support programs do not accommodate MUDs with low charger demand or building owners require more certain return on investment, MUDs can increase charger utilization by opening their EVSE infrastructure to public use. These buildings can serve as charging hubs in areas with few neighborhood-scale charging options in the near term. As the MUD's new charging equipment gradually incentivizes EV adoption among tenants, building owners can eventually convert to fully private use to ensure that tenants' charging needs are sufficiently prioritized.

In practice, building owners may be unwilling to navigate the additional management and logistical burdens that accompany public charging accessibility. Charging sessions that differentiate between public and residential users may require Wi-Fi connectivity and specialized charging profiles. Widening the eligible pool of users beyond residents to the public introduces safety and parking access concerns (potentially including Americans With Disabilities Act (ADA) and other accessibility requirements) and may amplify maintenance requirements.[61] Additionally, conversions from public to private accessibility may challenge nearby drivers and MUD residents who grew reliant on the MUD's charging amenities – so building managers that eventually roll back public charging access should do so with ample notice and close discussion with local governments. The following case studies represent instances where MUDs could successfully accommodate publicly accessible charging equipment.

- **Case Study – Temporary Public Access**, *Honolulu, HI*; The Ko'olani condominium building adopted three networked, load-balancing charging stations to serve growing demand among existing and prospective residents. The charging equipment includes control features that can differentiate charging access and pricing by different users (e.g., residents and public). Initially, the stations were open to both residents and the public. Access was then restricted to only residents as tenant EV adoption grew. (Approximately ten percent of the building's residents drove electric vehicles in 2021.)[62]

- **Case Study – Public Access**, *Minneapolis, MN:* The chargers at Green Rock Apartments are primarily intended to serve tenant drivers, but they are open for public use for a fee in cases of emergency.[63]

The additional burdens of public charging accessibility likely limit this strategy's optimal use cases to temporary periods of low demand. Local governments or public utilities could offer small financial incentives for MUDs to provide limited, emergency-use public access to support the existing public charging infrastructure. A conditional or limited accessibility policy following temporary public access may also reduce adjustment challenges for nearby residents who grew reliant on the MUD's chargers.

C. EQUITY BARRIER: ELECTRICAL CAPACITY LIMITATIONS

Insufficient electrical capacity – at buildings and in local distribution networks – can generate the bulk of financial challenges associated with EV charging installation in MUDs. Beyond fixed EVSE equipment costs, MUDs must pay for wiring that connects chargers to electrical panels (costs can range from the hundreds to multiple thousands of dollars), any necessary panel upgrades (hundreds to multiple thousands of dollars), and electrical service upgrades (typically in the tens of thousands of dollars) if the building's existing power supply fails to accommodate charging needs.[64] In California, newly constructed buildings subject to 2022 and later building energy codes must have adequate capacity for EV charging needs.[65] However, retrofitting challenges are prevalent in older buildings with dated electrical infrastructure and limited financial resources, which are disproportionately likely to house lower-income residents.[66] A variety of EVSE equipment decisions and their load-management implications can help building owners minimize the electrical capacity upgrades necessary to deliver residential charging services. This section highlights these strategies and measures to maximize their equitable implementation.

1. Load-balancing charging equipment can help minimize electrical upgrades but also reduces user convenience

Primary Actors:
Building Owners/Managers
Electric Utilities/CCAs
Local Governments

In instances of limited electrical capacity and insufficient resources to fund extensive upgrades, load-balancing mechanisms can allow building owners to deliver EV chargers using the building's existing power infrastructure. Specialized charging equipment can employ demand-response systems that calibrate individual chargers' power to the level of overall strain on the charging system or the building's power.[67] Simpler, less expensive equipment can use multiplexing technologies that send multiple signals over a shared circuit, or rotating models that distribute power intermittently among charging vehicles.[68]

While load-balancing equipment can thus reduce the upfront cost of charging installation and facilitate access at power-constrained sites, multiple factors may limit their advancement of equitable outcomes. For one, demand-response equipment itself requires Wi-Fi-enabled, networked charging infrastructure which can add costs. While building owners can opt for less expensive load management systems that use non-networked, standalone chargers, these

devices provide less reliable and convenient charging opportunities for users, relative to demand-response systems.[69] Furthermore, to the extent that a demand-response charging system must reduce users' charging speed to accommodate capacity constraints, these systems subject drivers to slower, less predictable charging experiences compared to standard, dedicated Level 2 charging systems. This issue is less pronounced for vehicles that are parked and charged for long durations, such as overnight.

State and local leaders and building owners could seek compensatory measures to offset systematic disadvantage among tenants who live in MUDs that use shared, load-balancing charging equipment. Charging prices for load-balancing systems could be reduced by values commensurate with the potential reduction in service speed or convenience. If building owners or the local utility identify capacity limitations, especially among older MUDs or clusters of older MUD properties, the provision of additional charging options in parking sites nearby these capacity-constrained properties can widen tenants' opportunities. (Section D discusses this strategy in detail.) The local utility and/or city leaders should coordinate to identify the properties and communities in most need of greater building and grid capacity and help utilities prioritize system upgrades.

- **Case Study – Demand-response, Networked**, *Portland, OR; Scottsdale, AZ; Campbell, CA; Burlingame, CA:* Several MUDs adopting load-management charging systems have opted to use Enel X Way JuiceBox EV stations. Using this product, multiple charging stations are connected on a single circuit with a cap on their collective power usage. At the Portland, OR Pearl District condominium, the system allowed the electrician to install up to five stations on a single circuit, saving the building owners thousands of dollars in electricity upgrades. In Burlingame, CA, the Ansel building avoided panel upgrades and saved roughly $6,000 by using low-power outlet devices with smart-charging features; the Orange outlet attaches to existing electrical infrastructure and manages each outlet's power delivery using Bluetooth and Wi-Fi-enabled monitoring technology.[70]

- **Case Study – Rotating, Non-networked**, *Portland, OR, Atlanta, GA:* In response to growing demand for EV charging among tenants, the luxury, mixed-use Henry Condominiums in Portland installed the Cyber Switching Electric Vehicle Master Controller (EVMC), a system that switches power to multiple connected charging stations in a "round robin" fashion. The EVMC rotates power on a programmable time basis to each connected EV according to their battery level and is able to collect usage data on each station. Notably, this system can apply to low-cost, non-networked charging stations, upgrading their otherwise limited functionality to "smart charging" devices.[71] The Brookwood Complex in Atlanta installed similar software (Liberty Plugin's HYDRA-R) that connects up to ten chargers to one power line and connects to stations on a rotating basis.[72]

2. Level 1 charging can reduce the need for electrical upgrades at the expense of charging speed

Primary Actors:
Building Owners/Managers
Local Governments

The relative merits of Level 1 and Level 2 chargers are a subject of frequent debate. When infrastructure needs (including high-capacity outlets and adequate power) and other technical barriers deter building owners from installing even load-balancing Level 2 charging equipment, Level 1 chargers can, in some instances, offer a feasible alternative. Level 1 chargers' low-power output broadens the equipment's scalability through limited infrastructural and electrical capacity needs; vehicles only require access to grounded, standard 120 volt outlets.[j] However, when 120-V outlets are "daisy-chained" on a given circuit (risking overload if multiple vehicles are simultaneously connected) or they don't exist in a parking area, the need for basic electrical infrastructure work eliminates Level 1's cost-saving advantage. Additionally, the common ease and affordability of Level 1 charger installations can occur at the expense of user convenience due to slow charging speed. Several building owners and program evaluators included in the case studies dismissed Level 1 charging installations, primarily citing an overwhelming tenant preference toward Level 2.[k]

Level 1 equipment's slow charging speed presents a significant disadvantage for users, particularly those who share parking spaces and charging equipment. Whereas Level 2 chargers can deliver 10-20 miles of electric range per hour, Level 1 equipment charges only 2-5 miles per hour.[73] Drivers tend to express a strong preference toward Level 2 charging over Level 1, and building owners seeking to maximize EVSE use are incentivized to meet this preference. The Level 2 preference will likely continue to grow as 200-300 mile range EVs with larger battery-packs and longer charging times become more common. To the extent that Level 2 chargers serve mobility needs more effectively than Level 1, disproportionate access to Level 1 charging among priority populations would be inequitable.

Several additional considerations can support building managers' selection of Level 1 charging as a viable – if only short-term – option. When parking areas offer standard outlet accessibility and/or Level 1 funding programs offer opportune savings, Level 1 charging's substantially lower unit costs can allow for MUDs to install a significantly greater number of chargers (and thereby serve more EV-user tenants), albeit with slower charging speeds; if minimal Level 2 infrastructure costs exceed MUD budgetary constraints (as may be

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j The Muir Commons parking lot in Davis, California is separate from the housing units and did not contain 120-V electrical outlets at the time of the building's charger installation. In this case, the basic electrical infrastructure expansion required for any charging system significantly reduced the cost saving advantage of installing low-speed Level 1 chargers. This parking space context in conjunction with available grant funding for Level 2 equipment led residents to dismiss the prospect of Level 1 charging; Eugen Dunlap, Interview (March 8, 2024).

k The Smart Columbus program evaluators found that building owners should prioritize Level 2 equipment to meet tenants' preferences, while NYSERDA encourages Level 2 in its best practice guide on the basis of faster charging speed and better overall value proposition; see Smart Columbus Case Study, supra, p. 13; New York State Energy Research and Development Authority, "Best Practice Guides and Cases" available at https://www.nyserda.ny.gov/All-Programs/ChargeNY/Charge-Electric/Best-Practices.

the case among many lower-income MUDs), Level 1 charging can provide at least base-level support for residents' EV adoption. A consumer study by Peninsula Clean Energy (a Bay Area community choice aggregator) indicates that even such base-level support may fully serve many drivers' charging needs, especially for owners of plug-in hybrid vehicles and smaller EVs with limited battery capacity.[74] For residents whose needs are only partially served by Level 1 charging, access to nearby public charging facilities can provide occasional support when faster speeds are needed for a full charge.

- **Case Study – Scale and Nearby Public Support**, *Belmont, CA:* Building owners at the El Dorado apartments opted to install Level 1 instead of Level 2 chargers on the basis of user convenience and opportune funding. Whereas the owners' budgetary constraints could accommodate only a couple of Level 2 chargers that residents would need to share, a Peninsula Clean Energy (PCE) program covered almost all costs for the installation of 30 Level 1 "smart" outlets (nearly matching the number of available parking spaces), with limited infrastructure work required. Tenants who needed faster charging could conveniently access a public fast charger across the street from the residence.[75]

- **Case Study – Secondary Option**, *Campbell, CA; Minneapolis, MN:* The parking lot at the Revere Campbell Apartments offers Level 2 charging as its primary EV charging service but also includes several 120-V outlets that can provide an alternative Level 1 charging option.[76] Green Rock Apartments in Minneapolis also constructed Level 2 charging infrastructure in its parking space but remained open to installing supplemental Level 1 chargers if more Level 2 additions were "not viable." [77]

3. Mobile charging systems can substitute for fixed installations in very limited use cases

Primary Actors:
Building Owners/Managers
EVSE Companies

In cases where EVSE installations are highly limited by budget, grid infrastructure and site barriers, mobile chargers can offer a viable alternative.[78] Whereas an MUD's infrastructural composition constrains possible placement options for fixed stations, mobile systems can conveniently draw and store power from existing electrical supply. The device's battery can be charged in any convenient location then delivered to a different site to charge vehicles, thus providing EVSE access without any need for installation or upgrades at the charging location. Mobile systems' capacity to draw and store power at any time (e.g., during the day and/or during periods of greatest renewable energy availability) allows drivers to charge during peak electricity demand hours without paying peak-hour charging rates. Accordingly, mobile charging can yield both installation and operational consumption savings while reducing overall strain on the electricity grid.[79] Additionally, mobile chargers' minimal installation and permitting requirements can help building owners quickly satisfy tenant demand in the near term, without waiting for upgrades.[80] When used alone, the devices can also be used to address MUD-specific ADA access issues that restrict full installations.

However, mobile charging systems can be very expensive, with capital costs for one company's product nearing $70,000, or roughly the capital costs of 4-5 fixed Level 2 stations.[81] Additionally, these systems' output is inherently limited by their battery size (i.e., an 80 kWh unit can only charge this amount once before it must be recharged). Mobile chargers' high upfront price and size limitations restrict their cost-effective use cases to only those instances where permanent installations are infeasible. Furthermore, the devices' mobile function adds a utilization component that may require resident training or onsite staff, potentially increasing costs. As a result, mobile charging can likely offer an equity-oriented solution where it provides a bridge to fixed installation at or near an MUD.

- **Case Study – Dual-port Mobile Chargers**, *San Leandro, CA*: FreeWire Technologies developed a mobile charger ("Mobi") that includes two ports and delivers Level 2 power. FreeWire did not sell any Mobi devices to MUDs but used the system in its corporate headquarters. The device includes an 80-kWh battery pack that required roughly 12 hours to reach full charge. Capital costs for one Mobi roughly match those of 4-5 fixed stations, and FreeWire claimed that each Mobi can serve about 8 vehicles per day at an average of 10 kWh per vehicle (35-40 miles per light-duty vehicle). The device can be moved from vehicle to vehicle on site. FreeWire considered trained attendants (such as building employees) to be highly preferable to residents in positioning and moving Mobi devices – citing concerns about vandalism and equipment misplacement following charging sessions.[82] (Freewire Technologies announced its termination of operations in 2024.)[83]

D. COMMUNITY MOBILITY STRATEGIES TO SUPPORT EQUITABLE MUD CHARGING ACCESS

The various challenges surrounding EV charging infrastructure at multifamily residences can, when necessary, find equitable resolution at the community level. Adequate off-site parking space combined with public and private resource contributions can help generate community-based EV charging arrangements that address lack of dedicated parking and insufficient on-site electrical infrastructure. The following subsections propose community-based mobility strategies that can enhance (or in limited cases, replace) on-site multifamily residential charging equipment.

1. Community ownership and investment models should accompany EV charging installations to address displacement concerns

Primary Actors:
Building Residents
Community-Based Organizations
Local Governments

Charging infrastructure is an increasingly desirable household amenity that can increase the value of MUD units and raise their rent prices. This value enhancement carries the risk of generating housing displacement among lower-income residents, if not proactively managed. To avoid gentrification in areas of residential charging accessibility, building owners and public agencies

should actively pair charger installations in MUDs with anti-displacement measures that protect lower-income residents.[84]

A range of anti-displacement strategies can address communities' gentrification concerns – including the development of community land trusts, community ownership structures for charger installations that allocate a portion of charging revenue back to residents, and numerous other actions highlighted in a comprehensive Journal of Urban Health study.[85] Government agencies can also combat development-induced housing displacement through various public policy strategies; the Urban Displacement Project has documented a range of anti-displacement policies and their previous or existing applications in non-EVSE contexts.[86]

- **Case Study – Community-owned EV Charging Sites,** *Alameda and San Joaquin Counties, CA; Oakland, CA*: Ava Community Energy issued a Request for Proposals for its new "Community Investment Grant for Development and Operation of EV Charging Stations." Ava's grant (up to $300,000 over three years) "aims to empower communities by fostering local ownership and innovation in EV infrastructure, promoting sustainability and electric mobility." [87] Eligible organizations include community, charitable, civic and other related organizations/agencies, and the selected recipient will develop one to three community-owned and operated EV charging sites (10-50 Level 2 EV charging stations) to serve priority communities. The recipient is expected to collaborate with local stakeholders, conduct community outreach, design "innovative community ownership models," and engage in a range of other locally based activities.[88]

  The Oakland EcoBlock pilot project takes a similar community-based approach to energy system retrofits; the pilot leverages the cost-reduction benefits of economies of scale by retrofitting amenities for existing buildings within city street groups. Retrofits include a shared EV charger, solar installations, and other energy systems. The project offers community members a range of strategies and tools to design infrastructure retrofits according to their needs. Prospective needs described on the program website include "shared landscaping, community ownership of EV chargers, or integrated community energy systems." [89]

Community ownership does not need to occur at the onset of charger utilization to address anti-displacement concerns. In instances where temporary utility- or other public/private-ownership offers efficiency or cost advantages, MUDs can consider models that transfer ownership from public/private entities to community members after a period of time.

2. Offsite, public charging options and carshare services can provide valuable supplements to (or in some cases, replacements for) onsite MUD resources

Primary Actors:
Building Owners/Managers
Community-Based Organizations
EVSE Companies
Local Governments
Building Residents

When public agencies, energy providers, and/or private investors show willingness to support EV charging expansion in affordable housing communities, MUD tenants may be well positioned to seek EV services beyond their immediate residence. Cities and EVSE providers can match MUD charging needs with access to nearby EV chargers or electric carshare services to avoid MUDs' infrastructural and/or vehicle investment burdens. For the subset of budget-constrained MUDs considering Level 1 chargers or limited load-balancing equipment, offsite areas equipped with Level 2 and …direct current fast charging (DCFC)… equipment can deliver residents fast, emergency-use alternatives and help justify slower on-site installations. If adequately informed by local input, these offsite areas near MUDs can also incorporate other clean mobility options like scooter- or bike-share and serve as models for equitable, need-based clean mobility development. Meanwhile, onsite or nearby ZEV carshare services can provide a valuable supplement to MUD charging installations that receive insufficient utilization due to low EV ownership. Supplemental infrastructure, services and amenities added to MUD installations or offsite facilities can help fulfill tenants' essential mobility needs while stimulating clean mobility demand among lower-income residents.

Selecting offsite areas to house EV chargers and other shared electric mobility presents a variety of challenges that planners must confront to secure basic feasibility and equitable outcomes. For instance, optimal sites that are occupied by existing organizations require strategic planning to align the hosts' incentives with residential user interests. The need to share the amenities with host users may create periodic availability gaps for nearby residents that should be negotiated and optimized based on local input.[90] Additionally, the owners must investigate methods to secure long-term business models; initial investors (private companies or government agencies) may not sustain funding beyond initial construction and installation stages unless sufficiently incentivized.[91] Planners must consider a range of community engagement principles and business models to capture local interests and sustain long term operation.

- **Case Study – Community-Informed Mobility Options**, *Bay Area, CA:* MTC, TransForm, and the Shared-Use Mobility Center conducted an extensive preliminary needs assessment to inform the distinct mix of travel options in three communities throughout the Bay Area. (The assessment included both quantitative and qualitative data.) The project team acquired support from several community-based organizations to assist the needs assessment and record a list of "Lessons Learned." Among key findings, the project team documented the importance of building trust with partner organizations and community members; budgeting funds for translation, incentives and staff time; and allocating considerable time and resources to an iterative survey development process. The project team found that each center exhibited highly distinct local needs that differentiated

the infrastructure, amenities and services that would optimize the centers' utility to nearby residents.[92]

- **Case Study – Mutually Beneficial Public/Commercial Partnerships**, *Takoma Park, MD:* The Takoma Park Community Center hosts a charging hub for nearby residents, and more than ten large MUD properties reside within a half mile radius of the center. The center is simultaneously occupied by the local police department, a city office, and an adjacent city library and park. The center's charging facility serves public and city vehicles during the day and is open and highly accessible for nearby residential use during the late afternoon through early morning. Although the charger equipment's use is not restricted to nearby MUDs, MUD residents account for the majority of charging sessions. The Electric Vehicle Institute operates the center's standard Level 2 and DCFC chargers and uses data analytics to inform additional installations.[93]

- **Case Study – Targeted Site Selection**, *Alameda County, CA*: East Bay Community Energy, a community energy provider, approved plans to contract with two EVSE companies to deliver 40-50 public fast charging hubs to serve nearby MUD residents. The plans include site selection criteria that prioritize three attributes: 1) close proximity to multifamily households, with intent to serve multifamily housing "hotspots," 2) walkability to driver amenities, and 3) limited proximity to existing fast charging locations – with an aim to "inves[t] in areas where [the] private sector has not been willing to thus far." [94]

- **Case Study – Supplemental Carshare Service,** *Stockton, CA; National* (*Forth Mobility*)*:* A 100 percent zero-emission vehicle carsharing program led by Míocar, Mobility Development Partners, and Sigala Inc. serves "historically underserved neighborhoods [in Stockton] where mobility challenges are well documented and where there's the greatest need." [95] Several stations are sited at MUDs, and the service area includes "major north-south transportation corridors connecting residents across the city to services, resources, shopping, schools and jobs." [96] The service is funded by California's cap-and-trade program, and parties interested in site-hosting can contact the program's administrators to inquire.[97] Forth Mobility leads a similar network of services through its Affordable Mobility Platform (AMP), which spans eight states throughout the country – including Michigan, Idaho, and New Mexico. AMP plans to deploy "50 shared EVs and level-2 chargers at affordable housing locations and in underserved communities" throughout the 8 participating states, with a unique set of partners and funding streams in each state.[98]

Nearby offsite locations for EV charging and other mobility services offer an alternative option for MUDs. City leaders and EVSE companies should consider community-informed amenities, mutually beneficial partnerships and targeted siting strategies that meet local opportunities and constraints. Local agencies seeking to promote clean mobility options in addition to EVs should also consider full-scale mobility hubs (which are more multi-modal than the examples discussed above). Mobility hubs can include community EV charging while linking residents to non-vehicle options like e-bikeshare and transit.[99]

3. Curbside and public right-of-way charging can complement or serve as residential options

Primary Actors:

EVSE Companies

Local Governments

To maximize convenience for MUD residents, curbside and public right-of-way (PROW) charging should only complement (rather than replace) tenants' residential charging options. However, the curbside and PROW offer key venues to support a comprehensive and reliable charging network.[100] Local governments and/or EVSE companies can use outreach and mapping tools to site charging equipment in public locations near clusters of MUDs.[101] In areas where MUD residents rely heavily on public charging as an alternative option, public charger rates should be comparable to residential rates; currently, public charging prices tend to far exceed residential prices, adding to the mobility cost burdens among MUD residents whose buildings lack EV infrastructure.[102]

Though many cities have piloted initiatives to expand publicly accessible charging options, only a few – including Seattle and Portland – have taken first steps to target priority communities for charger deployment.[103] (Market demand-based strategies that typically guide EVSE companies' site selections disproportionately skew curbside and PROW charging availability toward higher income areas.) An effective continuation of early city efforts to promote an equitably-distributed charging network would incorporate housing types – and their respective EVSE installation challenges – into geographical mapping and targeting analyses.[104]

For a comprehensive overview of pilot programs featuring charging at the curbside and in the public right-of-way, see full CLEE Report, *Case Studies: City Public & Curbside EV Charging Strategies*

III. CONCLUSION

The clean mobility transition will require significant expansion of EV charging availability across key charging sites. While at-home charging equipment serves a central role in fulfilling EV drivers' mobility needs, multifamily buildings face complex challenges to secure adequate charging opportunities for residents.

Accordingly, MUDs currently lack the same rapid growth in charging availability that single-family residents have begun to experience. Because MUDs disproportionately house lower-income residents, an equitable clean mobility transition will require concerted efforts to address these residents' heightened barriers to charging access. Local government leaders, building owners/managers, and other stakeholders can pursue a range of equity-focused strategies to overcome MUDs' charger installation and operational challenges. Measures to reduce costs, increase information, and build EV awareness can all help to align incentives among the many stakeholders involved in MUD charging infrastructure. Local leaders and stakeholders should focus on the following top-priority strategies for equitable program design:

Grants, rebates, and other incentive programs require **equity-focused allocation methods** to reach all residents and deliver equitable outcomes.

Primary Actors:
Electric Utilities/CCAs
Local Governments

MUD-specific electricity rates can address inequities in charging prices by more closely matching residential rates that single-family households face.

Primary Actors:
Electric Utilities/CCAs
EVSE Companies
Local Governments

EV ownership incentives and accommodations for MUDs with low near-term charging demand can improve charger accessibility and help jumpstart EV adoption.

Primary Actors:
- **Building Owners/Managers**
- **Local Governments**

Targeted stakeholder outreach is crucial for equitable participation in incentive programs.

Primary Actors:
- **Advocates and Educators**
- **Local Governments**

Load-balancing charging equipment can help minimize electrical upgrades but also reduces user convenience. Potential inconveniences associated with load-management technology should be offset by lower prices and/or supplemental charging and mobility options beyond the MUD.

Primary Actors:
- **Building Owners/Managers**
- **Local Governments**
- **Electric Utilities/CCAs**

Community ownership and investment models should accompany EV charging installations to address displacement concerns.

Primary Actors:
- **Building Residents**
- **Community-Based Organizations**
- **Local Governments**

With collective efforts to target and accommodate MUDs in incentive programs, utilize emerging technologies that minimize charger installation costs, and extend educational and ownership opportunities to building managers and residents, MUD communities can share the many benefits of an equitable clean mobility transition.

LIST OF CASE STUDIES

This report drew eight case studies from the Center for Sustainable Energy's VCI-MUD Toolkit website, available at https://vci-mud.org/.

Alameda County, CA: East Bay Community Energy approved plans to finance and site charging hubs near MUD hotspots located in charging deserts.

Alameda and San Joaquin Counties, CA: Ava Community Energy issued a Request for Proposal for a grant that aims to support community-owned charging infrastructure.

Atlanta, GA: The Brookwood multiplex installed a rotating, programmable charging system that connects multiple chargers to one power line.

Bay Area, CA: The Metropolitan Transportation Commission partnered with Transform to develop community-informed mobility options sites in three affordable housing areas.

Belmont, CA: El Dorado apartment complex took advantage of a grant program to install 30 Level 1 chargers with minimal electrical work.

Brooklyn, NY: Itselectric, a Brooklyn-based EVSE company, excludes directly-attached cables from its charging device and instead sells detachable cables to customers.

Burlingame, CA: Ansel purchased low-power charging outlets with power monitoring capabilities to avoid panel upgrades.

California (*Central/Northern*)*: PG&E* has partnered with Ecology Action to install Level 1 and Level 2 chargers at MUDs with a targeted focus on serving lower-income buildings.

Campbell, CA: The Revere uses a charging system that includes data-monitoring features and allows for users to reserve and extend charging sessions.

Columbus, OH: The Smart Columbus Rebate Program distributed funds for 48 charger installations across 11 MUD sites and incorporated EV outreach/education components.

Columbus, OH: The Ride and Drive Roadshow, part of the Smart Columbus Initiative, hosts EV educational events for local employers in Columbus.

Davis, CA: Muir Commons tenants collectively took advantage of grant and rebate programs to substantially reduce costs for 26 Level 2 charger installations.

Honolulu, HI: The Ko'olani condominiums installed two Level 2 stations with data management features/services and temporarily opened the chargers for public use.

Oakland, CA: The EcoBlock project in Oakland, California retrofits energy systems for existing buildings within city street groups according to community-based design.

Los Angeles, CA: Westside Cities evaluated EVSE infrastructure in MUDs in Los Angeles and nearby Westside cities and reported key installation barriers and solutions.

Mebane, NC: A 100-unit property purchased Orange chargers partially on the basis of the company's usage-dependent fee structure.

Minneapolis, MN: Green Rock Apartments supplemented its Level 2 charging installations with several EV adoption incentives for tenants.

New York City, NY: The New York State energy Research and Development Authority supported the expansion of EV charging services for multiple MUD buildings in NYC.

Portland, OR: Pearl District High Rise condominiums installed a networked load-balancing charging system to serve growing EVSE demand while avoiding costly electrical infrastructure expansion.

Portland, OR: Henry Condominiums installed a non-networked load-balancing charging system that delivers power to multiple stations on a rotating basis.

Sacramento, CA: Loop, an EVSE company, serves several MUDs in Sacramento that face charging rates that surpass the standard utility rate – a typical feature of MUD charging prices.

Sacramento, CA: SAC EV is a community-based nonprofit organization that educates local residents about EVs and their supporting infrastructure.

San Francisco, CA: The Madrone, a mixed use residential complex, uses a cloud-based charging software with data management features and accessible service staff.

San Francisco Bay Area and Southern California: EVgo, an EVSE company, instituted a location-based pricing model for its charging stations in California.

San Leandro, CA: Freewire Technologies developed a mobile charging product and uses the device in its company headquarters.

Scottsdale, AZ: Sage Condominiums uses a networked, load-balancing charging system that connects multiple stations to a single circuit and caps their collective output.

Southern California Region, CA: Southern California Edison operates a rebate program that offers tiered funding for both utility-side and customer-side charging infrastructure.

Stockton, CA; Míocar, Mobility Development Partners, and Sigala lead a carsharing program that sites vehicle stations at MUDs in historically underserved neighborhoods.

Toronto: New Times Square, 375-unit building, hired SWTCH, an EV charging management company, to help guide cost-mitigating software management decisions.

Takoma Park, MD: TP Community Center hosts a charging hub that primarily serves nearby MUD tenants.

United States: Forth Mobility leads a network of carshare services in affordable housing communities spanning eight different states throughout the U.S.

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