CADMUS

Public Electric Vehicle Charging in Somerville – Status, Options, and Considerations

Prepared for:

The City of Somerville

Office of Sustainability and Environment

June 2020

Table of Contents

Tables

Figures

Acronym List

Acronym	Definition
AC	Alternate current
ADA	Americans with Disabilities Act
BEV	Battery electric vehicles
City	City of Somerville
DC	Direct current
EV	Electric vehicle
eVMT	Electric vehicle miles traveled
EVSE	Electric vehicle supply equipment
EVSP	Electric vehicle service providers
GIS	Geographic information system
MOR-EV	Massachusetts Offers Rebates for Electric Vehicles
MOU	Memorandum of understanding
MUD	Multi-unit dwelling
PHEV	Plug-in hybrid vehicles
RFI	Request for information
VMT	Vehicle miles traveled
ZEM	zero emission motorcycles
ZEV	Zero emission vehicle

1. Executive Summary

The objective of this report is to identify the potential actions to increase access to electric vehicle (EV) infrastructure in the City of Somerville (City) in the near future. Electrification of vehicle miles is a critical component to the City's carbon neutrality goal, and this research is one piece of an overall strategy for vehicle electrification, a priority identified in Somerville's Climate Forward plan.

First, the Cadmus team determined the anticipated electrification needs in Somerville drawing upon EV adoption projections under different scenarios, EV supply equipment (EVSE) infrastructure required to support growing EV adoption, and available locations to install public infrastructure. EV adoption was modeled under three scenarios and the number, and type, of EVSE required to support a growing EV adoption was estimated for each adoption scenario at certain benchmark years. The team conducted a geospatial analysis to determine viable locations for public level 2 chargers to be installed given the projections for the short-term and a priority-index analysis of each census block to identify high-priority locations for investment. The analysis indicates that the installation of just five level 2 public chargers could put the majority of residents within 0.5 mile of a charging station.

To better understand the options to fill those charging gaps at the lowest cost, the City dissemminated an request for information (RFI) to EV service providers (EVSPs). The results indicated that a modest investment from the City would be required in the short term, as the private sector currently has limited viable options to support this kind of deployment.

Next, the report outlines the decisions the City will have to consider when investing in public chargers. The City is focused on exploring deployments of level 2 stations due to the challenging project delivery and economics of direct current (DC) fast charging stations. This report groups the points to consider by infrastructure installation, pricing, and supportive policies; Table 1 summarizes each decision point and its guiding question.

Table 1. Summary of Key Decisions

Infrastructure Installation Decisions		
1	Location	*How should the city prioritize locations to install charging stations?*
2	Station Hardware	*What design features should the City consider when deciding on station hardware?*
3	Universal Access and ADA Compliance	*How does the City ensure that EV charging is aligned with accessibility goals for those with disabilities? What amount of charging needs to be ADA compliant?*
4	Technology Considerations	*What technology and features need to be included at this stage of EVSE deployment?*
Pricing Decisions		
1	Revenue Structure	*What revenue streams should the City collect?*
2	Cost to Users	*What is reasonable to expect a user to pay? What is a fair rate of return on City-owned chargers?*
3	Different Rates for Specific Users	*Should the City create more favorable pricing for income qualified or disadvantaged users?*
4	Tracking Metrics to Inform Future Pricing Decisions	*What metrics does the City need to track to help inform its future pricing protocols?*
Supporting Program and Policy Decisions		
1	Parking Implications	*How can the City push toward electric mobility while adjusting overall parking policies to prioritize non-car modes?*
2	Education and Awareness Program Design	*How can the City design an Education and Awareness Program that complements its electric mobility vision?*
3	Additional Supporting Policies	*What other policies can Somerville implement to support its EV Goals and EVSE deployment?*

ADA = Americans with Disabilities Act

Additionaly, the team conducted a revenue analysis to better understand the different fee structures the City can implement, and how they impacted payback periods and potential revenue. The analysis concluded that revenue and cost recovery are sensitive to the assumptions that utility make-ready funds will be available and that utilization growth will be uniform and substantial at every station—neither of which can be guaranteed.

Development of the charging network needed to support Somerville's growing EV population will need to occur strategically, taking into account the location of existing chargers, anticipated market conditions, and City priorities for filing certain charging gaps to equitably distribute charging throughout the CIty. The decisions and analysis outlined in this report can help guide the City as they invest in a charging network that best supports their residents and future mobility goals. The Cadmus team identified the following potential next steps for the City:

- Add pricing protocols to existing charging stations
- Track current utilization data to inform future deployments
- Engage with eversource to plan future installations
- Expand strategically and gradually
- Monitor new business models and equipment developmet

2. Introduction

2.1. Background and Context

The purpose of this report is to identify potential actions to increase access to electric vehicle (EV) infrastructure in the City of Somerville (City) in the near future, drawing from extensive research on baseline conditions in Somerville, research on the current business models and options provided by market actors in the EV charging industry, and projections of future EV adoption. This research will provide the foundation for a comprehensive vehicle electrification plan that involves additional stakeholder input, further analysis, and a broader selection of EV market advancement activities.

Vehicle electrification is an essential component of achieving clean transportation emissions reductions that can contribute to the City's goals set forth in the Climate Forward Plan. Transportation accounted for approximately one third of Somerville's greenhouse gases in 2014 and The Climate Forward Plan calls for a 16% reduction in greenhouse gases from vehicle electrification efforts by 2050 to contribute to the City's overall progress. Even with the substantial necessary investments in improving the quality of low-emission, multimodal transportation options throughout Somerville (e.g., the Green Line Extension, bus priority projects, continued efforts to improve the active transportation network for bicycling and walking, and continued efforts to promote mixed use, transit oriented development and redevelopment), many residents will still need to rely on personal vehicles to access jobs and daily needs not currently served by non-personal vehicle travel modes. Thus, vehicle electrification is a critical component of the overall carbon neutrality strategy.

Existing City Level 2 Charger Installations:

- Somerville Public Charger Ports: **16**
- Somerville Public Charger Ports Under Construction: **4**

Yet, many Somerville residents face substantial barriers to adopting EVs, particularly surrounding the availability of convenient places to park and charge vehicles. Based on a variety of factors, we estimate that only 51.5% of Somerville residents will have access to home charging; therefore, investing in additional charging opportunities within walking distance of homes or key destinations could have substantial impact on the feasibility of going electric for numerous residents. Given the small geographic bounds of the city and the existence of a small early network of public charging, a limited investment in filling key geographic gaps could address short-term network deficiencies that may otherwise inhibit additional early adopters from choosing an EV.

The City has a two-pronged approach to reducing transportation emissions. The first priority is to reduce vehicle miles traveled in the community, and the second priority is to electrify the remaining vehicular travel modes. When combined with access to 100% carbon-free electricity, EVs become a zero carbon transportation mode. The City's EV strategy needs to fit into the broader context of mobility planning in Somerville. For example, SomerVision 2040, Somerville's comprehensive plan, sets a goal for 75% of work commutes to be made by non-car modes in 2040, electric or not. Climate Forward established performance metrics for evaluating progress on EV infrastructure, including these:

- Number of publicly accessible EV charging stations by type (e.g., level 1, 2, 3)

- Utilization of publicly accessible EV charging stations measured in number of annual users
- Number of building permits for private EV charging stations

Additional performance metrics can be developed around the topics of awareness, who the chargers serve, and charging management. For instance, the City can track public awareness of available public infrastructure (e.g., developing surveys distributed at dealerships, community centers, etc.). The City can also monitor use of the chargers by residents and visitors by analyzing the ChargePoint data output, which currently collects the driver's postal code and User ID. Charging management can be used as a performance metric if protocols are put in place to manage charging power, throttle, and duration. The City, in conjunction with Eversource, can monitor impact of these management protocols and determine if it reduces strain on the grid.

Types of EVSE:

- **Level 1**: offers charging through a standard household outlet (120 V alternate current [AC] plug) and takes 8-12 hours to charge an empty battery
- **Level 2:** offers charging through additional equipment (240 V AC plug), and can be installed in residential, public, or commercial settings. It takes 4-6 hours to charge an empty battery
- **Level 3 / DC Fast Charger**: offers charging through additional equipment and electrical upgrades (480V DC plug) and is typically only used in public setting. It can

The Climate Forward plan identifies suggested electric mobility actions, including additional research to support the Direct Installation Program, which is what this report aims to provide. This report will review utilization, policy, and geographic distribution of the City's existing public charging network to provide decision support on immediate next steps to enhance the network and its effectiveness.

2.2. City of Somerville Community Vision

City staff, with input from the community, have articulated a broad vision of equitable electrification in support of the Mayor's goal to be a carbon neutral city by 2050 and the mobility goal of Somerville Climate Forward. The goal stipulates that, "everyone has accessible and affordable zero carbon ways to commute and get around Somerville that are resilient to climate impacts."

Achieving this goal will require a broad portfolio of actions, many of which are beyond the focus of this report. That portfolio will include increasing access to charging, simplifying the EV charging installation process, guiding future investments and policy updates, and supporting an equitable, carbon neutral, and resilient transition to EVs.

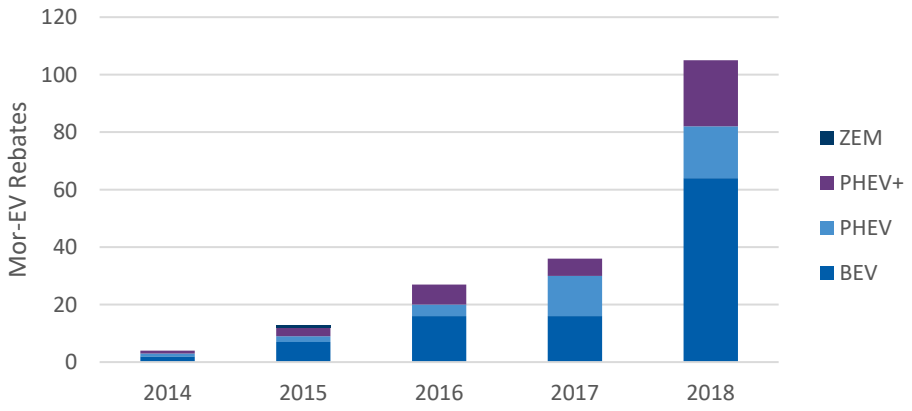
Within the realm of increasing access to charging, this report offers guidance on options focused on an equitable distribution of EVSE throughout the city. It also offers guidance on engaging the private market, where possible, by creating an environment that encourages independent actors to lead the EVSE buildout while staying aligned with City EV priorities and goals.

This research is one piece of an overall strategy for vehicle electrification, which is one of the priority actions identified in Somerville's Climate Forward plan to meet Somerville's carbon neutrality goal.

2.3. Current State of EVs and EV Charging in Somerville

According to Somerville's Excise Tax data, there were 46,427 vehicles registered in Somerville in 2018, and there were 3,455 new vehicles purchased by Somerville residents in 2017. Between 2014 and 2018, Somerville residents (zip codes 02143, 02144, and 02145) received a total of 185 Massachusetts Offers Rebates for Electric Vehicles (MOR-EV) rebates, with 105 of those received in 2018, as shown in Figure 1. MOR-EV rebates can be used for zero emission motorcycles (ZEM), plug-in hybrid EVs with battery capacity greater than 10 kWh (PHEV+), plug-in hybrid electric vehicles with battery capacity less than 10 kWh (PHEV), and battery electric vehicles (BEV).

Figure 1. MOR-EV Rebates Received by Somerville Residents



Source: Center for Sustainable Energy. 2019. "Massachusetts Department of Energy Resources Massachusetts Offers Rebates for Electric Vehicles: MOR-EV Program Statistics." Accessed February 2019: https://mor-ev.org/program-statistics

Caveat: The phenomenal growth in 2018 is not expected to continue into 2019 and 2020. The MOR-EV rebates reported in 2019 show a significant decrease in the number of rebates claimed. The 2019 data was not complete at the time of this analysis, and therefore was not included in EV adoption projections described in Section 3.1. The spike in sales in 2018 can be explained by the following impacts:

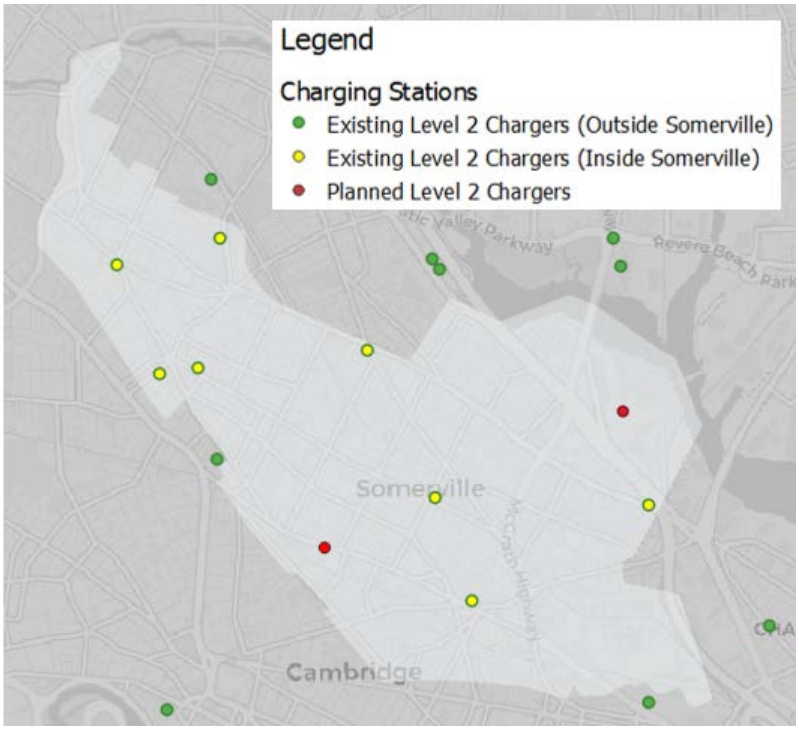
- Delivery of the Tesla Model 3
- Consumers looking to take advantage of the federal tax credit before it sunsets for some manufacturers
- A similar spike nationwide in EV adoption in 2018[1]

[1] Auto Alliance. "Advanced Technology Vehicle Sales Dashboard: U.S. Light-Duty Advanced Technology Vehicle (ATV) Sales (2011–2018)." Accessed March 2019: https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/

As of February 2019, Somerville has eight public EV charging stations with two level 2 charging plugs, each spread out across the city. The City does not have DC fast chargers, though neighboring cities, Arlington and Cambridge, each have one.[2] Figure 2 is a map of all the existing and planned public charging stations in Somerville.

A Plug vs. a Charger: a charging plug refers to the number of connections to charge a vehicle at any site. A charger, or charging station, can have multiple plugs. For example, a dual-plug charger is one charger with two access points to simultaneously charge two vehicles.

Figure 2. Public Charging Station Locations in Somerville and Surrounding Communities.



In 2017, Massachusetts had a high ratio (152 public plugs per 1,000 EVs) compared to the national average (43 public plugs per 1,000 EVs). Somerville is estimated to have somewhat closer to the national average, with an estimated 52 public plugs per 1,000 EVs in 2019. Note that EV charging supports residents of Somerville and visitors, and that residents of Somerville who own cars are likely driving to many other places within the Boston metro area on a regular basis, including commuting to work. Based on census data provided by the Metropolitan Area Planning Council, it is estimated that of approximately 24,000 Somerville workers, 65% (15,600) drive to work.[3] And according to the U.S. Census' tool OnTheMap, relatively few Somerville residents (less than 4,000) also work in the city, with most commuting to jobs elsewhere. About 20,000 workers who live outside Somerville commute to jobs

[2] U.S. Department of Energy. "Alternative Fuels Data Center." Accessed May 2019: https://afdc.energy.gov/

[3] DataCommon. "Transportation to Work from Workplace (Municipal). American Community Survey, 2012-2016." https://datacommon.mapc.org/browser/datasets/63

located in Somerville, and at least 15% of those workers commute more than 25 miles, as shown in Table 2. The flow of workers in and out of the City will influence the number of public chargers and workplace chargers the City will need to support its electrification goals.

Table 2. Distance Traveled to Work by Somerville Workers (on the map)

Distance to Home from Workplace	Percent of Somerville Workers
Less than 10 miles	67%
10 to 24 miles	19%
25 to 50 miles	10%
Greater than 50 miles	5%

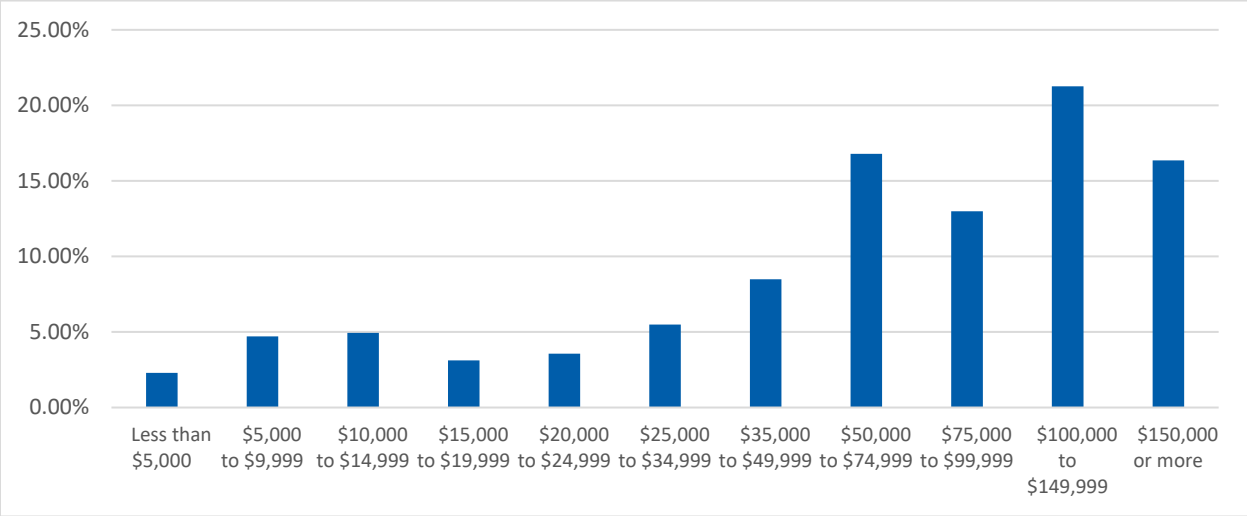
Determining how much of the city population has access to a dedicated off-street parking space will be key in deciding how many public chargers Somerville will need in the future. The City currently does not have adequate data on off street parking availability, but Cadmus was able to estimate parking availability based on census data and the City's parcel database.[4] Seventy-five percent of owner-occupied households and 35% of renter occupied householders with vehicles are estimated to have access, or the ability to install access, to some form of residential charging (level 1 or 2) and parking at home. This implies that infrastructure presents a significant barrier to a substantial proportion of vehicle owners, particularly in renter-occupied settings. Based on the 2015 Residential Energy Consumption Survey, only 45% of renters in single-unit dwellings are expected to have access to a level 1 charger (which uses a standard 120 V outlet). [5] For renters in apartments with two or more units, access to a level 1 charger drops to 21%.

Additionally, the renter population in Somerville is economically diverse (Figure 3) and has high turnover rates.

[4] Cadmus. 2019. *Memo 1 RE: EV Adoption and EVSE Demand Scenario Modeling*. (Cadmus Memo 1). See memo for a more detailed explanation of estimation method.

[5] U.S. Energy Information Administration. "Residential Energy Consumption Survey, 2015." https://www.eia.gov/consumption/residential/data/2015/

Figure 3. Household Income Distribution of Renter Population



American Community Survey, Tenure by Household Income (2018)
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_B25118&prodType=table

Figure 3 shows the distribution of household income, but it is important to note that the Census Bureau defines a household as any persons sharing living quarters, not necessarily by family. Therefore, an apartment in Somerville that houses multiple graduate students, for example, would report their combined income.

Equitable EV market advancement will be particularly challenging and important in Somerville due to the varying needs of the different groups. Whereas the cost to buy and install a residential charger is a barrier among low-income communities, lack of dedicated residential parking will be the primary barrier for wealthier early adopters. Furthermore, the high percentage of renters, who have less ability to install a residential charger, creates a greater need for public or shared chargers. Installing public charging stations in residential neighborhoods will be key to supporting Somerville residents.

3. Needs and Opportunities for EVSE Expansion

This section outlines anticipated electrification needs in Somerville drawing upon EV adoption projections under different scenarios, EVSE infrastructure required to support growing EV adoption, and available locations to install public infrastructure. It explains why investment in public charging is necessary in the short term, and how the installation of five new chargers in strategic locations could lead to the majority of Somerville residents having access to a charger within a half-mile of their residence.

3.1. EV Adoption Projections to 2050

Given the uncertainty about future transportation behavior and EV market dynamics due to the introduction of new shared mobility options, the increasing availability of affordable and used EVs, and ongoing changes to the EV Policy environment, past trends in EV adoption, car ownership, and vehicle miles traveled (VMT) are unlikely to predict the future. In a previous memo to the City,[6] the Cadmus team projected how the EV population in Somerville would grow under different scenarios to help Somerville understand and prepare for a range of potential futures. The team modeled three scenarios for EV adoption in Somerville's passenger vehicle fleet:

Scenario 1. Historical Extrapolation (Low Scenario): In this scenario, the trend in MOR-EV rebates received in Somerville from 20142018 is linearly extended. This translates to a conservative 1.1% increase per year in EV market share, reaching 40% of new sales by 2050.

Scenario 2. Zero Emission Vehicle (ZEV) Memorandum of Understanding (MOU) (Medium Scenario): This scenario assumes EV adoption rates are sufficient to meet Massachusetts's commitment to the ZEV MOU.[7] This analysis assumes a fast increase in EV sales in early years, leveling off to 60% of new sales in 2030.

Scenario 3. Carbon Neutrality Goal (High Scenario): In this scenario, EV adoption rates accelerate sufficiently to meet Somerville's 2050 carbon neutrality target, reaching 40% of registered vehicles by 2030 and 100% of registered vehicles by 2050.

Figure 4 and Table 3 summarize the results of the EV population growth analysis. The analysis suggests that if the City expects to meet its policy goals, both the state's ZEV MOU commitments and the Somerville's carbon neutrality goal, it should anticipate EV adoption to increase rapidly between today and 2025, from 310 EVs to over 6,000. Even the low scenario implies a six-fold increase between today's levels and 2025.

---

[6] Cadmus Memo 1.

[7] The state committed to putting 3.3 million EVs on the road, or 15% of projected registered vehicles by 2025.

Figure 4. Percentage of EVs of Total Personal LDV Fleet in Somerville by Scenario

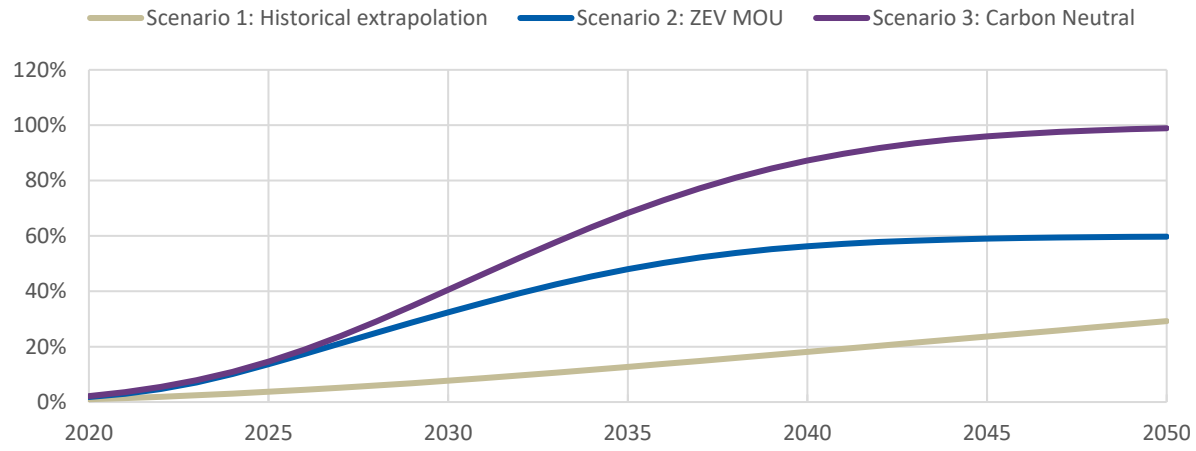


Table 3. Total Registered EVs in Somerville by Scenario

Scenario	2025	2030	2050
Scenario 1. Historical Extrapolation	2,000	4,000	14,500
Scenario 2. ZEV MOU	6,200	15,200	28,100
Scenario 3. Carbon Neutral	6,600	19,000	46,500

3.2. EVSE Quantity Needed to Support Long-Term EV Adoption

This section estimates the public, workplace, and multifamily residential charging stations needed to support the EV adoption projections from the previous section. Key inputs include expected home charging availability, number of commuters who drive to work, and recent literature and publicly available tools to estimate the number of EVs that can be supported per charging port.

The Cadmus team used NREL's public tool, EVI Pro-Lite,[8] to create ratios of charging station per EV to estimate Somerville's charging infrastructure needs. The tool takes into account Somerville's high share of residents in five unit or more multifamily dwellings (28%). A large percentage (49.5%) of these residents are expected to lack the ability to access home charging.[9] The calculations also predict workplace charging needs. Data from the American Community Survey was leveraged to develop contextual assumptions about the housing stock, resident tenure, and commuting patterns in Somerville.[10]

---

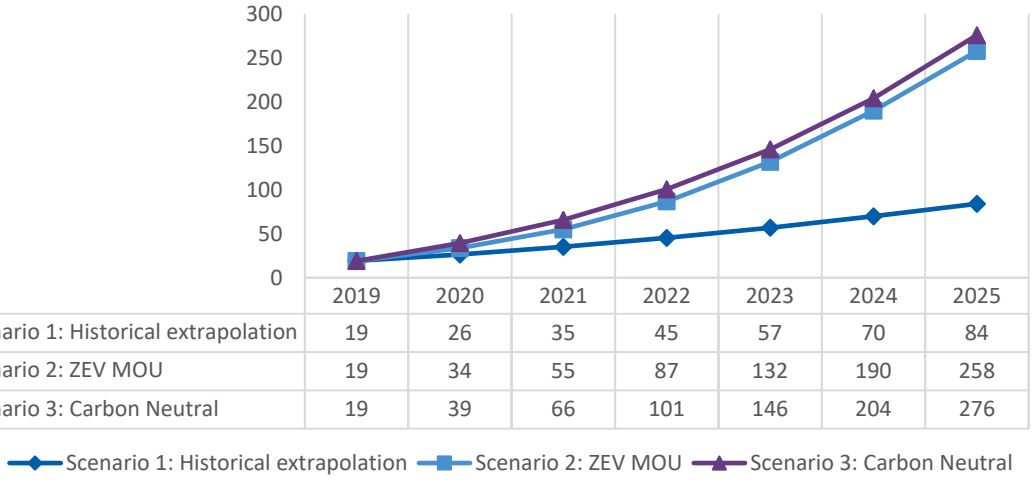
[8] U.S. Department of Energy. "Alternative Fuels Data Center: How Much Electric Vehicle Charging Do I Need in My Area." Accessed March 2019 https://afdc.energy.gov/evi-pro-lite

[9] The ability to access home charging is defined as the ability for a vehicle owner to access an outlet for level 1 charging or readily install a level 2 charger.

[10] For a more detailed explanation of analysis methodology see Cadmus Memo 1.

The resulting estimates underscore the importance of adopting a strategy that supports home charging, where feasible, given that the more ambitious scenarios include a large amount of charging ports relative to the geographic size of the city, even by 2025 (Figure 5 through Figure 7). This will be particularly important for owner-occupied units of all types and renters in larger multifamily buildings. Figure 5 summarizes the estimated number of level 2 public chargers by each scenario. At the writing of this report, Somerville has 16 public level 2 plugs installed, with four more planned. For Somerville to be on track to meet its policy goals, the City needs to install 15 to 20 more level 2 public plugs in the next year.

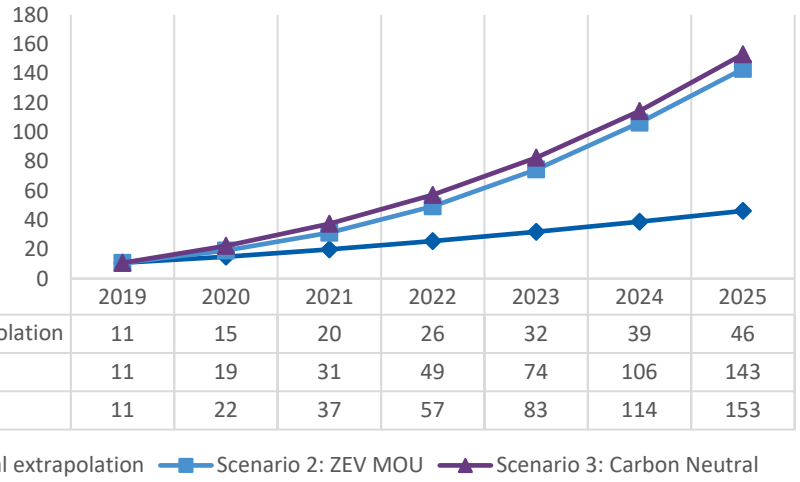
Figure 5. Estimated Level 2 Public EVSE Plugs by Scenario, 2019-2025



	2019	2020	2021	2022	2023	2024	2025
Scenario 1: Historical extrapolation	19	26	35	45	57	70	84
Scenario 2: ZEV MOU	19	34	55	87	132	190	258
Scenario 3: Carbon Neutral	19	39	66	101	146	204	276

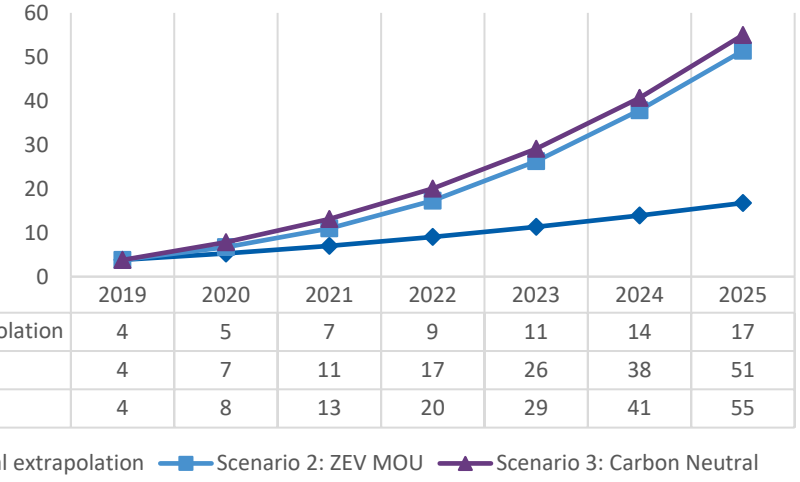
Figure 6 and Figure 7 show the estimated number of level 2 workplace and DC fast charging plugs needed to support Somerville's growing EV fleet in the near term. Somerville will need between 15 to 22 level 2 workplace EVSE plugs and five to eight DC fast charging EVSE plugs installed in the next year according to this analysis. Somerville currently has no DC fast charging stations within the city limits, though there are a few located in neighboring cities. There are limited data available to the City regarding the number of existing workplace level 2 plugs available.

Figure 6. Estimated Level 2 Workplace EVSE Plugs by Scenario, 2019 - 2025:



	2019	2020	2021	2022	2023	2024	2025
Scenario 1: Historical extrapolation	11	15	20	26	32	39	46
Scenario 2: ZEV MOU	11	19	31	49	74	106	143
Scenario 3: Carbon Neutral	11	22	37	57	83	114	153

Figure 7. Estimated DC Fast Charging EVSE Plugs by Scenario, 2019-2025



	2019	2020	2021	2022	2023	2024	2025
Scenario 1: Historical extrapolation	4	5	7	9	11	14	17
Scenario 2: ZEV MOU	4	7	11	17	26	38	51
Scenario 3: Carbon Neutral	4	8	13	20	29	41	55

Additionally, it is estimated that the city would need approximately 499 level 2 residential chargers by 2025 in multifamily buildings with five or more units for Somerville to be on track to meet its carbon neutrality goal, as shown in Table 4. Separate estimates were created for these buildings, as buildings of this size more frequently have off-street parking where residents can charge at home, whereas two- to four-unit buildings more frequently lack access to off-street parking and need to rely more on public charging.

Table 4. Estimated Level 2 Multifamily (5+ Units) Charging Plugs by Scenario, 2019-2025

Scenario Description	2019	2020	2021	2022	2023	2024	2025
Scenario 1. Historical Extrapolation	35	49	65	84	104	127	151
Scenario 2. ZEV MOU	35	62	102	161	243	347	467
Scenario 3. Carbon Neutral	35	73	122	186	269	373	499

Future Trends

While these scenarios are useful in understanding the rate at which Somerville can expand, these estimates can shift significantly based on several potential sensitivities and trends:

- **Greater support for maximizing the ratio of electric VMT (eVMT) to total VMT from PHEVs**: This analysis assumes that about half of PHEV drivers will rely on their gasoline engine regularly; if PHEV drivers were to maximize their eVMT, additional level 1 and 2 charging at workplaces and in public would be needed. Additionally, if the current trend from PHEV to more BEV continues, more charging will be needed to support increasing eVMT.
- **Greater reliance on workplace level 1 charging**: The EVI-Pro Lite model assumes that drivers who cannot complete their daily travel needs will rely on level 2 charging at workplaces and in public, and with DC Fast Charging. Some of the estimated level 2 workplace charging needs could be filled by level 1 charging instead.
- **Shared home chargers**: The analysis assumes that households with multiple vehicles and access to charging at home will be able to share a charger between vehicles. Assuming instead that each vehicle needs access to its own home charger will result in higher estimated needs for all charging types. Sharing chargers in a residential setting is likely more feasible with level 2 chargers due to their faster charging time. Because this assumption primarily impacts owner-occupied units, which more frequently have multiple vehicles per household, and which are more likely to install level 2 charging, this more conservative assumption (i.e. results in lower charging estimates) is likely appropriate. It does suggest that the City may want to consider ways to support residential level 2 charging in other buildings than those with five or more units.
- **Population and employment growth:** The analysis does not yet consider potential growth in population and employment between now and 2025, which could increase charging needs, depending on concurrent trends in vehicle ownership and mode share.
- **Shared mobility and autonomy:** In addition to electrification, ride sharing and connected and autonomous features represent two other potential transformations to our transportation system in the coming years, both of which present significant uncertainty. While commercially-ready autonomous vehicles are in operation in very few places today, shared mobility options have become widely available and are already reshaping how Somerville residents get around. In 2017, the Massachusetts Department of Public Utilities reports Somerville had the third highest transportation network company (e.g., Uber or Lyft) trips per capita of cities and towns

in Massachusetts.[11] If more Somerville residents shift their travel to shared mobility options, Somerville may need to consider additional DC fast charging plugs to serve car share or ride hailing vehicles, while lessening its plans for level 2 chargers designed to serve private vehicles.

- **VMT**: Some assessments predict that autonomy and shared mobility could increase VMT by inducing more travel and freight and delivery trips due to lowered costs and barriers to traveling more frequently.[12] The analysis does not currently assume an increase in VMT due to autonomy, but such an increase would likely require additional DC fast charging plugs to serve shared mobility and autonomous vehicles. It is also possible that many people will not wish to spend more of their day traveling and that the total amount of travel per person will remain fixed, while transportation mode share in the city may change.
- **Vehicle ownership and mode share**: In addition to its goals to increase EV adoption, Somerville's Climate Forward plan also includes goals to increase trips on bikes and public transportation by 2050. Additionally, trends in vehicle ownership amongst younger people have declined over time. If the rate of vehicle ownership and/or single occupant vehicle mode share decreases substantially over the next five to six years, the charging needs estimated in this report could decrease.
- **EV technology advancements**: Finally, changes in charging and vehicle technology, including charging speeds, range, and more, could impact the number of chargers needed. For example, higher powered DC fast chargers may mean fewer DC fast charging plugs are required in the future to serve the same number of vehicles. Longer-range EVs may also lessen the need for EVSE of all types by reducing the number of drivers who have home charging who would use charging in public.

3.3. Mapping Analysis

Cadmus conducted geospatial analysis, or geographic information system (GIS) mapping, next in order to assess the potential to site EV chargers in City-owned lots and in curbside spaces in the right of way. Cadmus used QGIS and PostGIS to clean, process, and analyze City datasets for the analysis and is hosting the outputs of the analysis in ArcGIS Online so City staff can more easily explore the data.[13]

Somerville is focused on the constraints of its available parking spaces, parking enforcement, and multimodal planning efforts. Because Somerville is projected to need a substantial number of additional EV chargers over the next five years to accommodate growing EV adoption and achieve climate targets, and because Somerville is relatively uniformly dense, projecting areas of higher demand becomes less relevant than identifying short term gaps and identifying specific streets and lots with capacity to host the projected number of needed chargers becomes more important. The results of the EV adoption and supporting EVSE analysis identified the level of public charging needed by 2025 and are summarized in

---

[11] Mass.gov. 2018 "Rideshare in Massachusetts: 2017 Data Report." https://tnc.sites.digital.mass.gov/

[12] AECOM, 2017. *City of Somerville Climate Neutral Pathway Assessment. Final Whitepaper*.

[13] For access to the online map, please Contact the Office of Sustainability & Environment.

Table 5. Figure 2 in Section 2.3 display the locations of existing and planned level 2 charging stations across the City of Somerville.

Table 5. Summary of Pubic Charging Needs in 2025

Charging Type	EV Adoption Scenario		
	Low Scenario 1	Medium Scenario 2	High Scenario 3
Estimated Registered EVs	2,000	6,200	6,600
Public Level 2 EVSE Plugs	84	258	276
DC Fast Charging EVSE Plugs	17	51	55
Total	**101**	**309**	**331**

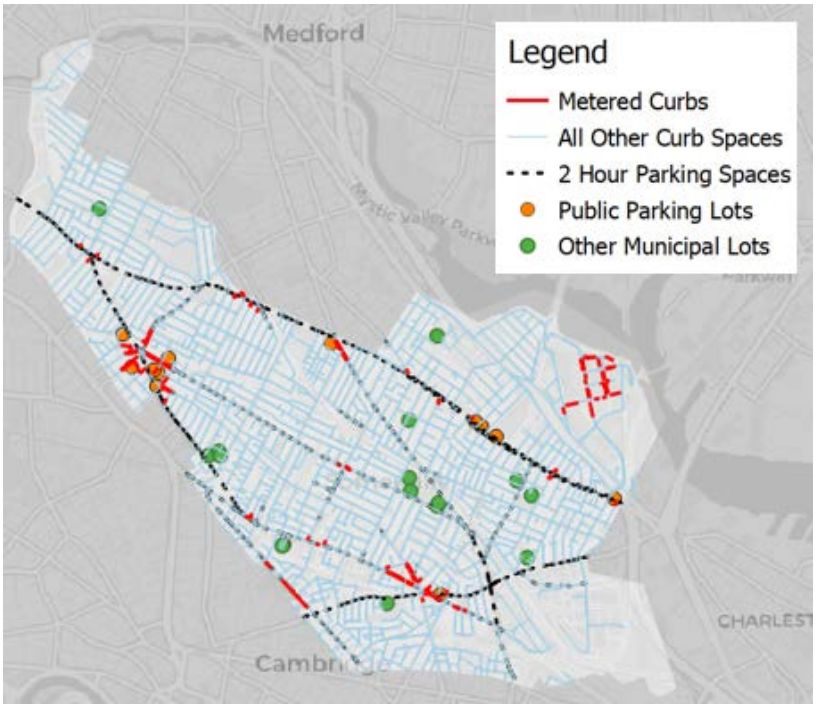
To prioritize locations for new charger installation, Cadmus performed the following actions:[14]

- Identified and mapped city-owned parking spaces by type
- Collected, cleaned, and processed city provided datasets
- Removed priority corridors from consideration for curbside charging—Broadway, Elm, and Holland—that the City had already identified for potential transit improvements
- Estimated parking space capacity of each parking type by neighborhood
- Developed a preliminary allocation of estimated chargers needed for each type of parking space to estimate the percentage of utilization of each group of City-owned parking spaces
- Established and executed a weighting methodology to identify high-priority locations in Somerville for EV charging infrastructure

Figure 8 is a map of potential city-owned parking spaces available for EV charging. Metered curbs are highlighted in red, two-hour parking spaces are the dotted black line, public parking lots are the orange circles, other municipal lots are green circles, and all other curb spaces in light blue.

[14] Cadmus. 2019. *Memo 3: Geospatial Analysis*. See memo for a more detailed explanation of analysis methodology.

Figure 8. Potential City-Owned Off-Street and Curbside Locations for EV Charging



Caveats: This analysis serves to provide a high-level estimation of potential charging siting for planning purposes and is not meant to identify specific sites. While the analysis included conservative assumptions about the number of curbside spaces available on each street segment, it did not systematically ground truth each street. For specific site planning, more detailed review would be needed to account for additional constraints such as street trees, business parking permits, bus stops, curb cuts, bike share, and electric distribution capacity.

Table 6 summarizes a preliminary allocation of EV chargers across different parking space types. It shows the estimated saturation of charging infrastructure as a percentage of the number of parking spaces of each type. The analysis suggests that a high percentage of two-hour parking spaces can be allocated for charger use, even though they make up a small percentage of City-owned parking. Twenty percent of chargers are allocated to spaces adjacent to City-owned land and the remaining allocation is spread evenly between other City-owned parking option.

Table 6. Preliminary EV Charger Recommendations by Parking Space Type - High Scenario

EV Charge Recommendation	City-Owned Parking Lot Spaces	Municipal Building Parking Lot Spaces	Parking Meter Spaces	2-Hour Parking Spaces	Other Spaces Adj. to City Land
Preliminary Percent of Total EV Charger Need	15%	15%	15%	35%	20%
Chargers Allocated to Each Space Type	50	50	50	116	66
Total Spaces of Each Parking Space Type	406	335	553	1811	358
Percent Total Parking Spaces Allocated to Charging	**12%**	**15%**	**9%**	**6%**	**18%**

Table 7 lists the number of estimated spaces in each category by neighborhood, highlighting the potential parking resources that can be dedicated to EV charging to enable equitable access to EV charging across the city. This analysis suggests that it will be important to utilize all parking space types in order to provide citywide access, given the concentration of certain types of parking, like metered parking and public lots, in a few neighborhoods.

Table 7. Summary of Available Parking Spaces by Neighborhood

Neighborhood	City-owned Parking Lot Spaces	Municipal Building Parking Lot Spaces	Parking Meter Spaces	2-Hour Parking Spaces	Other Spaces Adj. to Public Land	Total
North Point	-	-	-	-	-	**0**
Boynton Yards	-	-	-	26	3	**29**
Twin City	-	-	-	34	-	**34**
Brickbottom	-	-	-	-	13	**13**
Duck Village	-	-	39	40	3	**82**
Inner Belt	-	-	-	83	1	**84**
Union Square	38	123	106	482	110	**859**
East Somerville	10	65	11	102	72	**260**
Porter Square	-	73	26	175	7	**281**
Spring Hill	62	-	29	457	23	**571**
Ten Hills	-	-	-	-	6	**6**
Assembly Square	-	-	153	-	18	**171**
Magoun Square	41	-	33	97	20	**191**
Winter Hill	53	44	7	106	23	**233**
Ball Square	-	-	16	49	23	**88**
Teele Square	-	-	6	-	0	**6**
Davis Square	202	-	125	160	21	**508**
Powder House Square	-	-	-	-	-	**0**
Hillside	-	30	2	-	15	**47**
Total	**406**	**335**	**553**	**1811**	**358**	**3463**

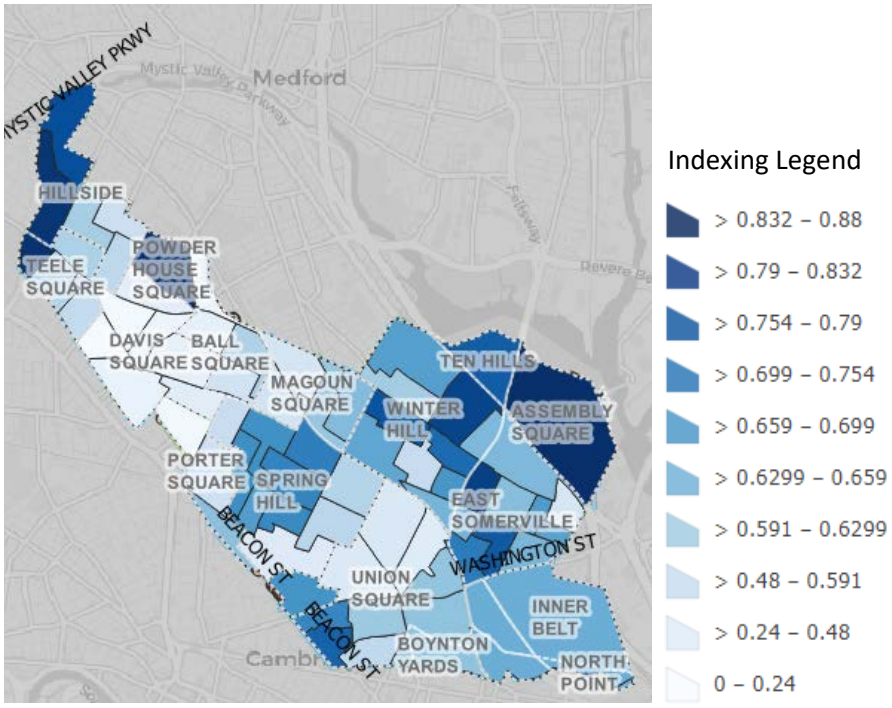
3.3.1. Priority Index Analysis

The next step in this analysis involved applying an index score to census block groups based on four criteria, listed here in order of importance:

- **Existing access to level 2 charging stations**: block groups received a higher score if they have less access to existing ports

- **Tier within the Massachusetts Environmental Justice Community's framework:** block groups were scored higher if they were in a higher tier (e.g., meeting more of the criteria)[15]
- **Multifamily unit dwellings density:** block groups received a higher score if they had a higher density
- **Commuting patterns:** block groups with more individuals commuting to work by car received higher scores

Figure 9. Somerville Index Rankings by Block Group



Cadmus evaluated and combined each of the above criteria to create a composite score for each block group, ranging from 0.00 (lowest priority) to 0.88 (highest priority). Figure 9 shows the results of the indexing, where darker blue shades represent block groups of highest priority and lighter shades represent block groups of lower priority based on the criteria described. Table 14 in Appendix B lists the index ranking for each census block and neighborhood. These block group rankings help identify priority investment areas for the short term. Some of the areas identified for priority investment already have

[15] Defined as communities "whose annual median household income is equal to or less than 65 percent of the statewide median ($62,072 in 2010); or 25% or more of the residents identify as a race other than white; or 25% or more of households have no one over the age of 14 who speaks English only or very well."

Source: Massachusetts Department of Environmental Protection. "Environmental Justice Communities in Massachusetts: 2010 Census." https://www.mass.gov/info-details/environmental-justice-communities-in-massachusetts

plans for public chargers, such as Assembly Square and at the parking lot adjacent to Conway Park and the ice rinks.

3.4. Public Investment to Fill Short-Term Gaps

The geospatial modeling of EV infrastructure conducted throughout Somerville identified several underserved locations as high priority for additional infrastructure. As shown above in Figure 9, ***adding approximately five stations in targeted locations could enable the vast majority of Somerville residents to walk to an EV charger within half a mile of their residence***.

The City sought to understand what options they have to fill those charging gaps at the lowest cost, ideally leveraging private-sector investments. Therefore, Somerville disseminated a request for information (RFI) seeking interest among electric vehicle service providers (EVSPs) in deploying charging through innovative business models that would enable substantial expansion of the public charging network with the least upfront cost to the City. The RFI included these learning objectives:

- Where, geographically, would EVSPs want to put EVSE?
- What station ownership models are EVSPs open to?
- What business models and revenue sources would they propose?
- What types of stations would they propose?

Results indicated that most EVSPs were flexible and open to exploring new business models, but few offered concrete details about how EV charging could be deployed without the City providing upfront investments. The main solution proposed to alleviate upfront costs involved the City making a commitment to enter a lease arrangement. Only one EVSP, Greenspot, offered a business model where EV charging could be installed at no cost to the City by offering a unique additional service as part of their business model: electric shared mobility access including carsharing, bike share, and scooters through partners like Zipcar and Maven.

The City of Somerville is seeking to expand its EV charging network in a way that centers equity, is accessible citywide, provides a great service to residents, and incurs the least cost and ongoing management effort by the City. Because of the limited options and models available from the private sector, the City needs to take a more proactive role in setting a vision and parameters for an EVSE network buildout as the EV charging industry continues to mature. Therefore, Cadmus determined that the most expedient course of action to fill the needs for an equitable EV charging network in the short term is to find a way for the City to cover the cost of installing a limited number of additional stations in critically important locations.

While immediate action to fill these short-term gaps will require a modest investment from the City, it is clear that it will be untenable for the City to fund a substantial proportion of the identified need for chargers in the long term. Therefore, the City will continue to monitor developments in private sector business models and trends in the value proposition for site hosts (including private-sector actors and the City) to deploy charging with an adequate return on investment.

The City will also establish guidelines and rubrics to help with ongoing management of its charging assets, keeping in mind its interest in providing equitable and affordable access to charging of a sufficient quantity to enable market growth. To do so, the City should strive to include some key elements:

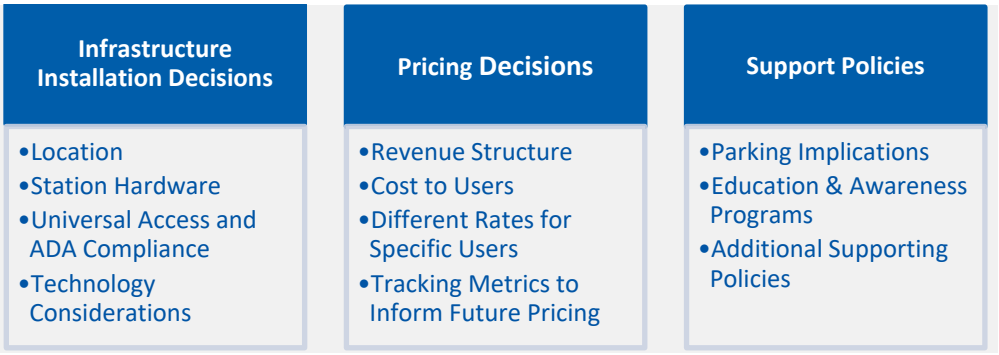
- Provide enough infrastructure to ensure reliable access and keep the frequency of EV drivers being turned away (or queuing) minimal
- Provide reliable access to EV drivers who do not have access to their own home chargers, particularly at critical times of day
- Make charging available to as many people who need it as possible
- Establish pricing that will not create undue EV adoption challenges for renters and people who cannot install charging

The City will also track key performance metrics to assess the impact of its initial investment. Metrics can include utilization patterns, behavior patterns, charging duration, dwell times, number of unique users, and the cost to revenue ratio. Section 4.3.4 goes into more detail about the metrics the City can track and how these statistics can inform its future decisions.

4. Key Decisions and Options for Public Investment in Infrastructure

This section outlines the decisions Somerville will need to make regarding infrastructure choices, pricing protocols, and supportive policies. Figure 10 summarizes the decision-making points the City should consider as it evaluates its options for public chargers. The following sections detail the key questions and data points the City can use to make decisions.

Figure 10. Summary of Decisions



4.1. Infrastructure Installation Decisions

The City is currently focusing on level 2 stations due to the challenging project delivery and economics of DC fast charging stations.[16] With this in mind, Somerville's objective is for the charging infrastructure selected to be accessible to the widest range of potential users, while remaining cost-effective for the City to install and for users to take advantage of. Accessibility to the widest range of potential users includes questions of how users with disabilities are accommodated, how to balance the needs of EV drivers with existing internal combustion engine drivers, if users will need to move their vehicles at inconvenient times, and if installations ensure equitable use of the curbside (how are pedestrians and other residents impacted). The following sections outline topics to guide decision-making in light of these objectives.

4.1.1. Decision 1: Location

Question: How should the City prioritize locations to install charging stations?

Location of the charging stations is a key decision for the City as it can affect utilization rates and, therefore, the cost-effectiveness of the investment. Utilization is not the only metric the City needs to consider when choosing locations, but also the potential impact to access a charger at that location might have. Adding chargers to existing locations that have high demand will have a different impact

[16] DC fast charging stations currently cost $10,000 to $40,000 per station. The construction and installation costs can be five times more than a level 2 station because of the electrical upgrades, and they are typically billed on a higher rate because of the demand charges they incur (B2 General Rate).

than installing a new charger in a location that currently has limited access. The potential to increase widespread access to charging should be a key consideration for the city.

The mapping analysis described in the previous section is the first step the City has already taken toward determining the geographical distribution of charging stations in Somerville. The analysis determined that the installation of five stations in targeted locations will enable almost all residents to be within 0.5 mile of a public charger. The mapping analysis included indexing census block groups based on four key questions, as described in Section 3.3.1 Priority Index Analysis.

Locations with a higher index score and darker coloring on the map in Figure 9 are higher-priority investment areas. Somerville will need to balance investing in higher-priority locations with locations that have high demand, as the two might not align. Revenue from high-demand locations can help to offset the investment in high-priority locations with lower anticipated short-term utilization.

4.1.2. Decision 2: Station Hardware

Question: What design features should the City consider when deciding on station hardware?

When deciding on station hardware, the City should evaluate how the station integrates with the surrounding streetscape. Stations in a residential neighborhood can look different than those in commercial areas, and the needs of different locations should factor into the station hardware decision.

There are a few different styles of charging station hardware available: pedestal chargers and mounted chargers. Mounted chargers can be connected to streetlights or mounted to the wall or ceiling. Pedestal chargers are a very common style of level 2 charger and typically stand independently. Wall, ceiling, or pole mounted (streetlight) chargers are less common in public charging settings, and RFI responders listed varying levels of experience with them.

It is important to note that wall and ceiling mounted chargers are different than pole mounted streetlight chargers. Wall or ceiling mounted chargers have similar cost and space saving benefits but are better suited for parking lots or garage sites. Wall or ceiling mounted chargers should be located in proximity to the electrical panel to minimize installation costs.

Streetlight chargers take advantage of the existing electric infrastructure and can potentially reduce installation costs significantly as electrical upgrade costs would decrease and the need for trenching could be eliminated. Pole mounted streetlight chargers also can potentially save space on the sidewalk and enable right of way charging. This is particularly relevant in Somerville where many streets have other sidewalk considerations such as bike racks, high foot traffic, and are narrow in width. Pole mounted chargers can provide a compact solution that does not infringe upon limited sidewalk real estate.

One challenge in Somerville is that some poles are City owned and others are owned by Eversource. The City has already inventoried which streetlights it owns, which will aid in determining the feasibility of this solution. Another challenge the City can anticipate is establishing a billing procedure with Eversource as most streetlights in Somerville are not metered.

Example City: Los Angeles

Los Angeles is the most prominent U.S. city to install streetlight charging. The stations installed are operated by multiple charging network companies including ChargePoint, EVGo, Flo, and Greenlots. Conversion to energy-efficient LEDs in city streetlights made this solution possible. The higher-efficiency bulbs both saved the City $9 million a year and alleviated strain on their electrical grid, enabling them to both invest in EV charging and avoid straining their grid's capacity. The fee for charging is $1 to $2 per hour and parking is free. The initiative was a collaboration between the City's Department of Transportation (giving up parking meter revenue), the Department of Water and Power (to ensure adequate electrical capacity), and the Bureau of Street Lighting (to manage the network).

Los Angeles is served by a municipal utility, a key distinction when considering creating a similar program elsewhere. Somerville and Eversource would have to adapt this program if interested in replicating it as Eversource is an Investor Owned Utility and operates differently from the Los Angeles Department of Water and Power.

4.1.3. Decision 3: Universal Access and Americans with Disabilities Act (ADA) Compliance

Question: How does the City ensure that EV charging is aligned with accessibility goals for those with disabilities? What amount of charging needs to be ADA compliant?

The ADA requires nondiscriminatory access to places that accommodate the general public. A number of RFI responders indicated having ADA-compliant chargers but provided little guidance on what degree the City needs to provide ADA-compliant infrastructure. The U.S. Department of Energy published a document, *Guidance in Complying with Americans with Disabilities Act Requirements,* that focuses mainly on design requirements to meet ADA standards for any parking space.[17] The Massachusetts Department of Energy Resources also released a document, *Installation Guide for EVSE*, that identifies important design components[18] for ADA compliance. Guidelines include the following key considerations when designing ADA compliant parking spaces:

- Adequate space for exiting and entering the vehicle
- Unobstructed access to the EVSE
- Free movement around the EVSE and connection point on the vehicle
- Clear paths around the vehicle
- Close proximity to any building entrance

---

17 U.S. Department of Energy. 2014. *ADA Requirements for Workplace Charging Installation.* https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf

18 The Massachusetts Department of Energy Resources. 2014. *Installation Guide for Electric Vehicle Supply Equipment*. https://www.mass.gov/files/documents/2016/08/ox/ev-charging-infrastructure-manual.pdf

California was the first state to include an accessibility requirement into their building code (CALGreen) under Section 4.106 Site Development in Residential Measures. It states that when EV chargers are installed, they will be either adjacent to an accessible parking space to allow use of the charging from the accessible parking space or the charging shall be located on an accessible route to the building. It also states that one in every 25 EV spaces will have a minimum width of 12 feet.[19] The building code also suggests that nonresidential lots follow similar guidance. For Somerville, installing chargers adjacent to accessible parking spaces so that both spots have access to it might be the most effective solution that aligns with the City's accessibility goals.

4.1.4. Decision 4: Technology Considerations

Question: What technology and features need to be included at this stage of EVSE deployment?

In addition to determining what kind of station the City wants to install, there are other technological choices to be considered. The first is future-proofing charging sites**.** Future-proofing is when charging sites are installed with enough electrical capacity to enable the expedient scale up of charging ports in as demand is expected to increase in the future. Planning enough electrical capacity for double or more of the charging ports at the point of initial installation can save the City expensive upgrade costs. RFI responders recommended installing two to four plugs at sites at first installation, with the capacity to scale up to eight to 10 plugs in the future as demand grows.

Determining which sites need to scale up in the future typically requires tracking utilization patterns and identifying where demand is growing. This requires stations to have data collection capabilities and most often requires them to be networked or connected to Wi-Fi for data sharing purposes. Networked stations that have data collection capabilities, or more generically smart chargers, have higher upfront costs than non-networked stations. The decision to install smart chargers will have to be balanced with the value of utilization data and having a pulse on where demand is growing in the city. Additionally, it is unclear if non-networked chargers can handle a complex payment protocol. At this stage in the market, non-networked chargers that are independently metered can bill users per kilowatt-hour, but otherwise require simpler payment protocols such as per session or hourly fees. Time-of-use energy pricing, penalty fees, and other compounded pricing protocols will require networked chargers.

There are user functionality features that the City should consider when deciding which charger to install. Inclusion of these features can help reduce dwell times, increase utilization, and help users plan their charging events more efficiently. Inclusion of these features will require installing networked stations and might come with additional costs to the City. In addition to the added cost of installing a networked station, the City will need to update its enforcement mechanisms to incorporate these features. Common features include these:

- Real-time alerts

---

[19] California Building Standards Commission. 2017. *2016 California Green Building Standards Code*. https://www.ladbs.org/docs/default-source/publications/code-amendments/2016-calgreen_complete.pdf?sfvrsn=6

- Customer reservation/queuing
- Online/smartphone payments

The City can look for technology features that help with parking- and charging-rule enforcement by notifying or signaling to parking control officers that a vehicle has exceed is allotted time at the charger. Some app-enabled charging stations have both customer-facing features and owner-facing features. When purchasing EVSEs, the City will need to consider the value of adding a feature that can enable enforcement, and also determine how to adapt its parking policies to incorporate the enforcement feature.

4.2. Revenue Expectations

Under current utility tariffs and utilization stations, level 2 stations generally have lower upfront cost and lower ongoing costs and will enable better value for the City's investment when considering opportunities to expand charging access for renters and residents of multi-unit dwellings (MUDs). Therefore, the analysis presented here pertains only to level 2 stations. This analysis was conducted using an Economic Analysis Tool created by Cadmus and customized to Somerville's local costs and utilization patterns.[20]

4.2.1. Revenue Scenario Analysis for Level 2 Stations

This scenario analysis was conducted holding the cost to install the charger constant. Key assumptions about the type of charger modeled and utilization patterns are listed in Table 8. At a high level, this analysis assumes a level 2 pedestal charger is installed and connected to a network.

Table 8. Charging Station Assumptions

Input	Value	Source
Equipment Cost (Pedestal)	$6,129	EVSP Quote
Make Ready Funds	50% Installation Costs	Eversource's previous program
Utilization in year 1	4 sessions per day	Existing Utilization Data
Annual Growth	12%	NYSERDA Study
Utility Rate	A-9 General Non-Demand Service	Eversource

After projecting reasonable utilization growth of hypothetical new charging infrastructure, our team determined the costs, revenues, and overall payback period for such investments. Table 9 illustrates how singular revenue streams might provide pay back to the City at the recommended rate and the minimum rate amount required for the City to pay back its investment within the charger's anticipated lifetime of 10 years. The investment defined here includes capital costs (installation and equipment costs) and operation and maintenance costs (electricity, annual maintenance, and networking fees) over the lifetime of the charger.

[20] Contact the Office of Sustainability & Environment for more information on the economic analysis tool.

Table 9. Revenue Opportunities for One Dual Port Level 2 Station[21]

Revenue Structure	Common Rate	Payback Period (years)	Minimum Rate to pay back in 10 years
Pricing by time	$2.00/hr[a]	6	$1.46/hr
Pricing by energy	$0.49/kwh[b]	5	$0.33/kwh
Pricing by session (connection fee)	$1.00/session	No payback	$2.70/session
Penalties	$5/violation	No payback	$9.60/violation
Advertising Revenue	$300/month per station	No payback	$500/month per station

[a] One RFI provider responded with a recommended $2 per hour rate.
[b] Blink Network's quote for Massachusetts

In addition to analyzing the payback of recommended revenue structures and rates, our team also evaluated how rates from neighboring cities would perform given Somerville's current utilization patterns. Medford currently charges $0.25 per kWh and Arlington charges $0.30 per kWh. This comparison does not include a payback period analysis because both rates are below the minimum rate of payback for a pricing by energy structure, $0.33 per kWh, identified in Table 9. Alternatively, the analysis focuses on potential revenue at one dual port level 2 station.

Table 10. Neighboring City Rate Comparison

City	Rate	Revenue in Year 1	Revenue in Year 5
Medford	$0.25/kWh	$2,682	$4,221
Arlington	$0.30/kWh	$3,219	$5,065

Most commonly, multiple revenue sources would be applied to one charging station, which can improve investment payback significantly. Currently in Massachusetts, the City cannot require subscription or membership fees in addition to fees for using the charging station. The City can charge for the energy consumed and for parking in the EV charging station spot.[22] Additionally, advertising revenue is something can be compounded with all revenue streams. Table 11 summarizes the different scenarios of compounded revenue streams the team modeled with guidance from the City. The Table lists the payback period of each scenario with and without advertising revenue since it is a revenue source independent of the customer and depends on the kind of station the City decides to buy. Table 10 also lists estimated revenue in Year 1, Year 5, and Year 10. The revenue estimate does not include revenue from advertising as that is fixed per year at $300 and is not impacted by utilization and growth. The charging station assumptions and the revenue rates remain the same as those listed in Table 8 and Table 9. Revenue is assumed to grow based on utilization; this model assumes four sessions per day in Year 1, with 12% annual growth every year thereafter.

---

[21] Key assumptions include that most network operators collect transaction fees; 15% of revenue collected and utilization data provided by Somerville suggest that 24% of sessions are left longer than 1 hour. This was used to determine the number of penalties expected in a year.

[22] Our scenarios do not/should not account for parking revenue because it is assumed to be the same before/after installing charging since charging/parking are assumed to be unbundled.

Table 11. Revenue Scenario Summary

Scenario #	Revenue Streams	Payback without Advertising (Years)	Payback with Advertising (Years)	Estimated Revenue in Year 1	Estimated Revenue in Year 5	Estimated Revenue in Year 10
1	Price per Energy + Penalties	4	2	$7,082	$11,144	$19,640
2	Price per Time + Penalties	4	3	$6,608	$10,398	$18,325
3	Price per Energy + per session	4	3	$6,550	$10,307	$18,164
4	Price per Session + Penalties	7	3	$4,410	$6,940	$12,230
5	Price per Energy + Penalties (without Make Ready incentive)[23]	5	3	$7,082	$11,144	$19,640
6	Price per Energy + Penalties (low utilization)	(none)	5	$850	$1,337	$2,357

The two primary metrics evaluated here are payback period and estimated revenue. If the City's intends to recover its initial investment within a certain amount of time, then it should focus on the payback period. Scenarios 1 and 2 have the lowest payback periods without including advertising revenue. The City stated an interest in price by energy protocols as its existing chargers can implement it immediately, and neighboring cities have similar protocols.

If the City wants to encourage high turnover, they should consider protocols that include a penalty component in addition to payback and revenue. A simple price-per-energy fee structure has a payback period of five years, as shown in Table 9. In addition to incentivizing turnover, adding a penalty would reduce the payback period by 2 years. Scenario 3 analyzes the impact of a pricing scheme with a connection fee instead of a penalty fee and the payback period and estimated revenue is similar to Scenario 1 and 2.

The simplest fee structure to implement is a connection fee. Scenario 4 applies a higher connection fee ($2 per session) but includes a penalty fee in an effort to minimize long dwell times. While the protocol is simpler to implement, the payback period is seven years and the revenue is significantly lower. Scenario 4 is an example protocol that would significantly benefit from advertising, as the inclusion of this revenue streams reduces the payback period by four years.

Because pricing by energy with penalties appears to be the most likely decision the City will make, two additional contingencies were modeled with the same pricing approach as Scenario 1.

First, Scenario 5 modeled the impact of not having a make-ready incentive, a possible reality for the City. The make-ready incentive is assumed to cover 50% of installation costs in each of the other scenarios; its absence would increase the capital costs for the owner by about $7,000. The fee structure is the same

[23] In Scenario 5, the make-ready funds from Eversource are assumed to be 0% of installation costs.

as Scenario 1, and therefore the revenue estimates are the same. The payback period increases by a year without the make-ready incentive.

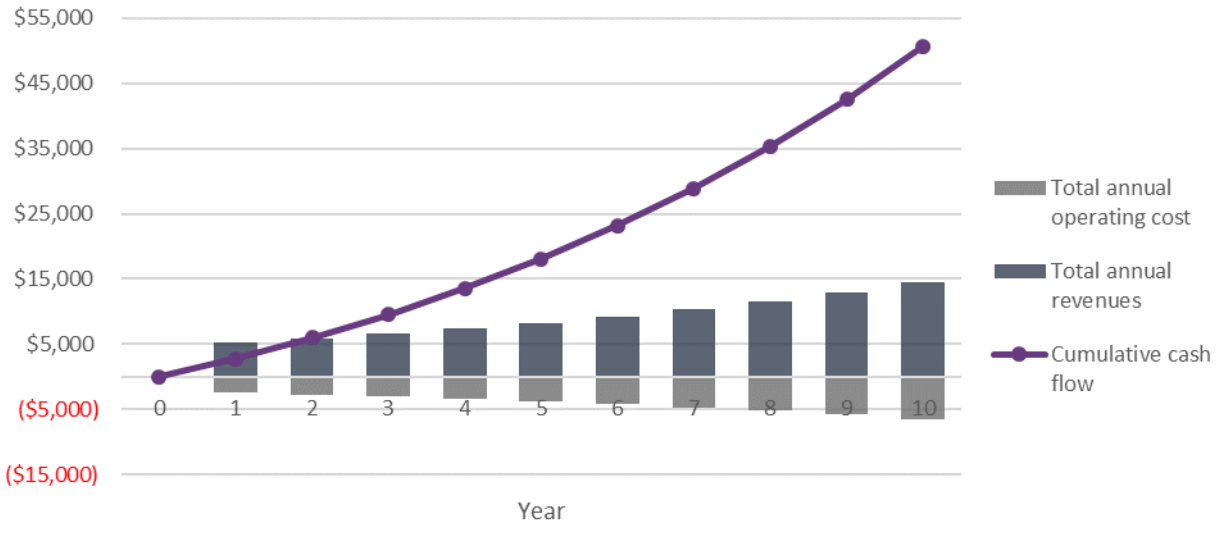
Second, the City was interested in evaluating Scenario 1 under a pessimistic utilization assumption. Scenario 6 assumes that utilization drops from four users a day to one user every other day. The intention of this scenario was to see if a charging station in a neighborhood that currently does not have a high demand and is not forecasted to grow quickly would still be economical. Without additional advertising revenue, the initial investment is not recovered over the lifetime of the charger. With advertising, the payback period is five years, one year higher than the add free version of Scenario 1. For locations where utilization is expected to be slow to grow, incorporating advertising might be key to a cost-effective investment.

Cash flow diagrams for each scenario can be found in Appendix C, Figure 12 through Figure 18. The cash flow diagrams show the initial investment, the operating costs and revenues and chart the cumulative cash flow over the lifetime of the charger. This analysis indicates that the payback period and estimated revenue are sensitive to the incentives available and the estimated utilization rate.

4.2.2. Estimated Revenue on Existing Chargers

Beyond the considerations outlined above for development of pricing for newly constructed chargers, the City also has the opportunity to apply a pricing protocol on their existing chargers. The current charging stations will most likely incorporate a price-per-energy fee structure. Figure 11 depicts expected revenue, operating costs, and cumulative cash flow from a charger with a price of $0.49 per kWh over a 10-year lifetime.

Figure 11. Expected Revenue on an Existing Charger



The City is also interested in phasing in pricing protocols similar to those in surrounding cities. As previously mentioned, Arlington charges $0.30 per kWh and Medford $0.25 per kWh at their public charging stations. Table 12 lists the estimated cumulative cash flow for one charger under each of these pricing protocols, and the $0.49 per kWh rate as modeled in Figure 11. This comparison focuses on

cumulative cash flow because it includes the operating costs as well as expected revenue and shows the accumulation of profit over time. A charger that implements a $0.25 per kWh fee structure and has six years remaining in its suggested lifetime, could generate $914 in profit in one year.

Table 12. Cumulative Cash Flow Comparison

Year	EVSP Quote: $0.49/kWh	Arlington Rate: $0.30/kWh	Medford Rate: $0.25/kWh
1	$2,822	$784	$247
2	$6,001	$1,679	$542
3	$9,580	$2,701	$890
4	$13,136	$3,393	$829
5	$17,193	$4,242	$834
6	$21,811	$5,267	$914
7	$27,058	$6,490	$1,078
8	$33,009	$7,934	$1,336
9	$39,748	$9,626	$1,700
10	$47,370	$11,596	$2,181

4.3. Pricing Decisions

Given the revenue modeling detailed above, Somerville must determine how best to approach pricing for City-owned EV charging. While the City aims to advance the market and make EV ownership more appealing, it does not aim to directly subsidize ongoing costs to charge.

4.3.1. Decision 1: Revenue Structure

Question: What revenue streams should the City collect?

There are a number of different revenue streams the City can collect, including price by energy, price by time, price by session, penalty fees, and advertising revenue. These revenue streams are modeled in the Section 4.2 under different scenarios to help the City decide on a rate, and if they want to compound different fees.

Some charging providers, like EVGo, set their prices (based on electricity costs and location) since they own their stations, while others like ChargePoint typically let site hosts set prices, since their model is typically to not own their stations. Many cities have set flat per-session fees for their infrastructure, while others have established dynamic prices. Vancouver has a baseline rate that they adjust to target 40% to 70% utilization of chargers. By monitoring and tracking utilization, they also track when and where they need to add infrastructure. Different partnership types with charging providers enable different levels of City control over setting pricing. For Vancouver, it was important to retain control over pricing in their partnership development, while Seattle let charging providers set prices since the City is not incurring any costs for the charging. Santa Monica's city-owned level 2 chargers have been free, similar to Somerville, but Sant Monica is now moving to charge user fees and enforce parking regulations.

Medford and Arlington, neighboring cities, have applied price per energy protocols on their public chargers. It is likely residents in Somerville will access chargers in neighboring cities because of their proximity, and vice versa, residents in other cities will use Somerville's public chargers. Therefore, it is suggested that the City implement a similar protocol and rate as their neighbors to not disrupt the market. Neighboring rates are currently not as profitable for the City but might be necessary if they want to start adding fees at locations where it was previously free.

4.3.2. Decision 2: Cost to Users

Question: What is reasonable to expect a user to pay? What is a fair rate of return on City-owned chargers?

In the short term, the City needs to consider the cost to the user as it determines what fee structure to implement. While the payback period to recover the investment is an important metric to use in determining what revenue to collect, the City needs to tangentially consider how the residents using the charging stations will be impacted. Adding a fee to City-owned charging stations should not make them cost prohibitive to residents and should not discourage EV growth. Providing EV charging that is lower cost than gasoline is one way to incentivize EV alternatives. But the City also should avoid excessively subsiding EV owners who can afford to bear the true cost of their charging. The City's objective is to provide a public good that increases access to EV charging but still incentivizes residents to charge at home when possible. Maintaining that incentive to buy an EV while not undervaluing the cost to charge will be difficult to balance. And this balance will change as the regulatory landscape and technology evolve, which is something the City should be prepared for.

Price Comparison

While the "right" price to charge is a subjective matter, there are two useful frames of reference to consider related to the price of public charging: the cost of charging at home and the cost of driving an equivalent gasoline car. At the lower end, the City will likely want to ensure that residential charging remains less expensive than public charging to encourage charging at home as much as possible.[24] The cost to charge a Chevrolet Bolt at home to 90% capacity is $6.47 per charging session, or $0.03 per mile.[25]

At the upper end, Somerville is interested in keeping the cost per mile of EV fueling less than the cost per mile of a gasoline vehicle. At $2.64 per gallon, fueling for a Chevrolet Impala costs $43.96 per tank, or $0.11 per mile (assuming 22 miles per gallon).

The price per fueling session ranges from $6.47 to $43.96, but this is not the best range to consider when setting prices because charging sessions typically occur more often than filling gas. Therefore, the pricing range to consider is $0.03 to $0.11 per mile, which equates to roughly $0.11 to $0.39 per kWh. It is important to note that the cost per mile and the cost per kilowatt-hour calculation will vary based on battery efficiencies, charging frequency, and the utility rate applied. The City should view this range as a guideline that is subject to change.

In the longer term, the City needs to consider using pricing as a tool for transportation demand management and determine if it can have an impact on driving and parking behavioral patterns. One of the City's long-term transportation goals is to reduce vehicle miles traveled and strategic pricing can help to shift behavior patterns. Strict enforcement procedures and variable pricing schemes can make public transportation more attractive to residents. This is a long-term consideration because, currently, EV charging costs need to remain more attractive to residents than traditional internal combustion engine costs. If the market shifts in the medium – long term to where there is less of a cost disparity between EVs and internal combustion engine vehicles, then pricing mechanisms can be used to shift behavior towards multimodal options. Building in the flexibility to adjust pricing schemes and parking policies is something the City needs to consider as it develops its pricing plan and parking enforcement policy plan.

---

[24] Note that this logic, while important for keeping the chargers available primarily for users who really need them (e.g., garage orphans), may have adverse effects on establishing equitable pricing schemes. Policymakers in California are beginning to discuss target dates for when the cost of charging in public becomes as low as the cost of charging at home to ensure that renters and others without home charging are not stuck paying substantially more per mile than people who have installed charging. This is still the subject of debate.

[25] It is assumed the home charger is not independently metered and the resident is billed on the A1 residential tariff.

4.3.3. Decision 3: Different Rates for Specific Users

Question: Should the City create more favorable pricing for income qualified or disadvantaged users?

Another consideration for the City is whether one rate should be blanketly applied across all City-owned charging stations, or if rates should be customized to different locations. In a previous memo to the City, Cadmus conducted research on best practices for City-owned charging stations, which included interviewing other cities. None of the city staff interviewed said their cities were offering low-income or means-tested rates yet, though a few indicated they may pursue this in the future. Some cities have focused on integrating charging payment into metered parking payment to streamline the process for customers (Flo is working on this with Montreal).

There are few ways Somerville can consider incorporating different rates at different locations. They can reduce rates at chargers located in areas designated as Environmental Justice Communities or low-income neighborhoods. Somerville can also partner with a charging provider and explore proxy mechanisms that unlock special rates for certain users. For example, the BlueLA's carshare program allows qualifying low-income members to receive a discount. This program requires users to register online and different members have access to different rates. While Somerville cannot charge membership fees on top of charging fees, a free membership program that screens low-income users might enable them to customize pricing by the user. A program that already exists in Somerville is Blue Bikes low-income program. Qualifying members pay a flat membership fee and then have a set number of rides per period with no additional fees.

4.3.4. Tracking Metrics to Inform Future Pricing Decisions

Question: What metrics does the City need to track to help inform their future pricing protocols?

As previously mentioned in Section 3.4, Somerville should establish guidelines and rubrics to help with ongoing management of its charging assets. Just as with regular parking, there are several ways to shape behavior, of which pricing is only one option. Achieving a target level of utilization can also be achieved by modulating the supply (which is made more feasible if the appropriate future proofing is established when the chargers are first installed, so more ports could be installed later) and by creating and enforcing regulations that discourage people from charging for too long.

With the assumption that pricing is the most easily modulated factor to manage utilization, here are several metrics to consider in refining pricing over time:

- Utilization: Somerville should determine an acceptable range of utilization and/or a target utilization level—on a portfolio level and a site-specific level. This metric will enable better informed decisions about adjusting price signals and whether to expand the number of ports made available. In particular, the City will need to find a balance between encouraging high utilization rates and reducing reliable availability. The chargers need to be available for residents to use, and long wait times due to high utilization should be avoided.
- Utilization can be considered in terms of percentage of hours when a car is parked at the port, percentage of hours actively charging, amount of kilowatt-hours dispensed, and other metrics.

- Utilization at different time periods should be disaggregated (e.g., daytime utilization vs. early evening vs. overnight). The ideal level of utilization may be different at different times of day and different days of the week.
- Variability of utilization from day to day is also important for assessing the viability of public charging to enable MUD residents and renters to adopt EVs. For instance, it could be problematic for renters to not be able to find an available port near home multiple nights in a row, even if the average nighttime utilization is sufficiently low. For this reason, percentage of days in which no charging ports at the site are available between, for instance, 7pm and 10pm may be a better metric than looking at utilization for each port individually.
- Turn-aways: On a related note, the City can occasionally survey EV users to understand how frequently they tried to charge but could not find a port in the location they desired. This survey can be done specific to each charging site. Turn-aways at certain types of locations and certain times of day can be more problematic than others.
- Charging duration vs. time plugged in: ChargePoint provides how long a vehicle was plugged in and how long energy was being dispensed. Somerville should evaluate the difference to determine if certain locations could benefit from a penalty fee to discourage long dwell times.
- Number of distinct users: In some cases, the City may want to see a large number of discrete users to show that the infrastructure is benefiting many EV users. In other cases, however, a lower number of discrete users at a specific site may not indicate a problem because it means that the site is enabling adoption of an EV for regular drivers (e.g., MUD residents who charge almost every night at a site).
- Ratio of revenue to costs: Managing this ratio by modulating pricing can, in theory, enable the City to increase its investment in charging at more sites in the future by ensuring that there is not an excessive amount of subsidy for any one station.
- Behavioral patterns: The City can look for behavior patterns in the charging data by analyzing average time of day residents are charging, duration of charging session, and differences in weekday and weekend patterns.

Currently, since Somerville provides charging for free, the utilization of its ports is robust, and has averaged 29%.[26] By comparison, other similar cities are seeing utilization of 15%.[27] Somerville can

[26] Based on ChargePoint data output in September 2019; calculated based on time used over 24 hours and averaged over 30 days

[27] Zeng, Teng, H. Ahang, and S. Moura. 2019. *Solving Overstay in PEV Charging Station Planning via Chance Constrained Optimization*. https://arxiv.org/pdf/1901.07110.pdf

experiment with differing pricing levels by setting up controlled trials. As Somerville creates these trials, it should consider a few key considerations:

- Test period length: Baseline and test periods should be the same length to effectively compare and sufficiently long to smooth out any outlier scenarios. The City currently can view its ChargePoint data annually, monthly, and daily.
- Test Price: The City first needs to decide which pricing protocol it wants to test and at what rate. The pricing decisions outlined above can help to inform which price format and rate is best for a trial.
- Driver Awareness: the City should account for the fact that drivers may take some time to become aware of the pricing change and may adjust their behavior slowly over weeks or months.
- Seasonality: The City should review historical data to determine how changes in season impact their utilization rates.
- Unusual Times: The City needs to consider the impact events, such as citywide stay at home orders due to the Covid-19 pandemic, will have on its utilization data and remove outliers.

Somerville can also consider imposing pricing at one location and not at a similar location that is sufficiently far away. Then, the City can conduct a trial by a difference-in-differences method.[28] This could alleviate the need for long baseline and trial periods and enable the City to draw inferences without considering the impact of behavioral variations over time.

4.4. Supporting Program and Policy Decisions

Somerville will need to make policy and regulatory decisions to support tangential initiatives and independently increase EV adoption. Changes to parking ordinances, enforcement practices, education and outreach programs, and parking space metering will support behavioral changes needed to make the most of EV charging in public spaces.

4.4.1. Decision 1: Parking Implications

Question: How can the City push towards electric mobility while adjusting overall parking policies to prioritize non-car modes?

The City will need to consider how to apply existing and new parking policies to the public charging stations. The City has the opportunity to tailor parking policies to different charging stations based on anticipated use patterns or location.

One option available to the City is to categorize charging stations as residential or destination and have a suite of policies applied to each. Behavioral patterns in residential areas will be different compared to destination locations and the policies applied can be customized to optimize utilization and cost-

[28] A difference-in-difference method is a quasi-experimental approach that compares the changes in outcomes over time between a population enrolled in a program (i.e., a pricing protocol) and a population that is not.

effectiveness both to the resident and the City. For example, residential chargers may be eligible for time-of-use rates that would reduce the utility bill to the City—the cost structure can be passed on through the City's pricing to users to incent charging for longer periods of time at off peak hours, like the middle of the night. On the other hand, a destination charger can be priced with a per-minute rate to incentivize shorter dwell times and higher turnover during times of the day that are busiest. Similarly, time restrictions, if imposed, can be determined based on charger categorization. Destination chargers might have shorter parking periods than residential ones to encourage turnover.

The City has the opportunity to use parking policies and enforcement protocols to nudge users towards the kind of behavior they want to see holistically. Identifying ideal behavior patterns to incentivize users will be key to developing these policies. Different behavior suits different location types, and the City will need consider what behavior it would like to move toward. EV parking and charging considerations should be included in efforts to revise parking policies.

4.4.2. Decision 2: Education and Awareness Program Design

Question: How can the City design an Education and Awareness Program that compliments their electric mobility vision?

Education about electric mobility and awareness regarding EV options and EVSE availability is a known barrier to increasing EV adoption and demand for EVSE. A program designed to disseminate key information to relevant stakeholders can help drive demand for public EVSE and increase utilization. The City will need to identify key resident groups to target, such as homeowners, residents in multifamily unit dwellings, owners of residential buildings, and commercial building owners.

Information should be catered to each target audience. The City can create education materials such as the following examples:

- Guide to permitting for property owners
- Guide to EVSE business models for property owners
- Retrofit toolkit (can be bundled with solar and heat pumps) for property owners
- Flyers for residents with public charging station locations and pricing
- Promotional material with parking permits
- Compilation of local incentives available
- List of local, experienced electricians and installers
- A robust EV section of the SustainaVille website with resources and information

4.4.3. Additional Supporting Policies

Question: What other policies can Somerville implement to support its EV Goals and EVSE deployment?

The City can pursue other policies and programs that support the development of its overarching EV goals. Somerville is participating in an Innovation Fund project with the Urban Sustainability Directors Network that is developing strategies targeted at increasing EVSE access for renters. As part of the

project, the City convened an Advisory Group of local stakeholders and discussed barriers to EVSE access unique to Somerville renters and prioritized the following strategies to pursue in addition to expanding the public EVSE network:

- Streamline residential EVSE permitting and provide property owners with clear installation and permitting guidance.
- Explore peer-to-peer sharing options for residential charging owners.
- Engage private lot owners to encourage them to install publicly accessible EVSE

While these programs will not directly impact the deployment or increase the utilization of public chargers, they will provide opportunities for more residents to charge at home, or near home. These programs can also help to alleviate demand on public charging infrastructure in the future, as the goal of this public deployment is balance high utilization with regular availability. As the number of EVs in Somerville grows, these policies and programs will encourage charging at home first, as opposed to relying solely on public opportunities.

5. Potential Next Steps for Somerville

Although the need for transportation electrification as a supporting pillar of Somerville's climate targets is urgent, development of the charging network needed to support Somerville's growing EV population will need to occur strategically, which means that it will necessarily start gradually and quickly adapt to evolving technology innovations, business model innovations, and data availability. Investments in public chargers will need to be targeted and well-planned to have the most impact. The decisions and analysis outlined above can help guide the City as it invests in a charging network that best supports Somerville's residents and future mobility goals. The following sections identify potential next steps the City can take.

Add Pricing Protocols to Existing Charging Stations: Somerville's public charging stations are currently free to the public and have cost the City $17,800 from 2015 to 2018. The City has the opportunity to add pricing protocols to existing charging stations before they begin to invest in the new charging stations. This step can be used to test different fee structures and pilot new parking policies. Existing charging stations are less than five years old, and with the right fee structure, can generate enough revenue in their lifetime to reinvest in growing Somerville's charging network. In the Estimated Revenue on Existing Chargers Analysis, a $0.25 per kWh fee can accumulate net revenue between $800 and $2,000, a $0.49 per kWh fee between $17,000 and $50,000, depending on the remaining lifetime of the charger and how utilization of the charging stations changes. Stations with high utilization trends, like the Day St. station, could see higher revenue than what has been estimated. While the current stations are not independently metered, they are networked and can readily incorporate price by energy, price by time, price by session, and/or penalty pricing protocols.

Track Current Utilization Data: The City has access to utilization data from its existing chargers. An important next step will be to monitor how demand is changing and if certain locations are growing at a faster rate than others. For example, from June to September 2019, the average number of charging sessions per day across all stations is 4.2. But during that same time period, the average number of charging sessions per day at the Day St. station was 7.8, while at the Lombardi St. Station it was 2.9. By consistently tracking and analyzing the utilization data output from the chargers, the City can better understand where demand is growing, at what rate it is growing, and if there are any distinct behavioral patterns at certain locations. The City can also survey residents to learn more about usage and their preferences for parking protocols. This can inform new parking policies and which locations can be expanded.

Engage with Eversource: The revenue analysis showed the impact of the make-ready incentive—it can decrease the capital costs for the City by $7,000 per charging station. Somerville needs to continue to engage with Eversource and work with the utility to plan their deployment and advocate for funding. Additionally, if the City wants to pursue streetlight mounted chargers, Eversource will have to help navigate metering, billing, and ownership. Eversource has a vested interested in EV growth and EVSE deployments and should be part of the planning process.

Expand Strategically and Gradually: Somerville can build out its new charging network incrementally and test out different business models, pricing schemes, and parking policies to understand what works in the local communities. With a focus on developing neighborhood charging stations, the City can monitor usage and continue to build out its charging network to support residents.

Monitor New Business Models and Equipment Development: The results of the RFI indicate that the EVSE market is still growing and charging station providers are developing new business models and services constantly. The City should continue to follow this market, monitor developments in the private sector, and track trends in the value proposition for site hosts. New innovations in the private sector can enable the City to deploy charging with an adequate return on investment.

Appendix A. Reference Maps and Layers for RFI Guidance and Planning Support

This section details the layers collected to support ongoing EV planning, as well as provide guidance to RFI respondents. To date, Cadmus has collected and processed the following GIS layers listed in Table 13. RFI respondents can use this information as reference layers, which are also included in the online map.

Table 13. List of Geospatial Layers for RFI Guidance and Planning Support

Layer	Source(S)	Reason for Inclusion and Notes
Reference Layers		
Neighborhoods	City GIS website	Can tabulate potential sites by neighborhood and to aim for even distribution
General Land Use	SomerVision	Indicates general land use types, utilizing zoning, maps from SomerVision
Existing EV Chargers	AFDC	Understand where there may be greater gaps in the current charging network. Also includes buffers around level 1, 2, and DC fast chargers to indicate levels of access to current charging.
Environmental Justice Block Groups	MassGIS	Eversource program may cover additional costs (charger costs too) for Environmental Justice+2 criteria block groups *(Note: was included in DPU filing, unclear if part of current program)*
MBTA Bus Stops	MassGIS	Reference layer to identify bus stop zones to avoid in considering EV charging spaces
Potential City-Owned Sites		
City-Owned Parking Lots	City data	Identify quantity of potential spaces for level 2 or DC fast charger
Other Municipal Lots	City data	Identify potential spaces at schools, libraries, etc. that may be used for charging overnight
Parking Meters	City GIS website	Identify potential on-street parking spaces, particularly in "around the corner" locations. Does not include meters on Broadway, Elm, or Holland because these corridors are priority transit/multimodal corridors.
Somerville Street Segments (Curbs)	Based on street centerlines	Simulates curbs by placing segments on 15 feet of each street centerline. Includes column flagging multimodal corridors to avoid, and two-hour parking. Highways and parkways were removed.
City-Owned Streetlights	City data	Identify locations of City-owned streetlights for potential EV charging
Potential Private Site Hosts And Demand Indicators		
Other Off-Street Parking Lots	OpenStreetMap	Identify potential private site hosts for level 2 or DC fast chargers
Potential DC Fast Charging Sites	Parcel data	Identify locations of specific compatible uses with DC fast chargers – grocery stores, major retail, gas stations.
Multifamily Buildings by Type/Unit Number	Parcel data	Identify areas specifically with greater numbers of 2-4 family, 5+ family with potentially different charging needs *(Note: not yet in online map due to file size)*
Jobs Density	LODES	Identify areas with high jobs density, which could indicate workplace charging potential, as well as potential for shared parking

Appendix B. List of Index Scores

Table 14 lists the index score assigned to each census block group and is organized by neighborhood. The scores range from 0 to 0.88, and a higher index score indicates a greater need for investment. These scores should be used to help guide prioritization of locations for investments.

Table 14. Index Scores

Neighborhood	GEOID10	Index Score	Neighborhood Score
Assembly Square	250173501031	0.000	0
Ball Square	250173504002	0.618	0.536
Ball Square	250173504003	0.568	
Ball Square	250173504005	0.421	
Davis Square	250173504004	0.418	0.367
Davis Square	250173505001	0.400	
Davis Square	250173505002	0.240	
Davis Square	250173506004	0.432	
Davis Square	250173508002	0.238	
Davis Square	250173509001	0.436	
Davis Square	250173509003	0.406	
Duck Village	250173512043	0.734	0.734
East Somerville	250173501043	0.650	0.693
East Somerville	250173514031	0.506	
East Somerville	250173514032	0.640	
East Somerville	250173514033	0.697	
East Somerville	250173514034	0.844	
East Somerville	250173514035	0.676	
East Somerville	250173514041	0.654	
East Somerville	250173514043	0.805	
East Somerville	250173514044	0.767	
Hillside	250173506002	0.592	0.696
Hillside	250173506003	0.572	
Hillside	250173507001	0.810	
Hillside	250173507002	0.879	
Hillside	250173507003	0.627	
Inner Belt	250173515001	0.660	0.660
Magoun Square	250173502001	0.649	0.601
Magoun Square	250173503001	0.630	
Magoun Square	250173503002	0.566	
Magoun Square	250173503003	0.559	

Neighborhood	GEOID10	Index Score	Neighborhood Score
Porter Square	250173509002	0.240	0.482
Porter Square	250173510003	0.637	
Porter Square	250173510004	0.570	
Powder House Square	250173504001	0.401	0.201
Powder House Square	250173506001	0.000	
Spring Hill	250173510001	0.739	0.667
Spring Hill	250173510002	0.691	
Spring Hill	250173510005	0.581	
Spring Hill	250173510006	0.739	
Spring Hill	250173511001	0.616	
Spring Hill	250173511002	0.754	
Spring Hill	250173511003	0.599	
Spring Hill	250173511004	0.742	
Spring Hill	250173511005	0.750	
Spring Hill	250173512041	0.460	
Teele Square	250173507004	0.882	0.674
Teele Square	250173507005	0.603	
Teele Square	250173507006	0.623	
Teele Square	250173508001	0.589	
Ten Hills	250173501032	0.804	0.804
Union Square	250173512031	0.744	0.603
Union Square	250173512032	0.628	
Union Square	250173512033	0.591	
Union Square	250173512034	0.796	
Union Square	250173512042	0.472	
Union Square	250173513001	0.484	
Union Square	250173513002	0.443	
Union Square	250173513003	0.636	
Union Square	250173515002	0.636	
Winter Hill	250173501041	0.832	0.708
Winter Hill	250173501042	0.682	
Winter Hill	250173501044	0.628	
Winter Hill	250173502002	0.725	
Winter Hill	250173502003	0.587	
Winter Hill	250173502004	0.670	
Winter Hill	250173502005	0.789	
Winter Hill	250173502006	0.808	
Winter Hill	250173514042	0.655	

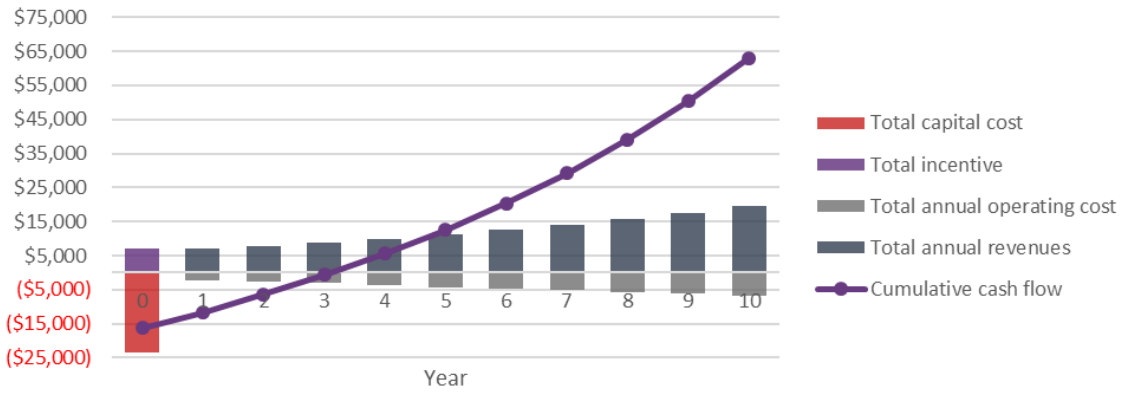
Appendix C. Supportive Cash Flow Diagrams for Revenue Scenario Analysis

Figure 12 through Figure 17 show annual and cumulative cashflows for each of the scenarios, under the assumption that no advertising revenue is obtained. Since Scenario 6 is not viable without advertising, Figure 18 shows how it can be made viable by adding cashflow from advertising revenue. All scenarios, except Scenario 5, assume that make-ready funds cover 50% of installation costs of the station. Table 15 summarizes the components of each scenario again for easy reference.

Table 15.Revenue Analysis Scenario Summary

Scenario #	Revenue Streams
1	Price Per Energy + Penalties
2	Price Per Time + Penalties
3	Price Per Energy + Per Session
4	Price Per Session + Penalties
5	Price Per Energy + Penalties – Make Ready[29]
6	Price Per Energy + Penalties (Low Utilization)

Figure 12. Scenario 1 Cash Flow Diagram



[29] In Scenario 5, the make-ready funds from Eversource are assumed to be 0% of installation costs.

Figure 13. Scenario 2 Cash Flow Diagram

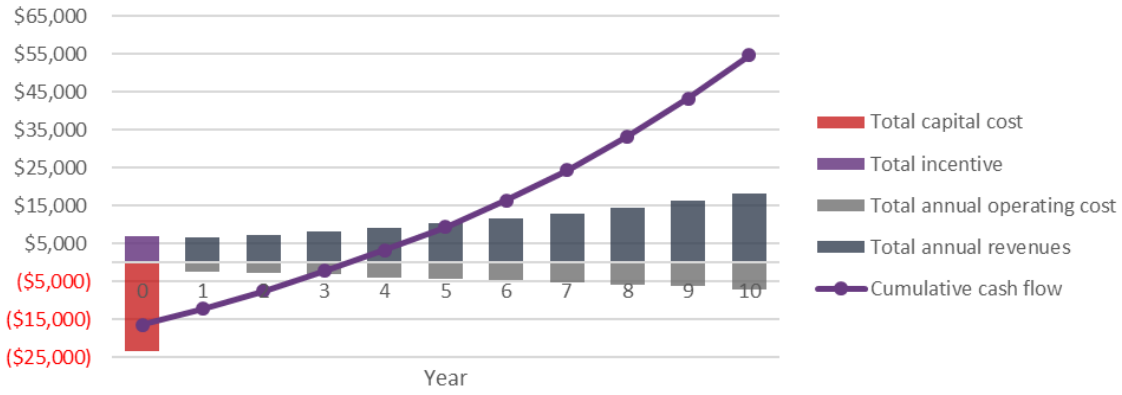


Figure 14. Scenario 3 Cash Flow Diagram

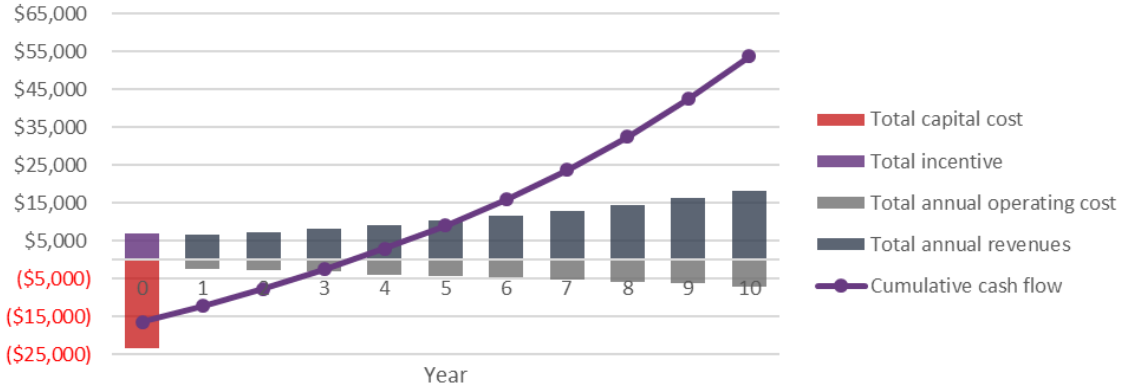


Figure 15. Scenario 4 Cash Flow Diagram

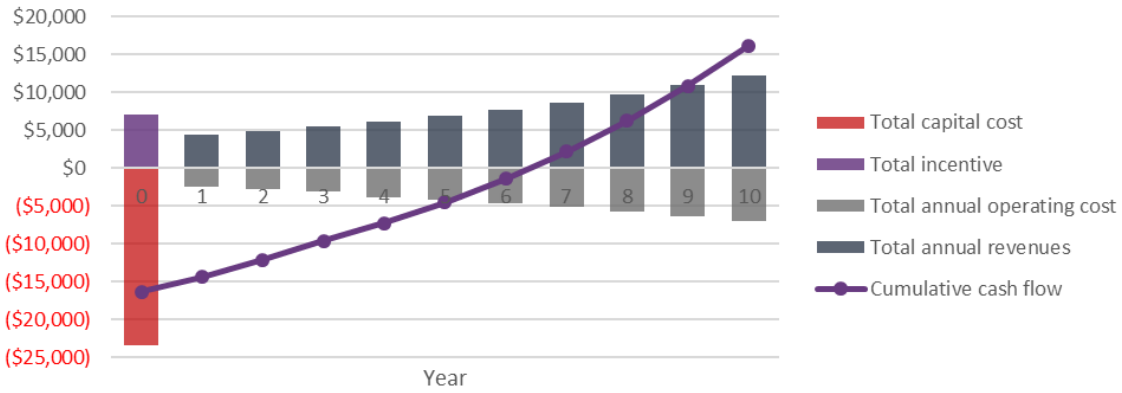


Figure 16. Scenario 5 Cash Flow Diagram

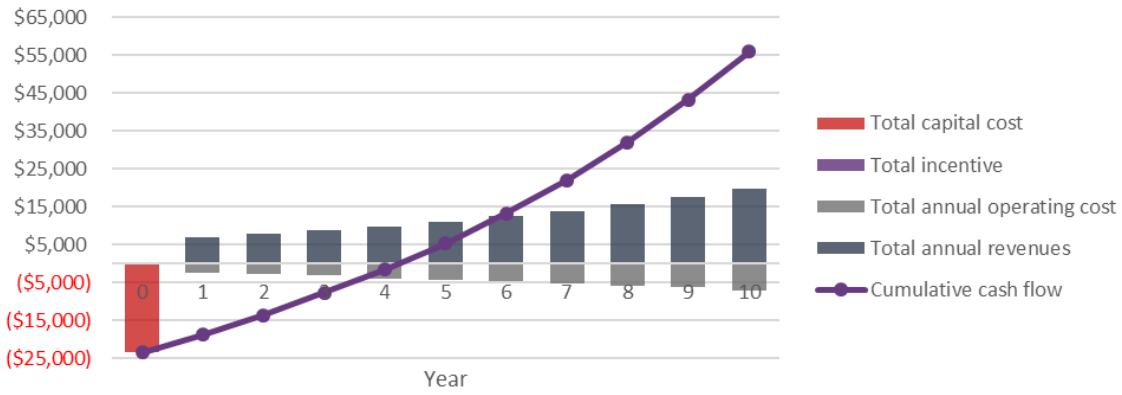


Figure 17. Scenario 6 Cash Flow Diagram without Advertising

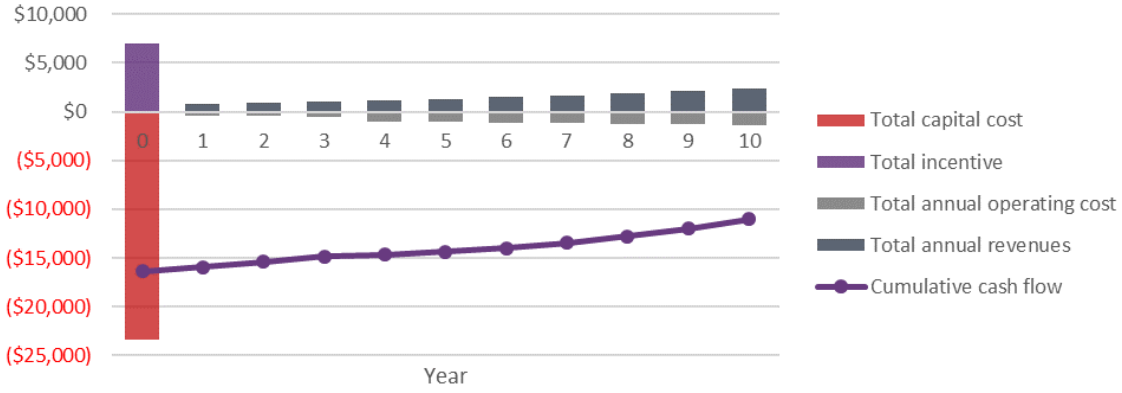


Figure 18. Scenario 6 Cash Flow Diagram with Advertising