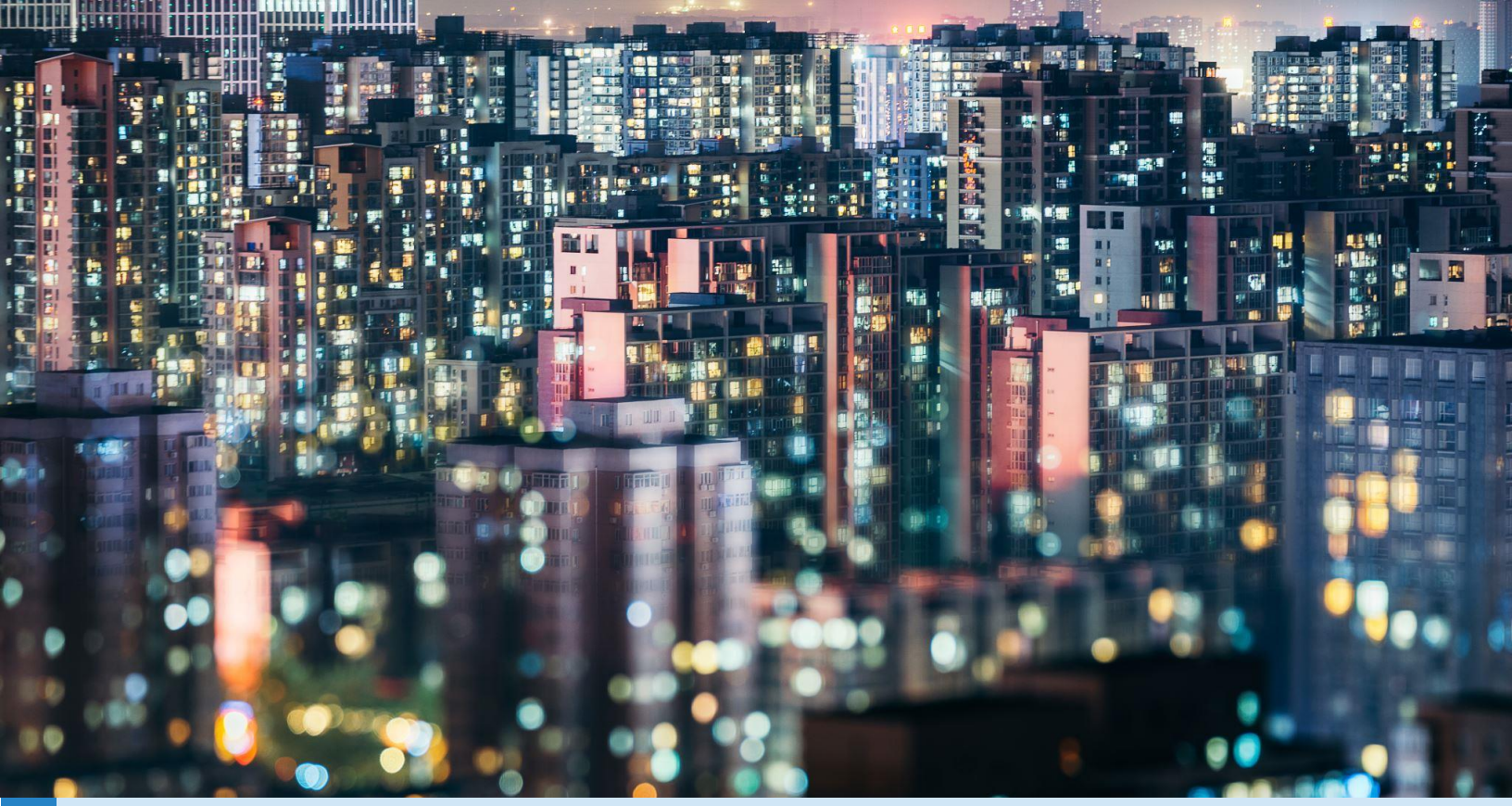

EV CHARGING AT MULTI-FAMILY DWELLINGS

Drivers, Barriers, and Recommendations

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EXECUTIVE SUMMARY

The U.S. Department of Energy reports that more than 80 percent of electric vehicle (EV) charging occurs at home [1]. Approximately 30 percent of U.S. households are multi-family dwellings (MFDs)[1] such as apartments and condos and almost 75 percent of MFD households have at least one vehicle. For the EV market to reach the entire driving population, EV charging must be made available to MFD residents [2]. This paper draws on case studies, other research, and charging use data from the Columbus, Ohio area[2] and New York state to summarize the key drivers and barriers for MFD building managers to install EV charging.

Due to the wide range of types of MFDs, no one-size-fits-all solution exists for charging projects, so caution should be taken in establishing an overly rigid incentive program. However, setting requirements is important to ensure that certain program goals are met. Requirements can also decrease the complexity of developing these projects. Balancing program flexibility and establishing certain requirements is essential to developing a successful incentive program. This paper provides the following recommendations to aid in designing an MFD incentive program that strikes this balance.

- Require or encourage Level 2 chargers rather than Level 1 chargers: While there is not consensus on this topic, Level 2 charging is a much more common recommendation for MFDs. Level 2 chargers provide a better user experience due to faster charging and they often have grid integration features, which are important for scalability as EV adoption increases [3]. Level 1 chargers may not be able to provide a complete charge during off-peak hours and they are usually not able to provide services that facilitate load management since they are usually not networked [4].
- Require or encourage equipment that is capable of separately metering charging load: Separately metering charging load, with a separate meter or by using equipment capable of submetering, is necessary in order to perform a variety of functions such as billing EV drivers based on charger usage, administering different rates such as time-of-use rates for charging load than for the rest of the building's load, collecting and analyzing charging use data, and excluding charging load from demand charge calculations for the rest of the building.
- Require or encourage equipment that is capable of data collection and sharing: Data collection and sharing is essential for electric utilities to integrate charging load into the electrical grid. This will be increasingly important as EV adoption and charging load increases. Analyzing and learning from charging use data is also important to improve future programs and policies.
- Require or encourage equipment that is capable of administering user fees or passing through energy costs: Having the ability to charge a user fee to the EV driver ensures that the cost of charging is not imposed on non-EV drivers and facilitates the use of time-of-use electricity rates that can help influence when charging occurs and aid in grid integration.

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[1] MFDs are often referred to as multi-unit dwellings.
[2] The Columbus region is defined as Franklin County and its six surrounding counties: Delaware, Fairfield, Licking, Madison, Pickaway, and Union.

- Encourage networked solutions for larger deployments but allow flexibility: Networked chargers help facilitate data collection, charging station access control, load management, and direct billing to the EV driver, but they are more expensive than non-networked chargers. Buildings that plan to install many chargers may have billing and load management needs that justify the additional cost of a networked solution. However, smaller projects that only plan to install a few chargers may be better-served by a less expensive, non-networked solution [5].
- Allow incentives to support lease/as-a-service products: Lease/as-a-service products where the charging service provider retains ownership of the charging station and the building manager pays monthly fees can relieve building managers of a substantial amount of work such as site planning, billing, and operations and maintenance [6]. This is especially valuable for MFD projects since building managers often have limited time and/or low interest in pursuing EV charging.
- Recommend or provide resources/points of contact for third-party EV charging service products: Third party EV charging providers offer products that relieve building mangers of many administratively burdensome responsibilities such as project development; billing for charging; operations and maintenance of the chargers; and collecting data such as energy usage, environmental impact, and revenue [6].
- Include Education and Outreach Component: Lack of awareness by building managers of the benefits of EV charging or how to pursue charging installations is a major barrier to EV charging adoption at MFDs. An MFD incentive program should include efforts to address this lack of awareness such as direct outreach to MFD owners or directing program participants to resources.

INTRODUCTION

The U.S. Department of Energy reports that more than 80 percent of electric vehicle (EV) charging occurs at home [1]. Approximately 30 percent of U.S. households are multi-family dwellings (MFDs)[1] such as apartments and condos and almost 75 percent of MFD households have at least one vehicle. Therefore it is essential for EV charging to be available to MFD residents in order to make EVs an option for a large portion of the population [2]. This paper draws on case studies, other research, and charging use data from the Columbus, Ohio area[2] and New York state to summarize the key drivers and barriers for MFD building managers to install EV charging. Due to the wide range of types of MFDs, no one-size-fits-all solution exists for charging projects, so caution should be taken in establishing an overly rigid incentive program. However, setting requirements is important to ensure that certain program goals are met. Requirements can also decrease the complexity of developing these projects. Balancing program flexibility and establishing certain requirements is essential to developing a successful incentive program. This paper provides the following recommendations to aid in designing an MFD incentive program that strikes this balance. Table 1 provides sources that are referenced frequently throughout this paper.

TABLE 1: DESCRIPTION OF SOURCES

Source Name	Description of Source
TDEC Light-Duty ZEV RFI Responses	The Tennessee Department of Environment and Conservation (TDEC) issued a Request for Information (RFI) on November 1, 2019 to collect recommendations regarding the use of Volkswagen Diesel Settlement funds for light-duty zero emission vehicle supply equipment [7]. Several questions in the RFI focused specifically on MFDs. Responses reviewed for this report were not inclusive of responses that contained proprietary or confidential information.
Smart Columbus Case Study on Multi-Unit Dwelling Charging Infrastructure	Smart Columbus, the smart city initiative of the Columbus region, released a case study report on their MFD rebate program in 2018 [8].
Pepco Transportation Electrification Working Group Report	The Public Service Commission of the District of Columbia established the Transportation Electrification Working Group to gather stakeholder input on the programs proposed by Pepco in their Transportation Electrification portfolio of programs. Among these programs was an MFD program [3].

WHAT DRIVES BUILDING MANAGERS TO INSTALL EV CHARGING?

In most cases, MFD building managers who install EV charging are not expecting to earn a profit directly from revenue generated by use of the station [9]. Instead, key drivers for building managers to pursue EV charging installations include things like tenant demand and the opportunity to increase property value, anticipation of emerging regulations that could require EV charging, and the availability of financial incentives to reduce costs. This section elaborates on each of these drivers.

TENANT DEMAND AND INCREASING PROPERTY VALUE

One driver for building managers to install EV charging is tenant demand. Building managers may wish to meet the demand of current tenants or they may anticipate future demand as EV adoption increases. As part of Smart Columbus' MFD rebate program, information was collected from applicants about their motivations for applying. Current and future tenant demand and the opportunity to increase property value and attract new tenants were all reported as drivers for applicants [8]. Private charging service providers have also identified these as key drivers, based on their online marketing materials [6].

EMERGING REGULATIONS

Building managers may also be driven to install EV charging by anticipation of emerging regulations that would require them to do so. Such regulations already exist in several states and cities. For example, "right to charge" laws, which give residents the right to install EV charging as long as certain conditions are met

(e.g., the resident covers the costs), exist in several states, including California, Colorado, Oregon, Hawaii, and Florida [10]. As of 2019, only California and Oregon right-to-charge laws apply to renters as well as owners. In addition, because the cost of installing EV charging is significantly higher after building construction than during construction, some cities and states have building codes that require newly constructed MFDs to install EV chargers or meet requirements that make them ready for future EV charging installations such as pre-wiring or space reservation. For example, California's buildings codes require EV charging at new MFDs and the City of Seattle recently established requirements that all new buildings with off-street parking must have EV charging infrastructure [11, 12]. ChargePoint's online marketing for its MFD products also highlights the emergence of new building regulations as a driver for building managers to install charging [6].

FINANCIAL INCENTIVES

Financial incentives for EV charging at MFDs are essential to counteract high installation costs, particularly at older buildings, and building managers' lack of interest or awareness in investing in EV charging. These barriers are discussed further in the section, *Installation Costs* and *Lack of Awareness Among Building Management*. Incentives can be offered through state programs, like the Smart Columbus program, or through utility programs. Incentives can take the form of grants, rebates, loans, tax credits, or, in the case of the utility, investment in the electrical infrastructure required to install EV charging ("make-ready" infrastructure).

Utility investment in transportation electrification shows that utilities view MFDs as an important sector to invest in and one that requires support. At least 28 utilities in 14 states have been approved to invest in transportation electrification programs that include support for MFD projects [13]. Two of the largest utility programs include significant incentives for MFD charging. These approvals include $701 million of investments across six utilities in New York and Southern California Edison's (SCE) $736 million Charge Ready 2 program [13].[3] Both programs aim to address the unique barriers facing MFD charging projects. The New York approval includes an MFD program where the utilities cover 100 percent of the make-ready costs and the SCE program includes not only a make-ready program paired with a 50 percent to 100 percent charger rebate but also an MFD program for disadvantaged communities[4] where the utility will own and operate the charging stations. SCE notes in their filing that the considerable support for MFD programs in the Charge Ready 2 program reflects lessons learned from low participation by MFDs in their previous Charge Ready 1 program [14].

Feedback from building managers reflects the value of financial incentives to building mangers' decisions to install charging. A survey of applicants to the Smart Columbus MFD rebate program confirmed that applicants found the financial incentives to be valuable and some applicants expressed that they would consider applying for more financial incentives to install additional chargers in the future [8].

[3] The docket number for the New York program is 18-E-0138 and the docket number for Southern California Edison's Charge Ready 2 program is A1806015.

[4] Disadvantaged Community (DAC) is a legally defined term in California [23].

BARRIERS TO EV CHARGING INSTALLATION AT MFDS

There are a number of unique barriers to installing EV charging at MFDs. MFDs vary widely in characteristics such as size, ownership structure, and whether or not parking is assigned. Because these variations require different charging solutions, there is no one-size-fits-all solution for EV charging at MFDs. In addition, there is a wide variety of players, such as tenants, building managers, utilities, and charging technology providers who must all coordinate to pursue EV charging installations. Coordination among so many players with varying interest levels, knowledge levels, and time availability can be very challenging. In addition, the cost of installing EV charging at MFDs, especially at older buildings, can be very high. In some cases, installations can cost more than $10,000 per charging port [8]. These potentially high costs combined with the fact that many building managers prioritize other types of projects such as repairs and renovations above potential EV charging installations, make the cost of EV charging installations a significant barrier. This section elaborates on these barriers to installing EV charging at MFDs.

WIDE RANGE OF TYPES OF MFDS - NO ONE-SIZE-FITS-ALL SOLUTION

One challenge to installing EV charging at MFDs is that, due to the wide variety of types of MFDs, there is no single solution that will work for all MFDs. Types of MFDs include, among others, apartments, condos, cooperatives, mobile home parks and townhouses, and within these types of MFDs, there is more variation [8]. For example, variables such as whether tenants own or rent their homes, whether parking is assigned or unassigned, whether MFDs are owned by an individual landlord or a larger real estate company can all influence what type of EV charging solution would work best [3]. Table 2 lists key variables that differ for different types of MFDs and describes incentive program design elements that are most ideal for different types of MFDs.

TABLE 2: KEY VARIABLES AMONG TYPES OF MFDS AND BEST-SUITED INCENTIVE PROGRAM ELEMENTS FOR EACH

Variable	MFD Type	Well-Suited Program Element
Networked or Non-Networked Chargers	Buildings with many chargers	Networked chargers are more expensive than non-networked chargers. The charger itself is around two to five times as expensive as a non-networked charger and there are annual per-charger networking fees of a few hundred dollars [5]. Networked chargers facilitate billing, charger access control, data collection, and load management. For buildings that plan to install many chargers, load management will be important from an electrical grid perspective and having networked chargers that enable this load management will be valuable. More charging load also means greater electricity costs, and this may increase the importance of being able to bill EV drivers for the use of chargers rather than spreading the costs among all building residents; networked chargers enable this type of billing [5].

Variable	MFD Type	Well-Suited Program Element
	Buildings with few chargers	Buildings that only plan to install a few chargers will have less EV load and smaller electricity costs and the higher cost of networked chargers may not be justified. In fact, in some cases the cost of networking services may exceed the station's electricity and other operating costs, making it hard to justify paying for a networked solution. Building managers may be willing to absorb the cost of electricity for charging or residents who wish to use the chargers may be willing to pay a fixed fee to cover the costs, avoiding the need for building managers set billing rates or bill based on charger usage, functionalities which require a networked solution. However, it is important to note that some MFDs, such as federal income-qualified buildings, may not be permitted to charge fixed fees.
Level 1 or Level 2 Charging	Newer buildings	Level 2 chargers provide 10 to 20 miles of range per hour of charging, whereas Level 1 chargers provide two to five miles of range per hour of charging [15]. This faster charging time makes Level 2 charging preferable to Level 1 charging from a user experience as well as from a grid integration perspective, since it may not be possible to get a complete charge from Level 1 charging during off-peak hours.
	Older buildings	For some MFDs, especially older buildings, installing Level 2 charging would require prohibitively expensive electrical and/or construction upgrades. In these cases, Level 1 charging may be appropriate [9]. However, it is important to note that most networked chargers are Level 2 chargers and the billing and administrative functions enabled by networked charging solutions are unavailable with most Level 1 chargers.
Shared or assigned parking	Shared	Whether parking is shared or assigned, building managers who do not plan to offer charging for free must be able to pass the cost of electricity directly to the user through some kind of user fee in order to avoid having non-EV owners pay for EV-owners' use of charging stations. Networked solutions make this type of billing easier but are especially necessary if parking is shared, since multiple users will need to be billed for the use of a charger as opposed to the situation where parking is assigned and all electricity can be billed to the resident who is assigned to the spot [16].
	Assigned parking	For MFDs with assigned parking, a networked solution will likely make it easier for building managers to bill the resident who uses the charger. It is possible to achieve this type of billing without a networked solution, however, it will be necessary for equipment to have the capability of separately metering charging load, whether through submetering or the use of a separate meter.
Building Size	Large, many units	Larger buildings may benefit more from an incentive program where incentive limits are proportional to MFD size or are set per charging port. Since larger MFDs have the potential to serve a greater number of EV drivers, they may want to install a greater number of charging ports. If incentive limits are a fixed amount per building, larger units

Variable	MFD Type	Well-Suited Program Element
		may not be able to install enough chargers to make it worth it to pursue installations.[5]
	Small, few units	Smaller buildings may benefit more from an incentive program where incentive limits are fixed per site because this would prevent larger MFDs from taking a substantial portion of available incentives. Smart Columbus imposed a fixed dollar limit per site to ensure a variety of sites received rebates [8].
MFD ownership type	Large real estate company with multiple properties	Imposing incentive caps per applicant could prevent a real estate company with multiple properties from receiving incentives at all of their properties.
	Small individual landlord	Imposing incentive limits per applicant could be beneficial to MFDs owned by small individual landlords by preventing large real estate companies from taking all the incentives.

The table above lists key variables that differ for different types of MFDs and describes incentive program design elements that are most ideal for different types of MFDs.

One way to overcome the challenges associated with the variety of types of MFDs when designing an MFD incentive program is to build flexibility into the program by not imposing rigid requirements on project design. In fact, a common theme among respondents to an RFI that TDEC issued to collect input on light-duty ZEV charging projects was acknowledgement that different solutions work for different MFD use cases [7]. The RFI asked respondents for recommendations on imposing networking requirements for MFD projects, requiring tenants to pay a fee for use of EV charging stations, and whether chargers at MFDs should be Level 1 or Level 2. Each of these questions received a variety of recommendations and several respondents recommended not imposing requirements and allowing for flexibility.

In designing an MFD incentive program, however, a trade-off exists between flexibility and simplicity. For example, the Smart Columbus MFD rebate outlined requirements in their rebate application for the specific purpose of avoiding confusion. They explain in their case study that, in anticipation of confusion regarding charging use, ownership, and charging use fees, their application required that charging stations be dedicated to use by tenants, must be owned by building management, and that use of the stations must be free for the first 30 days of operation [8]. It is worth noting that these requirements, while helpful in decreasing the number of questions building managers need to answer, would exclude certain types of projects. For example, since the program specifies that chargers need to be owned by building management, participants in the program could not use as-a-service products, where the charging service provider owns the charger, and utility-owned projects would also not qualify.

COMPLEX AND TIME-CONSUMING FOR BUILDING MANAGERS

A significant barrier to installing EV charging at MFDs is that both the installation and operations processes can be complex and time-consuming, and building managers often do not have a lot of time to devote to

[5] The topic of how to set incentive limits was discussed at Pepco's working group meeting about their MFD proposal. EVSE providers were among the stakeholders to recommend that limits be set in proportion to building size or be set per port [3].

this work. One major factor that adds complexity to charging installations at MFDs is that they require coordination among a large number of players including building managers, residents, developers, homeowner association boards, utilities, electricians/contractors and city permitting officials [8]. Not only are there challenges to coordinating all the players, there are also a large number of questions that need to be answered for each project and, as discussed, there are no one-size-fits-all solutions. These questions, among many others, include the following: will EV charging be accessible to residents only or guests or the pubic as well? Will there be fees for use of the chargers? If so, what should these fees be? Should they be time-based or energy-based and how will they be passed to the user? Will EV chargers have separate meters, use submetering, or neither? Will EV chargers use available EV electricity rates?

Third-party EV charging service providers offer products that relieve building mangers of many complicated or administratively burdensome responsibilities such as project development, billing for energy usage; operations and maintenance of the chargers; and collecting data such as energy usage, environmental impact, and revenue [6]. In fact, some providers offer lease or as-a-service products where the building manager pays a monthly subscription fee and the charging service provider retains ownership of the charging station [6]. See the section *Recommendations for Designing an MFD Incentive* for details on how an MFD incentive program could be designed to support the use of such lease or as-a-service products.

As mentioned previously, setting certain requirements in an MFD incentive program can decrease the number of questions building managers need to answer in pursing EV charging installations, but too many requirements can also result in an overly-rigid program that excludes certain types of MFDs.

INSTALLATION COSTS

For many building managers, there are several types of projects that take priority over EV charging from a budget standpoint, such as repairs, renovations, and providing other amenities that are perceived to be in higher demand than EV charging [17]. In addition, most building managers who install EV charging do not expect to earn a profit directly from revenue generated by use of the charger but rather see EV charging as a way to increase property value, meet future demand, or comply with potential new policies that would require them to install EV charging [9]. Building managers may be unaware of or unmotivated by these indirect values and therefore have a low willingness to pay for EV charging. In fact, among respondent's to TDEC's light-duty ZEV RFI, the most commonly listed barrier to EV charging at MFDs was building managers' lack of awareness [7].

Exacerbating building managers' potential low willingness to pay is the fact that EV charging installations at MFDs can be very high, especially if buildings are old and require complicated retrofits. According to the Smart Columbus case study, MFD installations can cost more than $10,000 per port [8]. In fact, because post-construction EV installations are so much more expensive, some cities and states, such as the state of California and the city of Seattle have adopted building codes that require some level of EV-readiness for new construction, such as requiring EV chargers to be installed or requiring prewiring or parking space reservation [11, 12].

Financial incentives are essential in order to overcome the substantial cost barriers that exist for MFD EV charging. Financial incentives can be provided through state programs as well as utility programs. Types of financial incentives include grants, rebates, tax incentives, loans, and, for utility programs, investment in electrical infrastructure required for charging installations ("make-ready" infrastructure). The section

Financial Incentives describes examples of utility support for MFD projects. *Table 3* below summarizes some of the benefits and drawbacks of different types of financial incentives.

TABLE 3: BENEFITS AND DRAWBACK OF DIFFERENT TYPES OF FINANCIAL INCENTIVES FOR EV CHARGING AT MFDS

Incentive Type	Benefits	Drawbacks
Grant	• Direct, near-term incentive • Can prioritize certain types of projects (e.g., projects in underserved communities, projects with smart charging capabilities, or specific MFD types).	• Requires potentially time-intensive review of applications and administrative oversight.
Rebate (first-come-first-served)	• Direct near-term incentive • Quick to implement (does not require extensive review process) • Can set rebate level based on population segment.	• Difficult to ensure equitable distribution of incentives with first-come-first-served. Note: it is possible to carve-out a certain amount of funding for underserved communities. • Segmented rebate level can add to application and administrative costs.
Tax Incentive	• Can set tax incentive level based on population segment. • Often does not require budget allocation since tax incentives reduce revenue as opposed to increasing costs.	• Requires legislative action. • Segmented tax incentive can add to application and administrative costs. • Generally, tax incentives will apply to income taxes and therefore are not applicable in states with no income tax.

Loan	• Can eliminate upfront costs for building managers ("operationalizes" costs).
	• Can prioritize loans to certain population segments.
		• Work required for set-up:
		  ○ Hire a loan officer
		  ○ Establish loan terms
		• Many small loans results in very high administrative costs.

The table above summarizes benefits and drawbacks of different types of financial incentives that could be offered for EV charging installations at MFDs.

MANAGING ELECTRICITY COSTS AND BILLING

There are three key challenges related to electricity costs and billing associated with EV charging at MFDs. First, gaining the support of all residents will often require making sure that non-EV drivers will not pay for the electricity used for charging by EV drivers. Specifically, it will be important for there to be a way to bill the user for their use of a charger, whether this billing takes the form of time-based fees, energy-based fees, or some other fee structure. As discussed in Table 2, networked solutions facilitate these types of billing processes. The second challenge is preventing charging load from increasing demand charges on the building's energy bills, which is particularly important for large EV charging stations with many

charging ports. This would require there to be a way to separately meter EV charging load, either via a separate meter or submetering, so it could be excluded from demand charge calculations [18]. Finally, having the ability to bill EV charging using a separate electricity rate from the rest of the building is important. Time-of-use rates can help utilities manage when EV charging occurs in order to integrate EV charging load into the electrical grid efficiently, and these rates can also save EV drivers money on their electricity bills [19]. Being able to separately meter EV charging load and pass electricity costs to the user is necessary for time-of-use rates to work.

LACK OF AWARENESS AMONG BUILDING MANAGEMENT

A significant barrier to EV charging installations at MFDs is lack of awareness by building managers. In fact, lack of awareness was the most commonly listed barrier for MFD EV charging deployment in the responses TDEC received to their light-duty ZEV RFI [7]. Building managers may not know about existing incentives or they may not understand how to pursue a charging project. Perhaps most importantly, building managers may not be aware of the potential benefits of EV charging. This is particularly true because, in many cases, the value of EV charging at MFDs is indirect, taking the form of increased property value, as opposed to a direct return on investment from revenue generated by use of the station [9]. As ChargePoint describes in their MFD brochure, many building managers "aren't interested in getting into the EV charging business [6]." Without education and outreach efforts to building managers, this indirect value may be less apparent and may make building managers less willing to pay for and devote time and effort to installations. In this sense, building manager lack of awareness exacerbates other barriers such as high installation costs and the complex and time-consuming nature of MFD charging projects by making building managers less motivated to overcome these barriers.

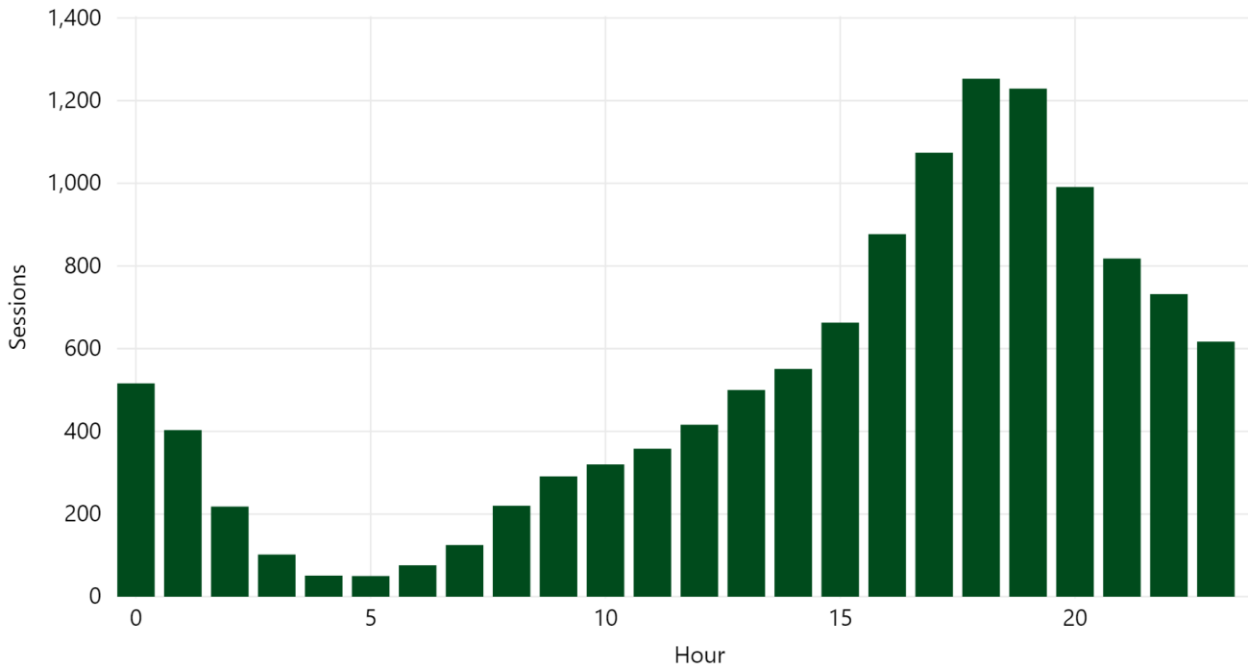
An MFD incentive program should include an education and outreach component to help overcome this barrier. One of the key insights from the Smart Columbus MFD case study was the importance of outreach to ensure interest in the program. The Smart Columbus case study concluded that in future MFD programs, they would likely extend outreach efforts through targeted contact with different types of MFD building managers [8]. In addition to direct outreach to MFD building managers, there are many resources that can help make building managers aware of the benefits of EV charging and help them understand how to pursue installations. For example, ChargePoint has a webpage specifically for MFD managers that includes a list of available incentives in each state [6]. An MFD incentive program may direct building managers to these types of resources. Electric utilities can also be helpful in providing resources and promoting incentive programs to building managers, since building managers who are interested in EV charging are likely to look to their utility as a source of information.

INSIGHTS FROM CHARGING USE DATA

Charging use data from MFD charging stations in the Columbus, Ohio region[2] and the state of New York suggest that EV drivers at MFDs tend to plug their vehicles in when they get home from work in the early evening. This is demonstrated by Figure 1 and Figure 2 which both show an increase in the number of active charging sessions in the early evening – around 5 pm for New York stations and around 6 pm for Columbus region stations. This charging load could likely be pushed to overnight, off-peak hours without

negatively affecting the EV drivers since they likely do not need to drive their cars in the middle of the night. Load shifting can be accomplished through time-of-use electricity rates or managed charging. Because both of these methods of load-shifting are best accomplished with Level 2, networked chargers, in designing an MFD incentive program, it may be valuable to require this type of equipment or to favor projects that plan to install such equipment.

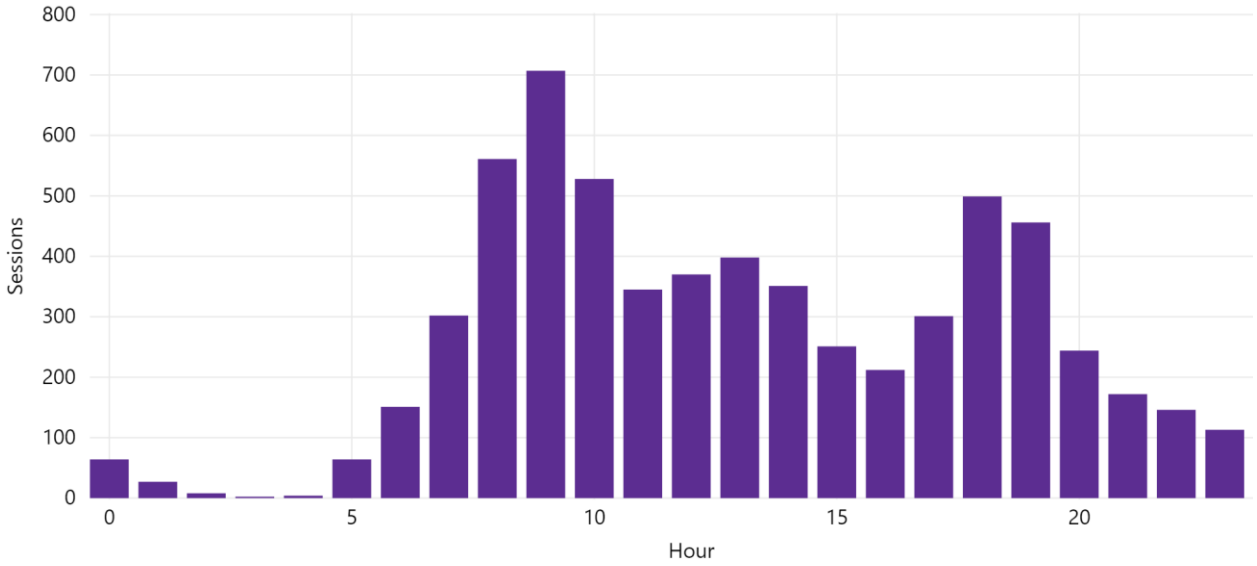
FIGURE 1: NUMBER OF CHARGING SESSIONS BY HOUR AT MFD STATIONS IN NEW YORK STATE



This figure shows that the number of active charging sessions at MFD stations in New York state peaks starting in the early evening, suggesting that MFD EV drivers plug their vehicles in when they get home from work.

Electric utilities may favor charging stations capable of smart charging in order to take advantage of potential benefits and avoid the potential challenges that EV charging load can bring to the electrical grid, especially as EV adoption increases. Representatives from Pepco expressed this preference at the Pepco working group meetings [3]. More than 75 percent of approved utility filings tracked on the Atlas EV Hub require charging equipment to be capable of smart charging [13]. Table 2 in the section *Barriers to EV Charging Installation at MFDs* provides more details on the benefits and drawbacks of networked versus non-networked chargers and Level 1 versus Level 2 chargers.

FIGURE 2: NUMBER OF CHARGING SESSIONS BY HOUR AT MFD STATIONS IN COLUMBUS REGION



This figure shows that the number of active charging sessions at MFD stations in the Columbus region increases in the early evening, suggesting that MFD EV drivers plug their vehicles in when they get home from work.

RECOMMENDATIONS FOR DESIGNING AN MFD INCENTIVE

An MFD incentive program should have two main goals.

1. Simplify the development and operations process for building managers.
2. Decrease installation and operating costs for building managers, EV drivers, and residents.

This section provides recommendations to help guide the design of an MFD incentive program that achieves these goals.

As discussed earlier in this report, one way to simplify the development and operations process for building managers is to set requirements in an MFD incentive program. Since setting requirements decreases program flexibility, it is important to be thoughtful in choosing which requirements to set in order to avoid creating an overly rigid program that excludes certain types of MFDs. The following list offers recommendations for designing an MFD incentive program that strikes a balance between simplicity and flexibility.

- Level 2 chargers rather than Level 1 chargers are preferable: Level 2 chargers provide 10 to 20 miles of range per hour of charging, whereas Level 1 chargers provide two to five miles of range per hour of charging [15]. While there is not consensus on this question, Level 2 charging is a much more common recommendation for MFDs. Of the respondents to TDEC's light-duty ZEV RFI who responded to this question, nearly all recommended Level 2 over Level 1. Some recommended that both charging levels be allowed and no respondents recommended Level 1 over Level 2 [7]. Similarly, during Pepco's working group sessions, while some stakeholders supported Level 1 charging solutions due to their lower costs, most stakeholders recommended

Level 2. The most common reasons for supporting Level 2 over Level 1 charging at MFDs are that Level 2 chargers provide a better user experience due to faster charging and Level 2 chargers make it easier for utilities to manage charging load, which is important for scalability as EV adoption increases [3]. Level 2 chargers make it easier to manage charging load for a variety of reasons. One reason is that, because Level 1 chargers draw less power than Level 2 chargers, they have less potential to provide value as a source of demand response. In addition, because it takes longer to charge an EV with a Level 1 charger, it may not be possible for drivers to shift all charging load to off-peak hours and still get a complete charge. In addition, networked chargers provide data collection and sharing capabilities that help facilitate load management and since Level 1 chargers are usually not networked, Level 2 chargers may be preferable [4]. The Smart Columbus MFD charging program noted the preference for Level 2 charging over Level 1 as one of their lessons learned from their MFD charging incentive program. They noted that, while rebates were available for Level 1 charging, all applicants were pursuing Level 2 installations [8]. For some buildings, especially older buildings, installing Level 2 chargers may require cost prohibitive electrical and construction upgrades. In these cases, Level 1 charging may be appropriate [5]. See Table 2 for more information on the question of Level 1 vs. Level 2 charging in different use cases.

- Equipment should be capable of separately metering charging load: Separately metering charging load is necessary in order to perform a variety of tasks such as passing electricity costs to the user, administering separate rates such EV time-of-use rates for EV charging load than the rest of the building's load, collecting and analyzing charging use data, and excluding charging load from demand charge calculations. Installing separate meters or requiring equipment that is capable of submetering can accomplish these goals.
- Equipment should be capable of data collection and sharing: Data collection and sharing is essential for utilities to integrate charging load into the electrical grid. This will be increasingly important for the electrical grid as EV adoption and charging load increases. For this reason, most utility EV programs require equipment capable of "smart charging," which includes data collection and sharing capabilities. More than 75 percent of approved utility filings tracked on the Atlas EV Hub Utility Filings Dashboard require charging equipment be capable of smart charging [13]. Data collection is also useful for building managers who are interested in understanding if and how their installations are being used. Such data is also very valuable for states that offer MFD incentives and want to evaluate program success and incorporate lessons learned into future programs. The Smart Columbus MFD program required collection and sharing of charging use data so that the program could evaluate its success and gain insights to apply to potential future programs [8]. Networked charging solutions facilitate this type of data collection and sharing and therefore an MFD incentive program may want to require or give preference to networked solutions.
- Equipment should be capable of administering user fees or passing through energy costs: Having the ability to charge a user fee to the EV driver may be important for a variety of reasons depending on the stakeholder. First, building managers may not want to absorb the cost of the energy used for charging. Second, for electrical grid integration reasons, electric utilities may want to influence when charging occurs through time-of-use rates. These rates cannot be effective at influencing charging behavior if they are not passed through to the charging user. Therefore, even if building managers choose not to administer a user fee, it may be advisable for an MFD incentive program to require that the equipment be capable of doing so in case it becomes necessary to administer a user fee in the future. This sentiment was expressed during the Pepco working group meetings. Specifically, several stakeholders expressed the opinion that, even though the proposed MFD incentive program was small and would not have a substantial

impact on the electrical grid, in order for the program to be scalable, it was important for the equipment to be capable of grid integration methods such as time-of-use rates [3]. Networked charging solutions facilitate this type of billing and administration and therefore an MFD incentive program may want to require or give preference to networked solutions.

- Networked solutions are preferable for buildings with many chargers: Networked charging solutions significantly decrease the administrative burden for building managers by allowing them to do things such as set billing rates and bill based on charger usage, control who can access chargers, and remotely monitor charging stations [16]. Networked solutions also facilitate optimal data collection and load management, which is important from a grid perspective. However, networked chargers are more expensive than non-networked chargers and there are situations, particularly at buildings that plan to install a small number of chargers, where these higher costs may not be justified. In fact, in some cases the cost of networking services may exceed the station's electricity and other operating costs, making it hard to justify paying for a networked solution. Therefore, an MFD incentive program may want to allow flexibility but encourage networked solutions for larger buildings. See Table 2 for more information on the question of networked vs. non-networked chargers in different use cases.
- Incentives should support lease/as-a-service products: Lease/as-a-service products where the charging service provider retains ownership of the charging installation and the building manager pays monthly fees can relieve building managers of a substantial amount of work such as site planning, billing, and operations and maintenance [6]. There are several ways to design an MFD incentive program that supports these types of lease/as-a-service products. First, because these products still require site hosts to prepare the site for the installation, offering incentives for the make-ready constructions costs can help support MFD building operators who want to take advantage of lease/as-a-service products. MFD incentive programs can also simply make lease payments eligible for incentives as the New Jersey Department of Environmental Protection's It Pay$ to Plug In program does [20]. It may also be feasible to create a model where the charging service provider receives the incentive payment and passes it along to building managers by lowering lease payments.
- Recommend or provide resources/points of contact for third-party EV charging service products: Third party EV charging providers offer products that relieve building mangers of many administratively burdensome responsibilities such as project development; billing for charging; operations and maintenance of the chargers; and collecting data such as energy usage, environmental impact, and revenue [6]. An MFD incentive program may want to encourage applicants to use such products and may want to provide resources or points of contact for applicants to pursue such products.
- Include Education and Outreach Component: Building managers' lack of awareness of available incentives, benefits of EV charging, or how to pursue a charging installation is one of the major barriers to MFD EV charging. An MFD incentive program should make sure to include efforts to address this lack of awareness. Some strategies to do this include direct outreach to MFD building managers and directing program participants to sources of information or points of contact.
- Provide Resources and Recommendations as Part of Incentive Program: In order to balance simplicity and program flexibility, an MFD incentive program might also consider making recommendations and directing building managers to resources rather than setting requirements. This can be accomplished by providing project development checklists and guides for MFD building managers, making specific project development recommendations (e.g. the above potential requirements could instead be made as recommendations), or providing points of contact with project developers such as EV charging providers who can make

recommendations and guide building managers through the complex project development process.[6]

CONCLUSION

With approximately 30 percent of U.S. households being MFDs and almost 75 percent of MFD households owning at least one vehicle, MFDs are an increasingly important sector to focus on for EV charging [1, 2]. Charging projects at MFDs face uniquely challenging barriers such as high installation costs, especially at older buildings, and a lack of interest by building managers who often have limited time or budget to devote to EV charging projects. The wide range of types of MFDs means there is no one-size-fits-all solution for EV charging projects and this adds to the complexity of the development process and exacerbates the challenges associated with building managers' lack of interest.

An MFD incentive program should aim to simplify the development and operations process for building managers and decrease installation and operating costs. Designing an incentive program that accomplishes these goals but maintains enough flexibility to accommodate the wide range of types of MFDs is essential. The recommendations in this report aim to guide the design of an MFD incentive program that achieves these goals.

REFERENCES

[1] Energy.gov, "Charging at Home," [Online]. Available: https://www.energy.gov/eere/electricvehicles/charging-home. [Accessed May 2020].

[2] National Multifamily Housing Council, "Renters and Owners," [Online]. Available: https://www.nmhc.org/research-insight/quick-facts-figures/quick-facts-resident-demographics/renters-and-owners/. [Accessed September 2020].

[3] edocket.dcpsc.org, "Formal Case Nos. 1130 and 1155," 29 January 2020. [Online]. Available: https://edocket.dcpsc.org/apis/api/filing/download?attachId=100412&guidFileName=27e3b2c4-7e96-45ce-a282-fbd916f8beeb.pdf.

[6] Of particular note is the Vehicle Charging Innovations for Multi-Unit Dwelling (VCI-MUD) project. The project plans to work with utilities, government agencies, technology providers, nonprofits, property owners, and other stakeholders to do the following:

- Engage stakeholders to document barriers to MFD and residential curbside PEV charging
- Collect baseline data from existing MFD and residential curbside charging stations
- Demonstrate innovative technologies that address identified barriers
- Compile project findings in an easy-to-use toolkit for MFD stakeholders
- Disseminate the toolkit across national, regional, state, and local channels

[4] ChargePoint, "Level Up Your EV Charging Knowledge," 23 March 2017. [Online]. Available: https://www.chargepoint.com/blog/level-your-ev-charging-knowledge/#:~:text=Level%202%20charging%20adds%20about,miles%20of%20Range%20Per%20Hour.&text=%22Networked%20Level%202%20charging%20stations,(miles%20per%20charge).%22.

[5] Cielo Electric, "EV Charging Debate: Networked vs Non Networked EV Chargers," [Online]. Available: https://cieloelectric.ca/ev-charging-debate-networked-vs-non-networked-ev-chargers/. [Accessed October 2020].

[6] ChargePoint, "Multi-Family Home Service," [Online]. Available: https://www.chargepoint.com/products/multi-family-home-service/. [Accessed May 2020].

[7] R. Respondents, Interviewee, *Responses to TDEC's Light-Duty ZEV RFI.* [Interview]. 2019 December 2019.

[8] Smart Columbus Case Study, "Case Study on Multi-Unit Dwelling Charging Infrastructure," 2018. [Online]. Available: https://d2rfd3nxvhnf29.cloudfront.net/legacy/uploadedfiles/playbook-assets/electric-vehicle-charging/mud-case-study-final.pdf.

[9] Energy Solutions, "PCE Low-Power EV Charging Pilot: Multi-Unit Dwelling Business Requirements," December 2019. [Online].

[10] NESCAUM, "Right to Charge Laws," October 2019. [Online]. Available: http://www.nescaum.org/documents/ev-right-to-charge.pdf/view.

[11] Alternative Fuels Data Center, "Plug-In Electric Vehicle Deployment Policy Tools: Zoning, Codes, and Parking Ordinances," [Online]. Available: https://afdc.energy.gov/bulletins/technology-bulletin-2015-08.html. [Accessed 23 10 2019].

[12] Utility Dive, "Utilitydive.com," 7 5 2019. [Online]. Available: https://www.utilitydive.com/news/seattle-passes-ev-readiness-requirements/554173/. [Accessed 15 10 2019].

[13] Atlas Public Policy, "Utility Filings Dashboard," [Online]. Available: https://www.atlasevhub.com/materials/electric-utility-filings/. [Accessed 14 10 2019].

[14] California Public Utilities Commission, "Decision Authorizing Southern California Edison Company's Charge Ready 2 Infrastructure and Market Education Programs," August 2020. [Online]. Available: https://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=346230115.

[15] Energy.gov, "Vehicle Charging," [Online]. Available: https://www.energy.gov/eere/electricvehicles/vehicle-charging. [Accessed October 2020].

[16] SemaConnect, "Networked or Non-Networked Stations, That is the Question," February 2019. [Online]. Available: https://semaconnect.com/blog/networked-non-networked/.

[17] Nova, "Electric Vehicle Charging in Apartment-Based Housing," April 2015. [Online]. Available: https://files.novaworks.org/Reports/EV-MUD.pdf.

[18] San Diego Gas & Electric, "Multi-Unit Dwelling (MUD) Vehicle Charging Case Studies," 2011. [Online]. Available: https://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/san-diego/SDG&E%20Multi-unit%20Case%20Studies%20CFT%20REVI.pdf.

[19] ChargePoint, "What You Need to Know About Residential Utility Rate Plans and EV Charging," 8 May 2017. [Online]. Available: https://www.chargepoint.com/blog/what-you-need-know-about-residential-utility-rate-plans-and-ev-charging/#:~:text=Time%2Dof%2Duse%20rates%20charge,time%20to%20charge%20your%20EV..

[20] State of New Jersey Department of Environmental Protection, "It Pay$ to Plug In: NJ's Electric Vehicle Charging Grant Program Overview and Instructions," April 2020. [Online]. Available: https://www.drivegreen.nj.gov/overview.pdf.

[21] FuelsFix.com, "Clean Cities Coalitions partner on vehicle charging innovations for multi-unit dwellings," January 2020. [Online]. Available: http://www.fuelsfix.com/2020/01/clean-cities-coalitions-2/.

[22] Tennessee Department of Environment & Conservation, "Light Duty Zero Emission Vehicle Supply Equipment," November 2019. [Online]. Available: https://www.tn.gov/content/dam/tn/environment/energy/documents/vw-resources/RFI_Light_Duty_ZEV_Final.pdf.

[23] California Office of Environmental Health Hazard Assessment, "SB 535 Disadvantaged Communities," [Online]. Available: https://oehha.ca.gov/calenviroscreen/sb535. [Accessed October 2020].

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