Smart Columbus Kickstarts EV Charging Development in Multi-Unit Dwellings: A Case Study on Multi-Unit Dwelling Charging Infrastructure Priority

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ABSTRACT:

This case study focuses on Smart Columbus' effort to support multi-unit dwelling (MUD) charging. Installing charging infrastructure at MUDs has unique barriers to overcome when compared to single-family homes, including the types of MUDs, the installation process, and the cost of deploying/payment for providing charging services. The team established a rebate program to support EV charging equipment installation at MUDs in the Columbus region. Initial funding for the rebate was $172,000 and aimed to deploy 30 Level 1 charging stations at MUDs. The first round of the rebate program application process was a success. Smart Columbus received 16 applications totaling $265,990 in requested funds; 11 applications were accepted for a total of $167,998 (leveraging $137,500 in private funds). The 11 applications will result in 48 new Level 2 charging ports, considerably more valuable than the 30 Level 1 charging ports originally targeted for the program. Future MUD funding efforts may be structured as a rebate program, which can be easier to administer than a grant. Equitable distribution of the funds may require the program review to be more complex than "first come, first serve." Future efforts to expand charging at MUDs may also include extended outreach through targeted contact with different types of MUD owners, developers, and managers across the Columbus region.

KEY WORDS: multi-unit dwelling, electric vehicle, residential charging, EV charging, smart city.

1. Introduction

Smart Columbus aims to put Columbus at the forefront of mobility innovation to drive economic growth, improve quality of life, foster sustainability, and improve safety throughout the region. As the winner of the U.S Department of Transportation's (USDOT) first-ever Smart City Challenge, Columbus was awarded $40 million from USDOT and $10 million from PGAPh to transform mobility in the country's 14th-largest city. Since the challenge, Smart Columbus has rallied more than $500 million in aligned investment from the region's public and private sectors to scale and sustain the initiative.

This case study focuses on Smart Columbus' effort to support charging in MUDs. The initial goal was set at 30 Level 1 charging stations at MUD residences, as Level 1 charging was cost-effective and initially thought to offer adequate charging speed for overnight parking for residents [2]. In planning for Year 2, the goal for residential charging was increased to 90 Level 2 charging ports in MUDs, 30 in Year 1 and 60 in Year 2, based on MUD owner demand. Other residential charging development was spearheaded by AEP, and non-residential charging was developed by the Smart Columbus team, the City of Columbus, and other partners.

Currently, over 80 percent of EV charging occurs at home, primarily in single-family homes with dedicated parking [10]. Expanding access to home charging at MUDs was critical for the Columbus region, as 40 percent of households in the city were multi-family and MUDs made up 30 percent of households in the suburbs [3]. Charging behavior at MUDs was not well-understood since most EV owners lived in single-family homes.

Smart Columbus understood that as the number of EV drivers, development of charging for MUD households would be necessary [3]. Focusing on MUDs was one way the Smart Columbus team worked to obtain adequate information to close the knowledge gaps around charging infrastructure. This helps to better prepare for future market development. Additionally, the team found that providing financial support helped to overcome some of the barriers to installing EV charging equipment at MUDs.

2. Grant Priorities and Need

Through the PGAPh grant, Smart Columbus and its partners are addressing five priorities to decrease greenhouse gas emissions: grid decarbonization, EV fleet adoption, deployment and expanded use of autonomous and multi-modal systems, consumer EV adoption, and charging infrastructure deployment.

Expanding access to charging infrastructure is essential to increasing EV adoption [1]. Smart Columbus is providing financial and educational resources to increase the number of charging stations in four sectors: residential, workplace, public, and fleet.

The cost of charging infrastructure varies with installation often accounting for more than half of the total installation costs. The equipment and installation per port can range from no cost if using a standard 120V power outlet at your home to $90,000 or more for a high-powered fast charging station.

The Smart Columbus Electrification Plan outlines the program goals and target numbers for the 925 total charging stations and types listed in **Table 1**. Charging stations will be installed by the Smart Columbus team, City of Columbus, the region's electric utility, American Electric Power (AEP), and members of the Columbus Partnership. The charging port goal in each sector was based on the need for charging, funding availability and infrastructure that was necessary to charge EVs. **Figure 1** shows the

TABLE 1: SMART COLUMBUS ELECTRIFICATION PLAN CHARGING PRIORITY GOALS

Charger Type	RESIDENTIAL		PUBLIC		WORKPLACE		FLEET	
	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted
Level 1	30 CoC	-	-	-	50	-	-	-
Level 2	1000 AEP	90 CoC 60 AEP	30 CoC 250 AEP	60 CoC 90 AEP	-	150 AEP 100 Other	300	300
DC Fast Charger	-	-	25 AEP	75 AEP	-	-	-	-

FIGURE 1: CHARGING LEVELS

		Primary Use	Power to Vehicle	Charge (Volts)	Power (kW)	Miles/hr of Charge	Time to Recharge
Level 1	L1	Residential	AC	120	≤ 1.8	4	6 – 20 hrs
Level 2	L2	Residential	AC	240	≤ 7.2	22	3 – 8 hrs
	L2	Public	AC	240	≤ 19.2	22	3 – 8 hrs
DC Fast Charging	DCFC	Public	DC	480	≥ 50	150	30 min
Supercharger (Tesla)		Public	DC	480	120	400+	20 min

different levels of charging for EVs. The charging capabilities (miles per hour rates) increase moving down the chart, along with the cost of equipment and installation.

In support of the Smart Columbus initiative, the National Renewable Energy Laboratory (NREL) completed a study in February 2017 that estimated the number of charging ports required to accommodate EVs in the Columbus region. The study projected that 3,200 new EVs would allow the Smart Columbus program to meet their target of 1.8% of light-duty vehicle sales from EVs by March 31, 2020 (the end of the program). This target of 3,200 vehicles was used to set the program's charging infrastructure goals [3]. The researchers assumed that 12%, or 636 vehicles, would be housed at MUDs and would require 404 Level 2 charging stations at those residences. The number of required charging ports was estimated with main assumptions about types of EVs, types of charging, travel patterns, and current spatial distributions of hybrid electric vehicles. All EVs were assumed to have charging stations at home. The model assumes consumers prefer to charge enough to complete their travel while minimizing operating costs.

As a result, Smart Columbus and its partners increased the target number of charging stations for Year 2 from 30 to 90 charging stations. This increased target will better support the Columbus region meeting the NREL estimated need of 404 Level 2 MUD chargers. The remainder of this case study will focus on MUD charging.

2. Background

Smart Columbus, the smart city initiative of the Columbus region, aims to put Columbus at the forefront of mobility innovation to drive economic growth, improve quality of life, foster sustainability and improve safety throughout the region. As the winner of the U.S Department of Transportation's (USDOT) first-ever Smart City Challenge, Columbus was awarded $40 million from USDOT and $10 million from Paul G. Allen Philanthropies to transform mobility in the country's 14th-largest city. Since the challenge, Smart Columbus has rallied more than $500 million in aligned investment from the region's public and private sector to scale and sustain the initiative.

Through the Paul G. Allen Philanthropies grant, Smart Columbus and its partners aim to decrease greenhouse gas emissions primarily from light-duty transportation through grid decarbonization, electric vehicle (EV) fleet adoption, deployment and expanded use of autonomous and multi-modal systems, consumer EV adoption, and charging infrastructure deployment.

Fleet electric vehicle adoption is one of five priorities in the Smart Columbus Electrification Plan. Fleet electrification was selected by Smart Columbus as a key way to accelerate EV adoption and drive decarbonization. The overall program goal is to increase EV adoption in the region by almost 500 per cent.

The original objective of Smart Columbus' fleet adoption priority was to introduce EVs to public, private and transportation service provider (TSP) fleets. At the program's outset, Smart Columbus' goal was to add 300 EVs to public fleets, 450 EVs to private fleets, and 30 EVs to car sharing/TSP fleets. Of the 300 public EVs, the City of Columbus committed to incorporate 200 vehicles into its fleet. Now toward the end of the program, the City of Columbus goal remains at 200 EV's, however the local public partner goal for the additional 100 fleet EV's has shifted to 65 light duty vehicles and ten electric busses to be deployed in 2019 by the Columbus Ohio Transit Authority (COTA). As part of the Electrification Plan, the City of Columbus and its partners evaluated the various financing mechanisms available to public agencies and existing policies for EV procurement.

3. Unique Barriers to MUD Charging Infrastructure

Installing charging infrastructure at MUDs has unique barriers to overcome when compared to single-family homes, including the types of MUDs, the installation process, and the cost of deploying/payment for providing charging services [4] [5].

There are at least five types of MUDs, which can be owned or rented, including apartments, condos, cooperatives, mobile home parks, and townhouses. Parking at MUDs can be shared, assigned, or residents can rely on street parking. The parking can be in a structure or a lot and can be owned by individuals, the building owner, or building associations/cooperatives. This allows for a sizeable number of environments to accommodate MUD charging; therefore, there is not a single charging solution for all MUDs.

Further complicating MUD charging installation is that the process is not as easy as just connecting an EV to an outlet. The charging infrastructure developer must work with tenants, owners, homeowner associations, boards, utilities, electricians/contractors, and city permitting officials to complete an installation. The property owner or manager is responsible for most of the steps in the process and while some of these steps are common to all charging equipment installation, the variety in property ownership and parking structures complicate the process [6]. For example, the building owners or property managers would need to establish a policy for charging use: who can use the charging stations, how much it may cost, and who owns the equipment. For a condo building, the installation would likely need to be approved through a homeowner association and clarity on equipment ownership would be required.

The cost and payment for equipment and installation are also important considerations and raise barriers to deployment at MUDs. Level 2 charging stations at MUDs could cost under $2,000 per charging port or more than $10,000 in some cases. Installation cost variables include equipment costs, labor costs, permitting fees, upgrades to electrical systems to support the use of the equipment, and grid upgrade costs (borne by either or both the electric utility and the charging host). For a MUD, costs can also be complicated by the ownership issues of MUDs. For example, an apartment building has an owner that would be responsible for the entire process of charging station installation and maintenance. In a condo building, parking spaces may be owned by individuals or be a part of common spaces managed by a homeowner association.

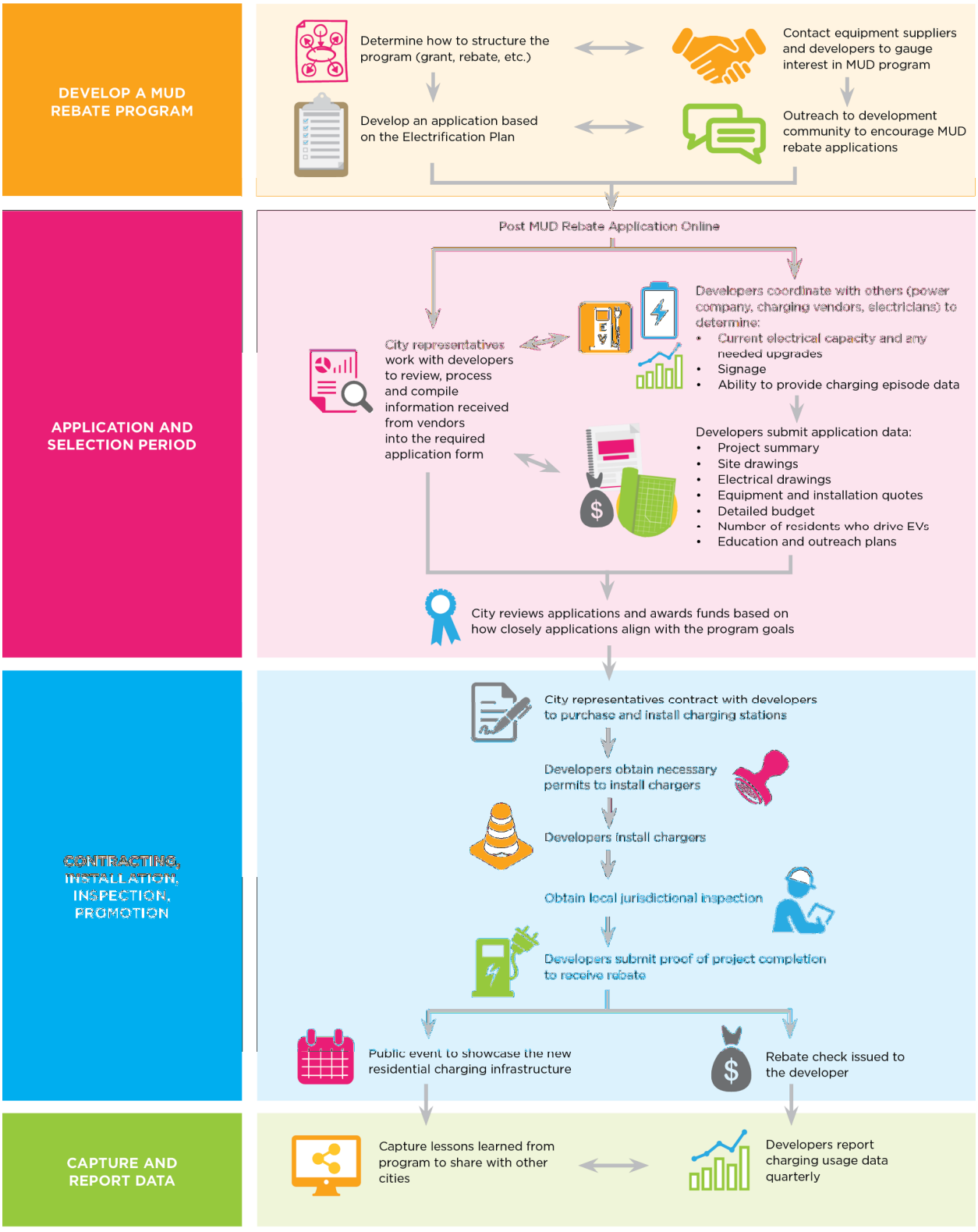
5. Available Options to Overcome Barriers

Levers exist at the city and state level to address the barriers to charging deployment at MUDs, including financial incentives, education, building-related regulations, and utility engagement. For Smart Columbus, the city initially focused on actions it could employ itself without additional actions by state agencies or the legislature.

These actions are captured in **Figure 2**, which illustrates the Process for Developing and Implementing a MUD Rebate Program. The left side of the diagram captures the overall process, starting with designing the program/application process and engaging MUD developers to participating in it. It finishes on the bottom of the flow chart with capturing and reporting data. The remainder of the flow chart (right side) defines the steps needed with-in each of these categories to deliver the MUD Rebate Program.

Incentives that cover or reduce the costs of equipment and installation can come in multiple forms: rebates, grants, tax credits, and loans. Rebates and grants can provide the most direct, near-term incentive, as the funds are received closer to when they are incurred (see **Table 2** for a comparison of these two financial incentives). Importantly, a rebate requires less critical review than a grant, and therefore can be quicker to implement. Beyond enabling building owners and property managers to overcome

FIGURE 2: PROCESS FOR DEVELOPING AND IMPLEMENTING A MUD REBATE PROGRAM



financial barriers, a financial incentive can also benefit the funder. A city funder, for example, can require access to charging use data in order to receive a grant or rebate. These were the most applicable financial incentives to Smart Columbus. Other

incentives, like tax credits or loans, were not as applicable. A loan program would have required a lot of infrastructure to be created, including the hiring of financial loan officers, the establishment of loan terms, and an assessment of the suitability of a subsidized loan program. While the city could have explored property tax credits, equipment-based tax credits would have required state action and would have only been applicable to individuals and not building owners or homeowner associations (Ohio does not have a corporate tax).

TABLE 2. COMPARING REBATES AND GRANTS TO SUPPORT CHARGING INFRASTRUCTURE

Rebate Type	Rebate	Grant
Cash given directly to recipient	Yes	Yes
Criteria established for eligibility through an application process	Yes	Yes
Application acceptance	First come, first serve	Deadline for application
Project approval	Approved when it meets criteria	Scored based on established criteria
Awarding	Can still be based on performance (require auditing)	Highest scores receive the award
Length of process	Generally quicker	Can take longer with review

Education and outreach can help to clarify the installation steps for MUDs. Some organizations have prepared educational material for both EV and MUD owners/managers on charging equipment installation at MUDs [5]. The material may be location-specific, as states may have different policies. For example, in Columbus, MUD owners are not required to make at-home charging possible, as they are in California. In future rounds of MUD funding, the MUD process flow chart, **Figure 2**, can be used to educate stakeholders on how the process works. It will also be used as a tool in discussions with other municipalities and agencies considering implementing such a program.

Policies that address building codes or change regulations can also push development and make future installations easier to manage. Changes in policy take time and the motivation of policymakers. They are long-term efforts that can supplement the near-term efforts of financial incentives. Below are examples of building code and legislative efforts that could aid charging equipment installation at MUDs.

- Building code requirements: As an important initiative of the program, Smart Columbus intends to "develop and refine standards and codes to facilitate efficient City of Columbus EV infrastructure permitting" and "share information and lessons learned with other municipalities." This will include efforts to help ensure sites are "charger ready." Most existing buildings cannot accommodate the power consumption of EV charging equipment and retrofitting existing electrical systems can be expensive [6]. However, installing electrical systems that can handle EV charging equipment at the time of construction is a lower cost option, which is known as making a system "make-ready" for charging equipment [6]. To ensure that new construction can easily accommodate EV charging equipment, there is a requirement in the California Green Building Standards Code for "make-ready" electrical systems and designated parking spaces for charging [7]. The Code includes guidance for single-family and multi-family homes to ensure that all types of facilities are prepared to handle EV charging in the future.
- Legislation: EV owners may need to overcome the obstacle of convincing a building owner, manager, homeowner association, or board to install EV charging equipment. In some cases, the EV owners may have their requests denied. California dealt with this issue by stating, in law, that common-interest developments cannot prohibit charging equipment installation but can instead set conditions for their installation that must be met [5].

Government entities are not the only ones who can encourage charging expansion at MUDs. Given the importance of EV charging to the grid through electrical upgrade requirements, many electric utilities are leveraging their resources to support charging programs in public, workplace, and residential (MUD) settings. AEP's filing with the Public Utilities Commission of

Ohio (PUCO) has been approved and will allow the company to deploy a number of charging stations at MUDs through equipment rebates [8].

5. Charging Rebate Design

Considering the unique barriers facing MUD deployment and Smart Columbus' desire for near-term results, the team established a rebate program to support EV charging equipment installation at MUDs in the Columbus region. Smart Columbus stakeholders, including representatives from the City of Columbus and CFO, helped to develop the rebate program. Initial funding for the rebate was $172,000 and aimed to deploy 30 Level 1 charging stations at MUDs.

The City contracted with CFO, a non-profit serving Ohio that focuses on clean transportation. CFO developed the rebate application and reviewed the applications submitted. They will coordinate installation inspections and transfer the rebate funds to the recipients. The City of Columbus and CFO also conducted outreach throughout the program. They contacted charging equipment suppliers and developers to gauge interest in an MUD program and to get them thinking about how and where they could incorporate charging into their MUDs. The outreach helped to lay the ground work for a successful rebate program application process. The outreach also served to educate the building owners and managers, as this can be a challenging task for EV owners to do on their own.

The financial-based incentive encouraged MUD owners and property managers to install charging stations for residents by easing the financial burden of deployment. A rebate program was attractive because the application process was simple for developers, it did not involve the time-consuming act of scoring each application like a grant review, and only necessitated that applicants met the minimum stated requirements. Additionally, Smart Columbus required access to charging use data in order for the owners/developers to receive a rebate. This information will be used to learn charging behavior, modify policy as needed, and ultimately continue to increase consumer EV adoption.

With the rebate, Smart Columbus had four objectives: leverage city/PGAPh grant funds, improve the installation/ownership process, encourage widespread deployment, and learn charging behavior (the complete list of requirements for the developers are listed in the Smart Columbus MUD rebate program application). These objectives are shown in **Table 3**.

TABLE 3: FOUR SMART COLUMBUS REBATE OBJECTIVES

1st GOAL: LEVERAGE PGAPh GRANT FUNDS	**2nd GOAL: IMPROVE INSTALLATION / OWNERSHIP PROCESS**	**3rd GOAL: ENCOURAGE WIDESPREAD DEPLOYMENT**	**4th GOAL: LEARN CHARGING BEHAVIOR**
• $3,500 per plug/space • 35% cash match requirement • Two spaces for ≤ 20 units; Three spaces for 21-40 units; Four spaces for > 40 units • Six months to complete project and collect the rebate	• Detailed site and engineering plans required • Consult with utility to confirm site is suitable. • Level 1/2 equipment, installation, signage, stenciling, other equipment, education/promotion • Eligible users should be made clear through signage • 30 days free and "reasonable" monthly fee afterwards • Facilities will maintain ownership	• Franklin, Delaware, Union, Madison, Pickaway, Fairfield, and Licking Counties • $25,000 max per property	• Equipment must be capable of recording user data • Allow utility control for demand response. • Quarterly reports and data sharing for three years

First, the city wanted to further leverage the PGAPh Smart City Grant funds they received. Applicants applied for up to $3,500 per plug (or space as each plug must have its own parking space) with a maximum rebate of $25,000 per property. Applicants were also required to show a cash match of 35 percent of the total cost of the proposed project, which allowed the program to stretch the rebate money further and required the applicants to invest their own funds to show their commitment. Charging installations had to be completed by the end of 2018 (approximately six months from contract date) to collect the rebate, which limited the time and costs required to administer the program.

Second, Smart Columbus used the rebate program to improve the installation and ownership process of charging at MUDs. Applicants had to provide detailed site and engineering plans to ensure the installation was thought out and would go as expected. Although the plug costs may have been less than $25,000 for a two-space site, the rebate was also able to be used for installation costs, signage, parking stenciling, other equipment for data/network connection, and education or promotional material. The completed installations would also need to be inspected before funds were distributed to ensure the charging equipment met the project requirements. These inspections hold the developers accountable and keep them motivated to complete the projects.

Applicants also had to consult with their utility to ensure the equipment connection was feasible, thus expediting the process once a project was approved through the rebate program. Smart Columbus recommended in the application that the applicants consider preparing the site to be "make-ready," with wiring and panel upgrades completed, for 10 to 50 percent of parking spaces (beyond the minimum number of spaces in the application). The goal of this was to have these MUDs ready to install more charging equipment if the demand from residents increased.

Smart Columbus anticipated confusion over use, fees, and ownership and made sure the application outlined these items clearly:

- Charging stations must be dedicated for use by residents – although some applicants have negotiated to allow some public charging with priority still given to residents.
- Charging will be free for the first 30 days and the applicant must provide information on billing after that.
- Ownership was clearly specified to remain with the facilities.

Third, Smart Columbus wanted to spread the funding across the region and made the seven counties in-and-around Columbus eligible for funding. During the review process, the city considered the location of the applicant when deciding whether or not to issue the rebate. In addition, applicants could only receive up to $25,000 per site to ensure more properties received the rebate.

The fourth goal of the MUD rebate program was to learn more about charging behavior at MUDs. As this behavior at MUDs is still largely unknown, the new MUD charging ports will collect data that will help to develop a better understanding of charging use at these residences. The equipment must capture charging data that will be shared with Smart Columbus for up to three years. The charging stations must have the capability to be controlled by the utility for demand response adjustments through a separate meter. A diagram of the connected system is shown in **Figure 3** to demonstrate the range of equipment that must work together to build a networked system. Finally, awardees must provide quarterly reports that include utilization data, marketing/education efforts, feedback from the residents for lessons learned, and best practice development.

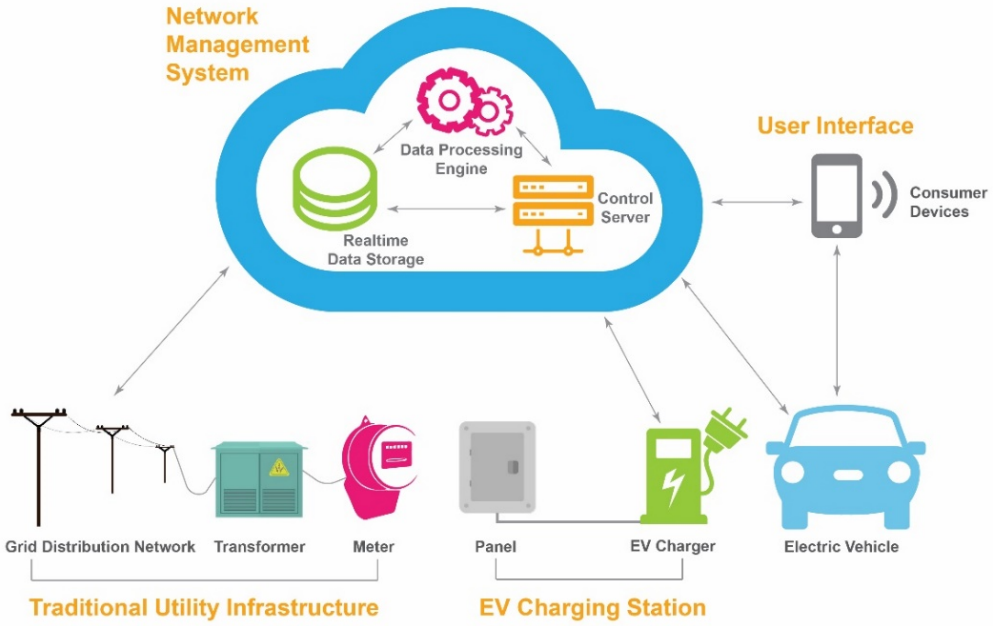
6. Application Review and Award Process

The first round of the rebate program application process was a success. At the end of the application period, Smart Columbus had received 16 applications totaling $265,990 in requested funds; 11 applications were accepted for a total of $167,998 (leveraging $137,500 in private funds). The 11 applications will result in 48 new Level 2 charging ports, considerably more valuable than the 30 Level 1 charging ports originally targeted for the program.

Most applicants are located in the City of Columbus, with two located north of the city (see **Figure 4**). The applications received were from four rental property owners, and directly reflected the outreach conducted by the city and CFO. Accordingly, most of the applications proposed similar equipment and costs. This is partly attributed to only having four unique applicants, as the same owner/developer is likely to quote identical costs across the different sites. CFO also attributes some of the commonalities to the charging equipment providers' active pursuit of sites. Not only did CFO and the City approach the developers, but charging providers also worked with developers on their cost estimates and plans. One other notable result is that only a few of the sites are currently under development, and most plan to add the charging systems into their existing parking and electrical systems. The Smart Columbus team had expected that most applications would come from sites that are under development.

The applicants included four unique developers that applied for the rebate at one to seven different sites. The total number of potential new plugs is 48 located across 11 sites (see **Table 4**). All sites had well above 40 residential units, which meant four spaces was the minimal requirement for all. Nine of the 11 sites applied for four plugs and two applied for six plugs. All sites

FIGURE 3: GRID INTEGRATED CHARGING EQUIPMENT DIAGRAM



Components of a grid integrated and connected charging equipment with: 1) utility infrastructure; 2) EV charging; 3) Network system (connection of data to servers); 4) User interface.

requested the full rebate amount per plug ($3,500). Sixty percent more charging ports were added with two times faster charging than originally targeted None of the approved applications applied for the $25,000 maximum; see **Figure 5** for a breakdown of costs per site.

Applicants expressed interest in the rebate program for a variety of reasons. The Smart Columbus team gathered that some of them were responding to the needs to current residents. In one case, an EV owner was dragging extension cords across the garage to charge their EV. In other cases, the applicants were anticipating a growing demand from current or future tenants. The rebate program presented a great opportunity to install the equipment with financial support. If the developers were already considering incorporating charging equipment, it was an easy decision to apply.

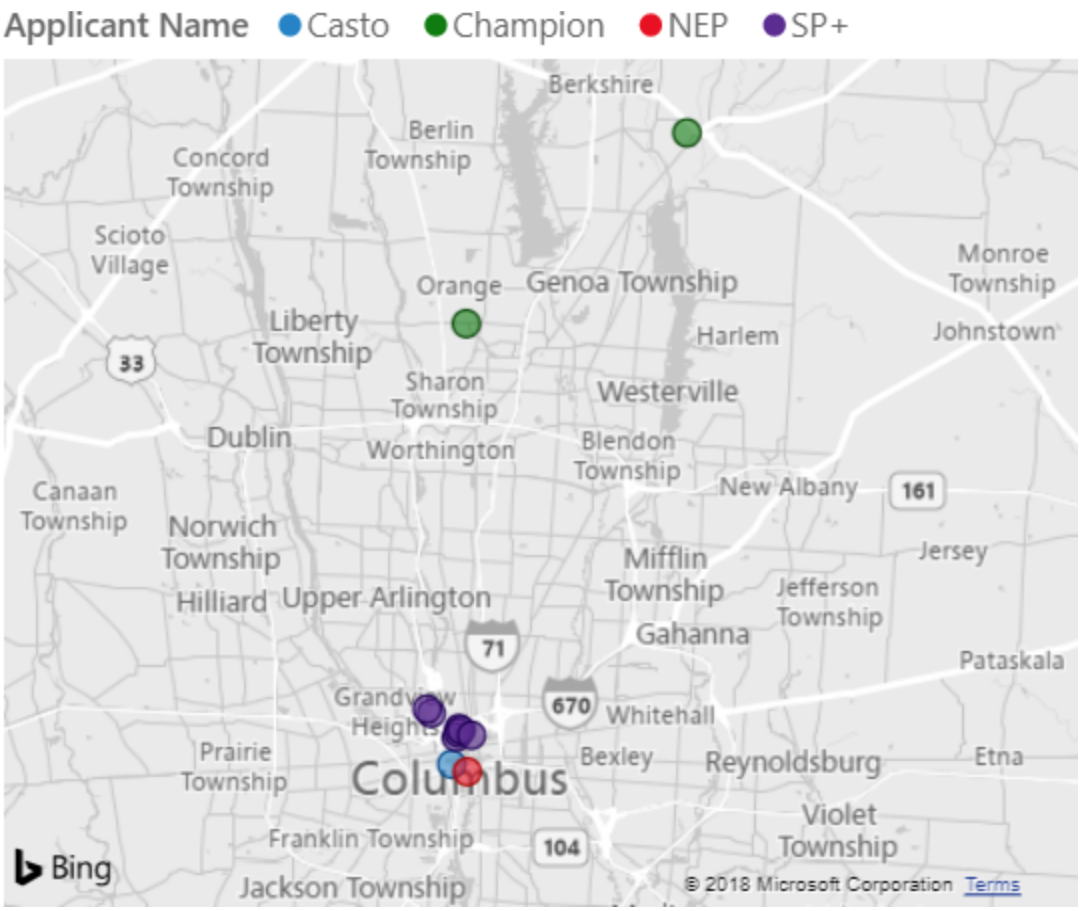
Round one applicants for the MUD rebate were primarily rental apartment developers from the Columbus region. The motivation for applying for the rebate varied among the developers, as mentioned above, but one applicant said in an interview that being able to offer charging as an amenity was a great motivator. John Riat, the Development Coordinator for Casto said he built internal support for their participation due to his personal interest in transportation electrification and innovative technology. Riat saw installing charging infrastructure at a new Casto apartment development as a marketing tool to attract residents to the building given growing popularity of EVs. The MUD rebate was an effective way for Casto to jumpstart this effort. Riat expressed that the process for applying was easy. Though developers could make a profit from the charging services, Casto is not relying on that revenue. Their goal is to advance marketing efforts and improve the company's environmental impact. Casto has found the rebate experience to be worthwhile thus far and would consider applying for more funding to install infrastructure in some of their existing suburban Columbus apartment complexes charging equipment.

Applicants included an outreach and education component with their responses to show how they would secure users for the

- SP+: Work with the garage owners of their properties (National Realty Investors) to educate residents on the equipment and release rules and guidance on their use and operation. They were also interested in having an EV expert on hand to help share reliable information and give a tutorial to other EV drivers.
- Champion: Prepare handouts for current and future tenants, make email announcements, and host an EV driving demo.
- Casto: Work with their equipment providers to prepare educational material on the EVs and equipment for building managers, and host a Ride & Drive event when the building is completed.

- NEP: Provide printed flyers, run on-site education programs, and make continued efforts to update information for residents.

FIGURE 4: MUD APPLICANT SUMMARY WITH LOCATIONS, NUMBER OF CHARGING STATIONS, AND TOTAL COSTS



Locations for MUD charging ports supported through the Smart Columbus initiative.

Source: Smart Columbus

TABLE 4: NUMBER OF CHARGING STATIONS/PARKING SPACES AND SITES BY APPLICANT

	SP+	CHAMPION	CASTO	NEP	Total
Number of Plugs	28	12	4	4	**48**
Number of Sites	7	2	1	1	**11**

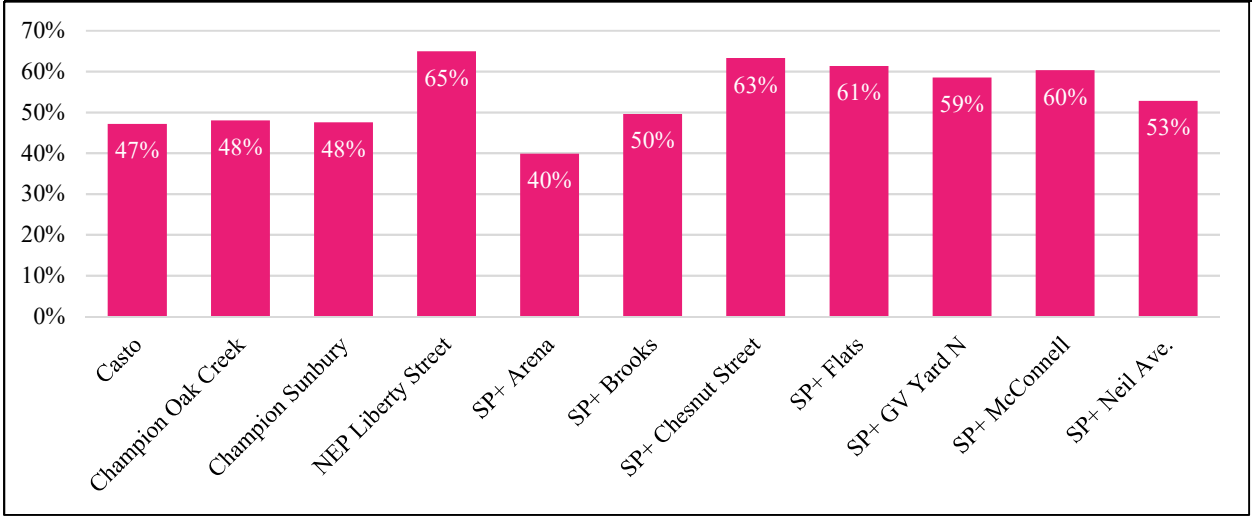
The city is having CFO provide ongoing coordination with the developers that received rebates. Developers provide data on a quarterly basis and at that time, CFO will discuss how the program is going, garner any lessons learned, and provide suggestions on ways to improve outreach and education. This activity will be included in the quarterly reports.

The applicants were informed of their approval and were given approximately six months to complete the installation of the equipment. CFO will conduct inspections at the sites upon completion, which will include bringing an EV to test the equipment. If a site does not pass inspection, CFO will work with the developer to make the changes needed to pass. Since CFO will be distributing the program funds, each developer will contract with them. The contract language was approved by the city and will

allow CFO to continue to collect quarterly reports and data from the sites for up to three years after the installations are complete. Requiring quarterly reports and data in the contract will keep the applicants accountable beyond the installation of the equipment.

FIGURE 5: PERCENTAGE OF TOTAL PROJECT COSTS SUPPORTED BY THE MUD REBATE

Developer	Site	Rebate Request	Non-Rebate Costs	Percent of Total Project Cost Supported by Rebate
Casto	Franklinton	$14,000	$15,701	47%
Champion	Oak Creek	$21,000	$22,733	48%
Champion	Sunbury	$21,000	$23,173	48%
NEP	Liberty Street	$13,998	$7,538	65%
SP+	Arena	$14,000	$21,112	40%
SP+	Brooks	$14,000	$14,224	50%
SP+	Chesnut Street	$14,000	$8,112	63%
SP+	Flats	$14,000	$8,812	61%
SP+	GV Yard N	$14,000	$9,912	59%
SP+	McConnell	$14,000	$9,212	60%
SP+	Neil Ave.	$14,000	$12,512	53%
Total		**$167,998**	**$153,041**	**52%**



Smart Columbus will advance charging at MUDs with additional funding. The city has already committed an additional $100,000 in rebates for the remainder of the round one applicants, which will result in 24 additional charging ports. Smart Columbus also expects to allocate up to $175,000 for a second round of funding in Year 2. The second round will include a new outreach and application process that will enable the City and others to build upon the lessons learned from the first round of applications.

7. Lessons Learned and Guidance for Other Cities

The rebate program has only just begun, but the Smart Columbus team already has a few lessons learned that can be applied to future funding and can be passed on to other cities.

- **Grant program rather than a rebate:** A rebate program is easier to administer but ensuring an equitable distribution of the funds requires the program to be more thoughtful than "first come, first serve." Only two of the six ZIP codes of winning applicants had household incomes below the median for the region. In addition, over half of adults in those ZIP codes have a bachelor's degree or higher while less than one-third of all adults in the region have that educational attainment [3]. A grant program will provide the city more flexibility in matching community needs with applicants.
- **Leverage local partnerships:** CFO and the city found that outreach was critical to ensuring interest in the program from a broad group. Future programs may try to extend outreach to get a more diverse set of applicants. The City took advantage of local partnerships, by contracting with CFO, to efficiently execute the program.
- **Define reasonable charging costs:** The original rebate program application required recipients to provide free charging for the first month and "provide free charging or require a reasonable monthly fee" for the 3-year reporting period. When the contracts with each developer were negotiated and signed, additional definition was provided regarding the fee: "Maximum hourly fee is determined to be no greater than three-quarters (¾) of the cost per mile of mid-grade gasoline (89 octane) for a comparable vehicle." In the future, this level of definition, provided in the contracts with developers, should be included in the application as a requirement to receive funding.
- **Level 2 instead of Level 1 Charging:** The charging needs at MUDs may require Level 2 charging. Although Level 1 was eligible for rebates, no applicant preferred the use of this charging level. This could be because of the influence of charging service providers that conducted outreach to developers, the availability of Level 1 charging equipment that met the other requirements of the rebate (e.g., data measurement and sharing), or the preference of EV drivers in the region.

So far, the program has shown that a city can successfully execute an incentive program for MUDs. The true success of the program will be determined after the equipment is installed and used. If the charging equipment is used regularly enough to produce data and allow the utility to test demand response, the information gathered could be used to inform the development of many more MUD residential charging programs. Additionally, the city will have succeeded at making EV ownership possible for a broader set of drivers.

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References

[1] Idaho National Laboratory, "Plugged In: How Americans Charge Their Electric Vehicles," September 2015. [Online]. Available: https://avt.inl.gov/sites/default/files/pdf/arra/PluggedInSummaryReport.pdf. [Accessed 11 December 2017].

[2] City of Columbus, *Paul G. Allen Family Foundation Smart City Challenge Request for Proposals,* Columbus, OH: City of Columbus, 2016.

[3] E. Wood, C. Rames, M. Muratori, S. Raghavan and S. Young, "Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio," February 2018. [Online]. Available: https://www.nrel.gov/docs/fy18osti/70367.pdf. [Accessed March 2018].

[4] M. Melaina, B. Bush, J. Eichman, E. Wood, D. Stright, V. Krishnan, D. Keyser, T. Mai and a. J. McLaren, "National Economic Value Assessment of Plug-In Electric Vehicles," December 2016. [Online]. Available: https://www.afdc.energy.gov/uploads/publication/value_assessment_pev_v1.pdf. [Accessed 11 December 2017].

[5] California Plug-in Electric Vehicle Collaborative, "Plug-in Electric Vehicle Charging Guide for Property Owners, Managers and Homeonwer Associations of Multi-unit Dwellings," 2013. [Online]. Available: http://pevcollaborative.org/sites/all/themes/pev/files/docs/MuD_Guide_1_final.pdf. [Accessed March 2018].

[6] D. Hall and N. Lutsey, "Emerging Best Practices for Electric Vehicle Charging Infrastrcuture," October 2017. [Online]. Available: https://www.theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf. [Accessed March 2018].

[7] California Building Standards Commission, "2016 California Green Building Standards Code, Title 42, Part 11," 2016. [Online]. Available: https://codes.iccsafe.org/public/chapter/content/2045/. [Accessed March 2018].

[8] Atlas Public Policy, "Atlas EV Hub," 13 12 2017. [Online]. Available: https://www.atlasevhub.com. [Accessed 13 12 2017].

[9] N. Nigro and A. Walsh, "Electric Vehicle Procurements for Public Fleets," October 2017. [Online]. Available: http://evsmartfleets.com/wp-content/uploads/2017/10/Electric-Vehicle-Procurements-for-Public-Fleets.pdf.