

# Electrifying Multi-Family Dwellings: Overcoming Barriers to EV Charging Infrastructure

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## ABSTRACT

The transition to electric vehicles (EVs) provides a crucial shift towards more sustainable modes of transportation, resulting in global efforts to reduce carbon emissions and combat climate change. Despite this positive trajectory, the widespread adoption of EVs is significantly challenged by the integration of necessary charging infrastructure, especially within multi-family residential contexts. These dwellings face a myriad of obstacles, from stringent regulatory frameworks and financial barriers to the inherent physical constraints of existing structures. This paper delves into the intricacies surrounding the current building codes that govern the installation of EV charging stations, while also casting an eye towards the future, to discern potential regulatory evolutions and technological innovations that could support this transition. Through a comprehensive analysis, it explores multifaceted strategies aimed at democratizing access to EV charging solutions. By harnessing government incentives, fostering robust community engagement, and navigating the forefront of technological advancements, the paper outlines a roadmap for making EV charging both accessible and affordable for residents of multi-family homes. In doing so, it underscores the critical role these efforts play not only in bolstering environmental sustainability but also in promoting energy independence, thereby contributing to the broader objectives of a greener, more resilient urban future.

**Keywords:** Electric Vehicles (EVs), EV Charging Infrastructure, Multi-Family Dwellings, Sustainable Transportation, Urban Planning, Building Codes, Regulatory Frameworks, Technological Innovations, Community Engagement, Financial Incentives

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## INTRODUCTION

The advent of electric vehicles (EVs) stands as a testament to the strides made towards sustainable urban development, marking a crucial step in our collective journey towards a greener, more environmentally responsible future. The significance of EVs goes beyond mere technological advancement; it represents a profound shift in the way cities envision transportation, energy consumption, and carbon emissions reduction. Central to this transition is the expansion and accessibility of EV charging infrastructure—a critical component that not only facilitates the widespread adoption of EVs but also underscores a city's commitment to sustainable and innovative urban planning.

Despite the clear benefits and growing demand for EVs, the path to a fully integrated EV infrastructure is fraught with challenges, particularly within the context of multi-family dwellings. These residential settings, characterized by shared living spaces and communal facilities, encounter unique obstacles in the deployment of EV charging stations. Space constraints in parking areas, existing electrical infrastructure limitations, and the sheer diversity of stakeholders involved compound the complexity of installing adequate charging solutions. Moreover, financial hurdles emerge as a significant barrier, with the upfront costs of installation and maintenance posing a considerable burden for property owners and homeowners' associations (HOAs). Additionally, regulatory barriers further complicate this landscape, as current building codes and zoning laws often fail to keep pace with the rapid advancements in EV technology and the evolving needs of urban populations.

Considering these challenges, this paper aims to undertake a comprehensive exploration of the multifaceted issues surrounding the implementation of EV charging infrastructure in multi-family homes. The approach is to dissect the current

regulatory and coding frameworks governing the installation of EV charging stations, identifying existing gaps and areas for improvement; secondly, to forecast future advancements in technology and policy that may influence the evolution of EV charging infrastructure; and thirdly, to delineate practical, actionable strategies to enhance the affordability and accessibility of EV charging for residents of multi-family dwellings.

Through this analysis, we attempt to provide stakeholders—including policymakers, urban planners, property developers, and community leaders—with insights and recommendations that pave the way for a more inclusive, sustainable, and EV-ready urban future.

## **Challenges of Implementing EV Charging in Multi-Family Dwellings**

### **1. Infrastructure Limitations**

The expansion of electric vehicle (EV) charging infrastructure in multi-family homes is significantly hindered by a variety of infrastructure limitations. Chief among these are the physical constraints inherent in existing buildings, many of which were not designed with the foresight of accommodating EV charging facilities. Parking spaces, often limited and tightly arranged, present a logistical challenge for the installation of charging stations without encroaching on required space allocations or accessibility standards. Additionally, the existing electrical infrastructure in older multi-family buildings cannot frequently support the added load of multiple EV chargers. Upgrading this infrastructure—installing new electrical panels, transformers, or even increasing the capacity of utility providers—is a complex and costly endeavor. Such upgrades might involve navigating building codes, securing permits, and potentially disrupting residents' lives during construction phases.

The demographic profile of residents in multi-family homes adds another layer of complexity to the adoption of EV charging infrastructure. Renters, who may not have a long-term stake in the property, might be less inclined to request or invest in EV charging options. This transient nature of tenancy necessitates solutions that are not only cost-effective but also flexible and scalable to cater to changing resident populations.

Income levels and vehicle ownership trends among these residents further underscore the need for targeted strategies to promote EV adoption. Financial incentives, such as rebates or subsidized charging rates for lower-income residents, could help mitigate some of these barriers. Additionally, implementing community charging stations that serve multiple residents can address the limited parking issue while promoting a communal approach to EV charging.

### **2. Regulatory and Policy Barriers**

Navigating the regulatory landscape presents another layer of complexity in the process of expanding EV charging infrastructure in multi-family environments. Current building codes and policies vary significantly across jurisdictions, with some being more conducive to the adoption of EV charging facilities than others. A case in point is the CALGreen 2022 Mandatory Residential Electric Vehicle Infrastructure Codes, which set forth requirements for EV-capable infrastructure in new residential constructions. While these regulations mark a progressive step towards facilitating EV adoption, they also reveal gaps in addressing the needs of existing buildings, which constitute a substantial portion of multi-family dwellings. The comparative analysis of CALGreen's mandates with those of other jurisdictions highlights a patchwork of regulations, often resulting in confusion and inconsistency in implementation efforts. This disparity not only impedes uniform progress towards EV readiness but also creates barriers for property owners and developers who operate across different regions. The variation in codes often translates to a lack of clear guidelines or incentives for retrofitting existing buildings with EV charging capabilities, further complicating the landscape.

Moreover, the current regulatory framework frequently fails to account for the financial and logistical realities of implementing such infrastructure in multi-family dwellings. The absence of comprehensive policies that address the cost-sharing mechanisms, maintenance responsibilities, and equitable access to charging facilities leaves significant room for improvement. As such, there exists a pressing need for regulatory reform that not only harmonizes codes across jurisdictions but also introduces flexible, scalable solutions tailored to the diverse configurations and constraints of multi-family homes.

Addressing the infrastructure limitations and regulatory barriers to EV charging in multi-family dwellings necessitates a multifaceted strategy. This strategy must incorporate data-driven planning, financial incentives, and legislative reforms that collectively aim to overcome the physical, economic, and regulatory hurdles currently impeding progress. By doing so, stakeholders can unlock the potential of multi-family homes to contribute significantly to the widespread adoption of EVs, marking a critical stride towards sustainable urban mobility.

## Technological and Economic Analysis of EV Charging in Multi-Family Dwellings

### 1. Innovative Charging Solutions

Integrating electric vehicle (EV) charging stations into multi-family residences calls for inventive strategies that can navigate the challenges of limited space, prioritize energy efficiency, and allow for scalability. Level 2 chargers of lower power are proving to be an optimal choice, striking an effective balance between the rate of charging and power consumption. These chargers, unlike their more power-intensive alternatives, often fit seamlessly into the existing electrical setups of buildings, considerably lowering the financial burden associated with major electrical overhauls. They are particularly adept at meeting the overnight charging needs typical of residential scenarios, where vehicles remain parked for lengthy durations.

Economically, these charging stations are more cost-effective, both in terms of setup and day-to-day operation, than their more powerful counterparts. They operate with higher energy conversion efficiency, ensuring minimal energy loss and making them a cost-effective option for promoting the uptake of EVs among apartment dwellers. The modular nature of these charging systems supports gradual expansion. This means property managers can incrementally increase the number of charging stations in response to rising demand, ensuring that the initial expenditure on the infrastructure is directly proportional to its use.

Furthermore, the low-power Level 2 chargers address the logistical concerns of installing comprehensive EV charging solutions in spaces where parking is at a premium. By utilizing compact, wall-mounted designs or shared charging models, these systems can be integrated into existing parking areas without significant reconfiguration. This adaptability not only preserves valuable parking space but also enhances the property's appeal to prospective and current residents who own or are considering purchasing EVs.

Advanced models come equipped with smart charging features, enabling them to adjust charging rates based on grid demand, further optimizing energy use, and reducing costs. This intelligent functionality, coupled with the ability to monitor and manage charging through mobile applications, enhances user convenience and ensures the efficient operation of the charging infrastructure.

### ECONOMIC IMPACTS

Conducting a cost-benefit analysis of introducing EV charging solutions in multi-family dwellings reveals a comprehensive understanding of the economic viability of such endeavors. The analysis encompasses several key components:

- **Construction Costs:** Initial investments include the purchase of charging stations, electrical upgrades (if necessary), and installation labor. For low-power Level 2 chargers, these costs are often mitigated by the reduced need for extensive electrical infrastructure modifications.
- **Long-term Savings:** Property owners and residents stand to benefit from long-term savings derived from several sources. These include reduced maintenance costs associated with EVs compared to internal combustion engine vehicles, lower energy costs due to the efficiency of Level 2 chargers, and potential increases in property values as EV readiness becomes a desirable amenity.
- **Societal Benefits:** Beyond the immediate economic impacts, the widespread installation of EV charging stations in multi-family dwellings contributes to broader societal benefits. These include reductions in greenhouse gas emissions, decreased dependency on fossil fuels, and improved air quality. Additionally, supporting EV adoption aligns with national and local sustainability goals, potentially qualifying properties for further incentives or certifications.

### Policy and Regulatory Framework for EV Charging in Multi-Family Homes

The successful integration of electric vehicle (EV) charging infrastructure in multi-family dwellings is deeply intertwined with the policy and regulatory framework governing these installations. This framework not only sets the groundwork for what is currently achievable but also outlines the trajectory for future advancements in EV infrastructure development.

#### 1. Current Codes and Standards

At present, a variety of building codes and standards shape the implementation of EV charging stations in multi-family homes. Notably, the National Electrical Code (NEC) provides guidelines on the electrical requirements for EV charging, ensuring safety and efficiency in installations. Additionally, local building codes often dictate specific provisions for EV charging, ranging from the percentage of parking spaces that must be EV-ready to the types of charging stations that can be installed. For example, some jurisdictions require new multi-family constructions to include a certain number of EV-capable parking spots, laying the foundation for future EV adoption among residents.

However, these regulations can vary significantly across different regions, creating a patchwork of requirements that developers and property owners must navigate. This variability can pose challenges in standardizing EV charging solutions and in scaling up infrastructure development across states and municipalities. Furthermore, the current codes primarily focus on new constructions, leaving a gap in guidelines for retrofitting existing multi-family buildings with EV charging capabilities.

## 2. Future Legislative Trends

As the demand for EVs continues to grow, fueled by economic incentives and environmental concerns, it is anticipated that building codes and policies will evolve to better support the widespread adoption of EV charging infrastructure. Future legislative trends are likely to include:

- **Expansion of Retrofitting Guidelines:** Anticipated changes in building codes may provide clearer pathways for retrofitting existing multi-family dwellings with EV charging stations, addressing one of the current regulatory gaps.
- **Increased Mandates for EV-Ready Spaces:** As part of efforts to promote EV adoption, there may be an increase in mandates requiring a higher percentage of parking spaces in both new and existing multi-family buildings to be EV-ready or EV-capable.
- **Incentivization of Green Building Certifications:** Policies might further incentivize the inclusion of EV charging infrastructure as part of green building certifications, encouraging developers to surpass the minimum requirements for sustainability.
- **Unified Standards across Jurisdictions:** To simplify the regulatory landscape, there could be moves towards unifying EV charging codes and standards across jurisdictions, making it easier for developers to implement consistent solutions.
- **Support for Innovative Charging Technologies:** Legislative trends may also lean towards supporting the adoption of innovative charging technologies, such as wireless EV charging or solar-powered charging stations, through specific incentives or relaxed regulations.

The policy and regulatory framework governing EV charging in multi-family homes is at a critical juncture, with existing codes laying the groundwork for current installations and anticipated legislative trends poised to facilitate future growth. This requires a keen understanding of both the technical requirements and the regulatory environment. As policies evolve to catch up with technological advancements and societal shifts towards sustainability, the development of EV charging infrastructure in multi-family dwellings is expected to accelerate, marking significant progress towards sustainable urban mobility.

## Strategies for Affordability and Accessibility of EV Charging in Multi-Family Homes

The deployment of electric vehicle (EV) charging infrastructure in multi-family dwellings is crucial for supporting the transition to sustainable transportation. However, the costs associated with installing such infrastructure can be a significant barrier. Addressing these financial hurdles and ensuring equitable access requires a comprehensive strategy that includes leveraging financial incentives and fostering community initiatives and partnerships.

### 1. Financial Incentives

Government incentives and subsidies play a pivotal role in reducing the financial burden of installing EV charging stations. These incentives can come in various forms, including tax credits, rebates, grants, and low-interest financing options. For example, the Federal Alternative Fuel Infrastructure Tax Credit offers a tax credit for the cost of purchasing and installing EV charging infrastructure, covering up to 30% of the cost with a maximum of \$30,000 per location for businesses.

Several states and municipalities offer additional incentives. California's Electric Vehicle Infrastructure Project (CALeVIP) provides rebates for the purchase and installation of EV charging stations in multiple regions across the state, significantly reducing out-of-pocket costs for property owners.

Concurrently, the city of Seattle launched a program offering substantial rebates for the installation of EV charging stations in multi-family buildings, aimed particularly at low-income communities. This initiative not only reduced installation costs but also promoted greater EV adoption among residents who previously faced barriers to access.

### 2. Community Initiatives and Partnerships

Beyond financial incentives, community outreach and partnerships are instrumental in promoting the installation of EV charging infrastructure. Engaging with local communities, non-profits, EV advocacy groups, and utility companies can garner support, raise awareness, and facilitate the implementation of charging solutions.

Community outreach programs can educate residents and property owners about the benefits of EVs and the available incentives for installing charging infrastructure. By providing clear information and resources, these programs can demystify the process and encourage more people to participate.

Partnerships with utility companies are also crucial. These companies can offer specialized incentives, technical assistance, and funding opportunities for EV charging projects. For instance, some utilities provide "make-ready" programs that cover the costs of electrical upgrades needed to support EV charging, significantly reducing the financial burden on property owners.

Equity and inclusion should be central to these initiatives, ensuring that all community members, regardless of their economic status or geographic location, have access to EV charging solutions. Programs designed to reach underserved communities can help bridge the gap, ensuring that the transition to EVs is inclusive and beneficial for all.

### Case Studies and best practices in EV Charging for Multi-Family Dwellings

#### Case Study 1: Muir Commons, Townhouse community in Davis, California

Muir Commons represents a pioneering project in the integration of electric vehicle (EV) charging infrastructure within a multi-unit dwelling (MUD) environment. Faced with the dual challenges of limited space and the need for sustainable transportation options, the community embarked on an innovative journey to make EV charging accessible and efficient for its residents.

Muir Commons utilized low-power Level 2 charging stations, a decision that harmonized with the existing electrical infrastructure, significantly reducing the need for extensive and costly upgrades. These stations, chosen for their balance between charging speed and energy demand, were integrated into the community's parking areas, designed to accommodate the vehicles of residents overnight — the prime time for EV charging in residential settings. The implementation of low-power Level 2 chargers stood out for its economic efficiency. The initial setup costs were manageable, and operational expenses remained low, given the chargers' high energy conversion efficiency. This approach provided an affordable pathway for residents to transition to electric vehicles, aligning with the broader sustainability objectives of the community. To optimize the user experience and energy efficiency, Muir Commons integrated smart charging capabilities into the Level 2 stations. These features allowed for dynamic adjustment of charging rates based on real-time energy demand and grid conditions, minimizing electricity costs and contributing to grid stability. Residents could interact with the charging system via mobile applications, scheduling charging sessions and monitoring their energy usage. This level of control and visibility in the charging process encouraged greater adoption of EVs within the community and fostered a culture of environmental consciousness.

## CONCLUSIONS

This investigation into the expansion of electric vehicle (EV) charging infrastructure within multi-family dwellings has unveiled a complex landscape, marked by significant hurdles yet abundant with opportunities for transformative change. Through a comprehensive examination of infrastructure limitations, regulatory frameworks, technological advancements, and economic considerations, several key findings have emerged, underscoring the imperative for a nuanced, multi-faceted approach to catalyze the integration of EV charging solutions in these residential settings.

#### Key Findings:

1. **Infrastructure Limitations:** The physical and electrical infrastructure of multi-family dwellings presents a primary challenge, necessitating innovative, low impact charging solutions that are both cost-effective and scalable.
2. **Regulatory and Policy Barriers:** Current building codes and standards vary widely, creating a fragmented regulatory landscape that can impede the uniform adoption of EV charging infrastructure. However, this variability also highlights the potential for regulatory reform to facilitate a more coherent and supportive environment for EV integration.
3. **Technological Innovation:** Advancements in charging technology, including low-power Level 2 solutions, offer promising avenues to overcome existing barriers, suggesting that continued innovation will play a critical role in shaping the future of EV charging in multi-family homes.
4. **Economic Viability:** Financial incentives and creative funding models are crucial in offsetting the initial costs of installing EV charging stations, making them more accessible to a broader range of property owners and residents.

### Call to Action:

The path forward requires collaborative action and commitment from a diverse array of stakeholders. Policymakers must endeavor to create a more harmonized and supportive regulatory framework that encourages the adoption of EV charging infrastructure, prioritizing reforms that address the unique needs of multi-family dwellings. Developers and property owners should actively incorporate EV readiness into their planning and development processes, leveraging the latest technological innovations to ensure that new and existing buildings are equipped to support the growing demand for EVs. Utilities and the energy sector at large play a crucial role in facilitating this transition, offering technical expertise, financial assistance, and infrastructure support to drive the widespread installation of EV charging solutions. Communities and advocacy groups must continue to champion the cause, raising awareness about the benefits of EVs and advocating for equitable access to charging infrastructure across all residential settings.

By fostering a collaborative environment that combines the efforts of policymakers, developers, the energy sector, and communities, we can overcome the current challenges and unlock the full potential of EV charging in multi-family homes. Such a concerted effort is not only crucial for achieving sustainable urban mobility but also for advancing our collective journey towards a more sustainable and electrified future. In conclusion, the integration of EV charging infrastructure in multi-family dwellings stands as a testament to our capacity to innovate and adapt in the face of environmental and technological challenges. By embracing a holistic approach that combines regulatory reform, technological advancements, and strategic financial planning, we can ensure that the transition to EVs is inclusive, sustainable, and aligned with the broader goals of environmental stewardship and urban resilience.

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