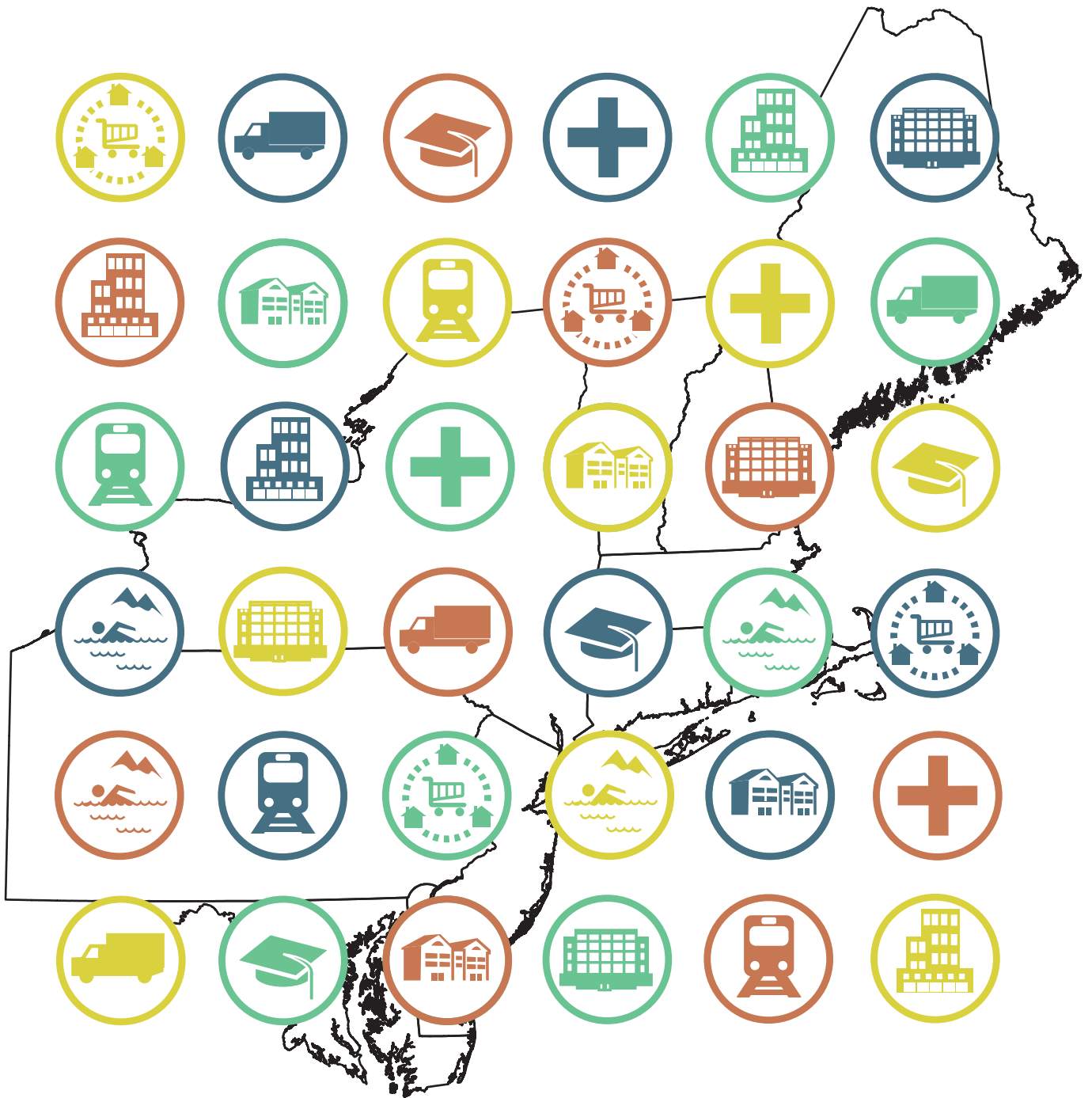


EVSE CLUSTER ANALYSIS

Electric Vehicle Supply Equipment Support Study



Prepared for:
New York State Energy Research and
Development Authority
and
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Prepared by:
WXY Architecture + Urban Design

With support from:
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Of the Northeast and Mid-Atlantic States



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LIST OF ABBREVIATIONS

BSO	Boston Symphony Orchestra
CBD	Central business district
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FEV	Fuel-efficient vehicle
GHG	Greenhouse gas
JHU	Johns Hopkins University
LEED	Leadership in Energy and Environmental Design
LMA	Longwood Medical and Academic Area
MASCO	Medical Academic and Scientific Community Organization
Metro-North	MTA Metro-North Railroad
MSA	Maryland Stadium Authority
NYPA	New York Power Authority
SUNY Albany	University at Albany, State University of New York
TCI	Transportation and Climate Initiative
TOD	Transit-oriented development
V	Volt
VMT	Vehicle miles traveled

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INTRODUCTION

Electric vehicles (EVs) provide a range of important benefits, from reducing greenhouse gas (GHG) emissions to minimizing dependence on petroleum. As a result, many municipalities are working toward creating policies and programs that encourage EV ownership and usage. In order for EVs to become a widespread consumer and fleet operator choice, it is understood that a reliable and accessible infrastructure must be deployed. The successful deployment of electric vehicle supply equipment (EVSE) will depend on joint efforts of the public and private sectors; targeting and coordinating these investments throughout the Transportation and Climate Initiative (TCI) region will multiply the impact of their efforts and provide the fertile ground necessary for the EV market to flourish.¹

In order for public institutions and private-sector organizations to work toward an EV-friendly environment, it is important to understand where the greatest opportunities are for enhancing the EVSE network.² This report takes a rigorous approach to identifying what types of places make sense for EVSE deployment in order to encourage EV ownership and usage. As both the public and private sectors consider investing in EVSE, infrastructure developers will need to determine how to most efficiently invest limited resources to provide battery charging infrastructure. The EV charging paradigm, which allows for recharging in existing parking areas and facilities, is very different from the conditions for conventional gasoline and diesel automobiles, which requires single-purpose refueling stations. As a result, identifying “sweet spot” locations—places where EV users will want and need to charge their cars—will be an important part of prioritizing the selection of EVSE locations that provide multiple public and private benefits.

Infrastructure developers in the public and private sectors can identify these types of places through a combination of market characteristics. Important factors include, but are not limited to: patterns of travel in an area; an area’s demographics, which may be correlated with characteristics typical of EV owners; and the nature of a potential EVSE location, whether it is public property, private businesses such as retail companies, multi-family housing or other institutions. For the purpose of this report, the term “cluster” will be used to represent typologies where these characteristics interrelate to create a place of likely EV usage with a demand for EVSE. This report explores the key factors that make up an ideal EVSE cluster, identifies the types of locations that are a part of that cluster and provides commentary on issues such as which clusters can best motivate EV ownership and which clusters are more oriented toward public-sector funding or private-sector investment.

As such, this report takes a qualitative approach to describing and analyzing the nature of potential clusters and builds on the quantitative findings of the companion TCI document to this study, *Assessment of Current EVSE and EV Deployment*. That report maps and presents an assessment of data collected from Clean Cities stakeholders, state government agencies, publicly-accessible data from the federal government, including the locations of current EV ownership and EVSE installations in the TCI region. These data can help connect current ownership and EVSE deployment to demographics as well

¹ This report uses the “TCI region” to refer to the states that make up the Northeast Electric Vehicle Network, a collaboration of energy, transportation and environment agencies that includes 10 Northeast and Mid-Atlantic states and Washington, DC, focused on reducing greenhouse gas emissions from the transportation sector. Participating states are: Connecticut; Delaware; Maryland; Massachusetts; New Hampshire; New Jersey; New York; Pennsylvania; Rhode Island and Vermont. The Network is organized through TCI, based out of the Georgetown Climate Center in Washington, DC.

² This implies the exclusion of EVSE located in single-family home garages, which constitute a majority of EVSE and charging, and are expected to for the foreseeable future.

as spatial relationships that demonstrate emerging patterns and trends that can be supported by EV-ready planning and investment.

The clusters identified in this report represent strong EVSE investment opportunities for the public and private sectors. Investment opportunities are measured by likelihood of success in terms of high utilization and/or benefits to the public. Stakeholders in the EV community throughout the TCI region can utilize the cluster approach and the lessons learned from the case studies in this report to strategically prioritize public resource allocation and incentivize private infrastructure deployment.

By prioritizing a group of high-potential locations that exist in many communities throughout the Northeast and Mid-Atlantic, it is hoped that the current ad hoc network of EVSE, which is primarily driven by individual EVSE hosts or the initiatives of individual municipalities, can be augmented by a regional strategy that defines EVSE placement based on the relevant strengths of the clusters.

The specific objectives of this study are the following:

- Identify and define clusters for EVSE deployment.
- Discuss the factors that influence decisions to deploy EVSE, including patterns of use; EVSE host facility operations; external influences such as demographics, local regulations and policies and benefits to private firms and to the public.
- Provide information to cities, towns, planners, and EVSE owners to consider when siting EVSE.
- Profile companies and institutions that are early adopters of EVSE and are examples of anchors for each of the different cluster types through case studies from throughout the TCI region.
- Assess the strengths, weaknesses, opportunities and challenges associated with each cluster type.

How to Use This Report

This study uses a cluster-based approach to help cities, towns and private enterprise throughout the TCI region prioritize and optimize investments in infrastructure. The report can serve as a guide for public and private planners to the types of EVSE locations that create the greatest benefits for EV drivers, EVSE owners, and the community at large. This report also informs those decision-makers and prospective EVSE hosts of which factors make a good EV-charging location so they can determine where EVSE should be sited. Targeting locations for EVSE rollout through this cluster approach can help create a mutually beneficial system of EV charging in the critical early stages of the EV industry.

Clusters: Early EVSE Hosts

This study identifies nine clusters based on an understanding of current EVSE locations and early EV adopter profiles. One or more case studies have been selected for every cluster type, each featuring in-depth interviews conducted with key officials, personnel and EVSE proponents associated with each cluster.

These clusters present unique opportunities for EVSE deployment, though locations can exist within more than one of the clusters discussed in this report. The goal of this report is to offer both a general discussion of each cluster as well as specific examples that explain how decisions about EVSE were made. Drawing conclusions from the case studies and other research, the study makes the assumption that early hosts of EVSE are not just EV owners—they are also the governments, businesses and institutions that install charging infrastructure in anticipation of its increasing demand. These early hosts of EVSE can anchor clusters that are becoming popular or common settings for EV usage.

It must also be noted that viable EVSE locations exist outside of these clusters types, and a location within one of these clusters does not necessarily imply a good site for EVSE. As with any planning effort, particular contexts must be considered.

Report Structure

The introduction section, Approaches to EVSE Deployment, provides a context for EV clusters by considering the demographics of EV owners and the issues surrounding EVSE installation. This section also defines an “EV cluster,” its usefulness as part of a strategy for enhancing EV usage and spurring further EVSE installation, and an overview of the factors that support and motivate clusters.

The next nine sections provide a more in-depth discussion of the key takeaways from each cluster type and summarize the information gathered through the 13 cluster case study interviews which underpin this report’s analysis.

The last section is a summary of the key findings of the EV cluster analysis.

APPROACHES TO EVSE DEPLOYMENT

EVSE is a form of decentralized transportation infrastructure. The equipment for EV charging will be provided by different entities, many of which are in the private sector, at locations that are not pre-determined by a public plan. In many previous cases of EVSE installation, however, the public sector has played a role in the rollout of EVSE either through subsidies paid to EVSE installers, government grant programs or direct investment in equipment on government property.

The future of EVSE funding and financing is still taking shape, with several different business models for EVSE still evolving. EV charging networks are gaining popularity and expanding, and numerous EV charging service providers such as ChargePoint, ECOtality, CarCharging and others are operating EVSE in partnership with private-sector hosts and installers across the TCI region and the United States. While the public sector will continue to be motivated by GHG emissions reduction goals, improving air quality and other public benefits of EV use, private development will be increasingly spurred by new grant programs, advertising and marketing opportunities and providing eco-friendly amenities to tenants and customers who demand them.

The factors that motivate and influence the decision-making process regarding where to install EVSE will be increasingly important as the EV market develops. For the purposes of this study, these factors can be summarized as the following:³

USER BEHAVIOR: EV driving patterns and the associated charging demand are a key factor for public and private investment in EVSE installations. Range anxiety associated with limited battery life for longer trips will impact real and perceived EV driving ranges and influence the locations to which concentrations of EV owners will be willing and able to drive without access to EVSE. What EV drivers do once they arrive at a location is also important. Whether there are enough activities or time spent at a location hosting or near the EVSE for a driver to achieve a full charge or to “top off” a battery will determine the effectiveness of a charging location.⁴

CLUSTER OPERATIONS: The business model and organizational practices of an EVSE location will motivate EVSE installation and further determine whether that location is good for EV charging. Certain operational factors can make a location particularly advantageous. For example, procurement policies can be used to encourage purchase of EVs or EVSE across an organization, agency or government, and existing procedures or policies for parking management and fees can also help make installation and use of EVSE an easy transition. On-site relationships, such as the ownership and management of parking facilities, as well as the presence of motivated individuals or groups within an organization can influence EVSE location decisions.

EXTERNAL FACTORS: Demographics, geography, utility and equipment costs, local regulations and policies, and variations in drivers’ transportation costs all contribute to business and planning decisions for potential EVSE locations.

³ See Appendix 2, DESCRIPTION OF DECISION-MAKING CRITERIA , for a table further detailing the decision-making criteria for EVSE installation

⁴ The level of charging, such as Level 1, Level 2 or direct current fast charging, has an important bearing on how much dwell time a driver will have while his EV charges.

BENEFITS: Businesses will want to ensure that EVSE provides enough of an amenity to customers or employees to justify the installation expense.⁵ Further, advertising or marketing revenue associated with EVSE is an incredibly important consideration as the EVSE network expands, with “green” branding associations being especially important. For publicly funded EVSE, public health and environmental benefits will be very important, while for private firms and institutions, sustainability goals (including green branding) may drive decisions to deploy EVSE. In both cases, EVSE can create local green jobs by spurring EV and EVSE market development.

Cluster Identification

The factors above, which are elaborated on further in this report, have guided the initial selection of the different clusters and formed a basis for the cluster analyses as they are presented in the following sections of this study.

The range of cluster types (described in brief on the following page) has been identified from an understanding of EV and EVSE markets, including an examination of the demographic and geographic profiles of early EV adopters. They have also been informed by the existing EVSE locations across the TCI region.

The value of the cluster approach includes not just an understanding of the physical assets and constraints of a given location for EVSE deployment, but also a lens through which one can grasp the motivations, mission or brand-driven considerations and organizational culture that make one type of place more successful in supporting EV usage or more easily financed through public or private dollars than another.

⁵ Some businesses will want to make a return on their investment directly from the provision of electricity as well, however no existing business model has proven successful as of the writing of this report.



DOWNTOWN CLUSTER

Downtowns, including main streets and central business districts, offer strong potential as an EVSE cluster, with their combination of municipally managed parking lots and garages, longer dwell times for local shopping and leisure, and accessibility to all driver demographics.



RETAIL CLUSTER

Retailers have good incentive to install EVSE as a customer amenity. Cutting-edge firms that attract or would like to attract customers fitting the early EV adopter profile can deploy EVSE to aid their marketing and branding efforts. Food markets, shopping malls and other retail operations with longer customer dwell times will experience the best early opportunities for EVSE.



WORKPLACE CLUSTER

Many offices, particularly those engaged in the technology sector, can offer EVSE as an employee benefit while also representing themselves as a cutting-edge firm. Workplace charging is seen as the second most important opportunity for EV drivers, after overnight charging at home.



HIGHER EDUCATION CLUSTER

More than 20 presidents of New York colleges and universities and dozens more across the TCI region have signed the American College and University Presidents Climate Commitment, signifying their environmental concerns. EVSE availability increases an institution's marketability to prospective applicants, faculty and donors, and college towns are well positioned as ideal early adopter communities.



FLEET AND FREIGHT CLUSTER

Fleets domiciled in urban areas have begun to incorporate zero-emission delivery vehicles and to deploy EVSE. Fuel price volatility, corporate goal setting and the negative impacts of diesel trucks and will likely continue to drive adoption of fleet EVs in manufacturing areas that are often close to environmental justice communities concerned with the effects of air pollution.



LEISURE DESTINATION CLUSTER

Wildlife parks, botanical gardens, museums, science centers, sports stadiums and other major cultural institutions in major metropolitan areas are all examples of leisure destinations that offer growing EV early adopter demand and good EV exposure. National and state parks and vacation destinations such as ski resorts in more rural areas offer opportunities for EVSE deployment as well. Siting EVSE in this cluster extends vehicle range throughout the region.



REGIONAL TRANSIT CLUSTER

Regional rail stations and park and ride lots are fertile venues for EVSE deployment due to the short driving distances between the home and the station of a typical commuter. EVSE deployment in this cluster may also build ridership for metropolitan transportation authorities around the TCI region.



MEDICAL CAMPUS CLUSTER

The high-traffic locations and demographics of many health practitioners and researchers make medical campus facilities an important potential EVSE cluster. The air quality benefits of EVs, the public health mission of medical facilities and research campuses' interest in clean technology innovation together create increased interest among institutions in this cluster to provide EVSE.

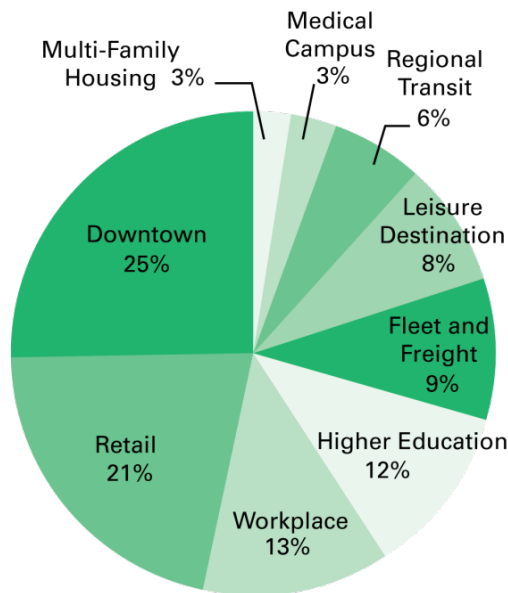


MULTI-FAMILY HOUSING CLUSTER

Residents will drive demand for residential charging in multi-family housing, a difficult market to establish EVSE availability due to cost, regulatory and resident tenure barriers. New multi-family dwellings offer opportunity for EVSE deployment when required through municipal zoning or code, or when encouraged through incentives.

Figure 1: Overview description of EVSE clusters

PUBLICLY ACCESSIBLE EVSE DEPLOYMENT IN THE TCI REGION BY CLUSTER, 2012



Concentration of EVSE Installations by Cluster

Multi-Family Housing	13
Medical Campus	15
Regional Transportation	29
Leisure Destination*	41
Fleet and Freight**	45
Higher Education	56
Workplace***	61
Retail †	103
Downtown‡	122
Total	485
<i>Other</i>	<i>443</i>

These numbers represent discrete EVSE locations within the TCI region, not number of EVSE. Many locations have more than one charging station. A significant number of EVSE locations occur in the automotive dealership and services sectors (383) and at utility providers (25). An additional 35 locations in this dataset were not classified as a part of any cluster or other sector grouping.

* Leisure includes leisure destinations as well as hotels.

** Fleet and Freight cluster may be underreported in the available data. The forty-five total locations include 42 government installations. Many more private fleets include plug-in electric and hybrid electric vehicles.

*** Workplace includes only key commercial sectors: tech, finance and non-profit. The workplace cluster may have overlap with offices in other clusters.

† Retail includes restaurant establishments and a large number (21) of food store locations.

‡ Downtown includes both municipal and private garages. Private garages outnumber public garages by two to one.

Source: Alternative Fuels Data Center, "Data Downloads," U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, accessed September 5, 2012, http://www.afdc.energy.gov/data_download.

Figure 2: Current publicly accessible EVSE deployment

The clusters described on the previous page are reflected in the current distribution of EVSE across the TCI region. Figure 2 shows how EVSE installations in the TCI region break down according to cluster. Not depicted in this chart is the top location for publicly accessible EVSE: dealerships and automotive service locations. Because EVSE is included as a necessary aspect of doing business in the automotive sector, it was not considered as a key cluster for the purpose of this report. Similarly, single-family residential EVSE is not included, because it is not considered publicly accessible.

The public and private parking garages included within the downtown cluster represent the largest existing cluster of EVSE currently deployed as of fall 2012, with 25% (122) of the region's EVSE locations. The growing EVSE market associated with retail locations and EV charging, driven by commercial charging networks and marketing opportunities, is next, making up 21% of the region's EVSE locations. Workplaces (offices) and higher education campuses follow as the next two most frequently occurring locations for EVSE. The remaining clusters—fleet and freight, leisure destination, regional transportation, medical campus and multi-family housing—together make up slightly more than one quarter of existing publicly accessible EV charging stations in the TCI region.

This information should be viewed with an important caveat: the current landscape of EVSE distribution across the clusters reflects not only its suitability, but also past and ongoing funding programs and subsidies as well as real and perceived regulatory barriers.

Geographic Considerations

An analysis of the location of current EVSE throughout the TCI region (mapped in Figure 3) demonstrates concentrations of existing EV charging infrastructure in urban and suburban areas and along the key transportation corridors that connect them up and down the East Coast. The map shows the locations of Level 2 chargers, indicating the intensity of EVSE locations in a particular area. The map demonstrates a clear pattern of metropolitan-area concentrations of existing EVSE.

EVSE CONCENTRATION IN THE TCI REGION 2012

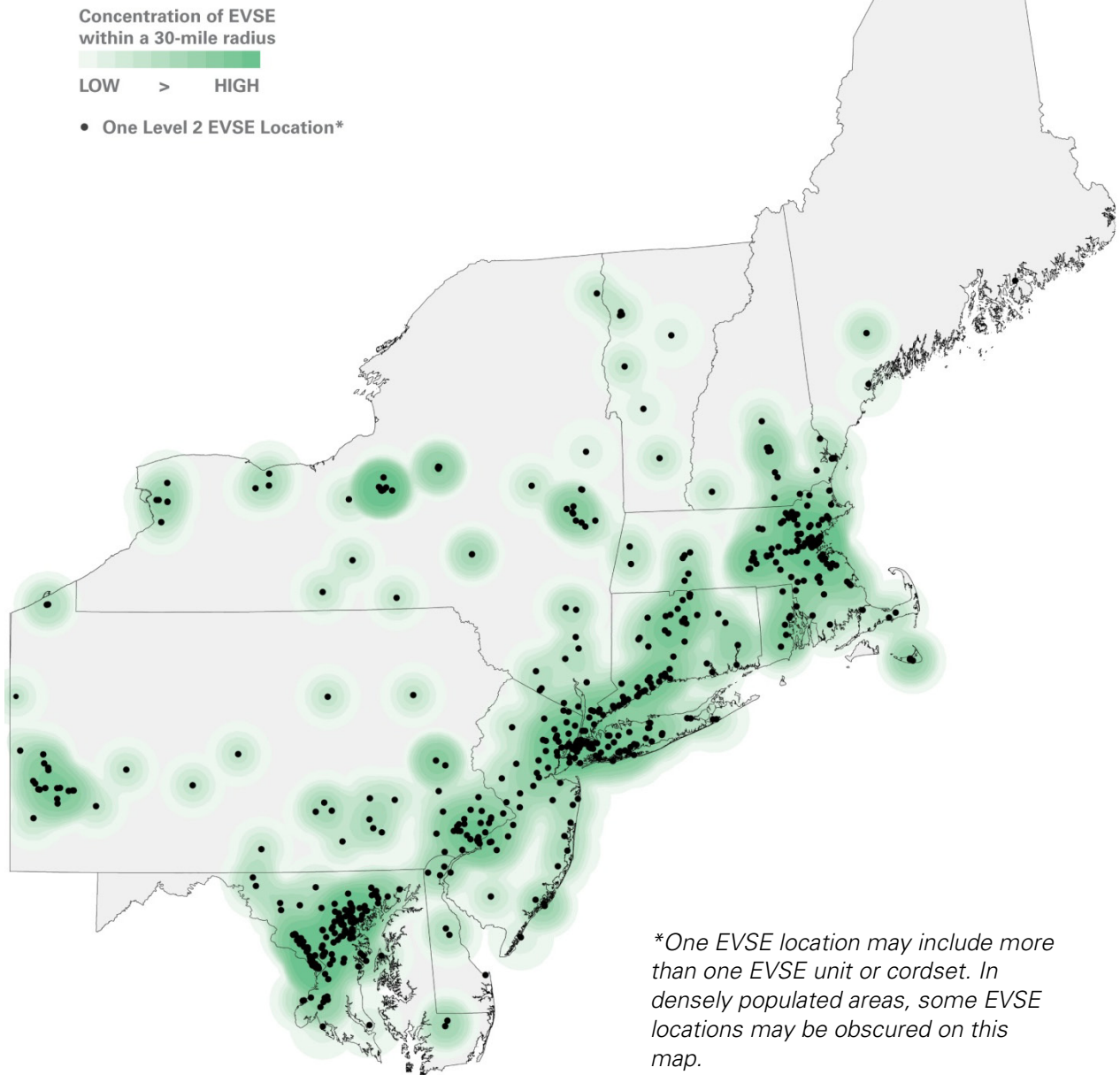


Figure 3: EVSE Concentration in the TCI Region, 2012. (Source: Alternative Fuels Data Center, http://www.afdc.energy.gov/data_download/.)

Case Study Selection and Overview

Through case studies, the project team profiled the nine clusters for EVSE deployment in the TCI region, using research methods such as stakeholder and expert interviews and secondary source research.

Primary and supporting case studies were selected, and an attempt was made where possible to consider both the region's metropolitan and rural areas. The introductory paragraphs in each cluster profile describe the cluster more thoroughly and indicate the specific reasoning behind each case study choice.

Analytical Approach

Qualitative data obtained through in-depth interviews and select quantitative data collected through Clean Cities Coordinators in the TCI region provided the material for analysis. In order to support the case studies, this report summarizes interview data using narrative analysis that profile the strengths, opportunities and challenges for EVSE deployment associated with each cluster. The analyses are summarized in a matrix (shown in Figure 4). The development of a set of descriptive terms and criteria that offer a multidimensional analysis of the factors affecting EVSE location decisions is included in the approach.

The case studies offer a qualitative analysis reflective of a sampling of representative responses from early acting EVSE hosts, including businesses, organizations and institutions in the TCI region. The interviews shed light on current challenges and concerns of different types of suitable EVSE locations and the potential to capture the value of investment in EVs and battery charging infrastructure. The analysis of this report begins the process of prioritizing action and investment within and among the clusters based on opportunities to install EVSE. Communities, institutions and businesses in places of all shapes and sizes across the TCI region should identify with one or more of the examples offered in this report.

EVSE CLUSTER SUMMARY MATRIX

	Downtown	Retail	Workplace	Higher Education	Fleet	Leisure	Regional Transit	Medical Campus	Multi-Family
USER BEHAVIOR									
Density of Use (Volume)	●	●	●		○	●	●		●
Intensity of Use (Thru-put)	●	●	○		○	○	○		
Vehicle Miles Traveled		○	●		●	●	●		
Dwell Time	○	●	●		○	●	○		
Diversity of Experience	○	●			○	●			
CLUSTER OPERATIONS									
Procurement	●		○	○	●		○	○	
Internal Interests	○	○	●	●	○	○	○	●	●
Parking Management	○	○	●	○	○	○	○	○	○
Location Ownership	●	●	○	○	○	○	○	○	○
EXTERNAL FACTORS									
User Demographics		●	●	●		●	○	●	●
Geography	○	○	○	●	●	○	○	○	○
Electricity Cost	●	●	●						●
Fuel Cost	○				●				
Regulatory Ease: Permitting, Zoning	●	○	○	○	○		○	○	○
Plans and Policy	●			○	●		●	○	○
HOST/PUBLIC BENEFIT AND VALUE CAPTURE									
Public Health	○				●			○	
Marketing Opportunity	○	●	○	●	○	●	○	○	○
Sustainability Goals	●	○	●	●	○	○	●	○	○
Economic Development	●	○	○	○	○	○		●	○

Figure 4: EVSE cluster summary matrix based on featured decision-making criteria

DOWNTOWN CLUSTER



Every town has one: as the centers of local activity, the region's **downtown cluster** locations are well positioned to become hubs of EV charging opportunities and include a broad range of potential applications throughout the Northeast and Mid-Atlantic. From small-town main streets to urban central business districts (CBDs), "downtown" represents a hub of government, economic and cultural activity for every community. While differences in city government structure, resources, existing infrastructure, market presence and other contributing factors impact municipal decisions about incorporating EVSE into the region's downtowns, funding and policy concepts derived from this cluster study will likely apply in more than one place, both within and between cities.

Across the TCI region, approximately 25% of all EVSE installations are publicly accessible locations in town and city centers, making the downtown cluster extremely important for overall deployment.



Figure 5: EVs charging outside San Francisco City Hall. (Source: Felix Kramer courtesy of Wikipedia).

Cluster Geography: Versatile EVSE Options

Downtowns include local centers throughout the TCI region. A wide variety of types of city and town centers can be included under the umbrella of the downtown cluster. Some may be master planned smart communities or transit-oriented developments (TODs) that center on a transit hub, mixed-use residences and retail or other planned development. Others may be a traditional main street with local services, retailers and cultural activities. In this way, the downtown cluster has a close relationship to other clusters, particularly regional transportation, retail, multi-family housing and workplace.

The downtown cluster is set apart due to the wide range of potential installation scenarios, including municipal parking lots and garages and privately owned and operated parking facilities. Further, on-street parking would be considered a part of this cluster because on-street EVSE is installed in the public right-of-way.

User Behavior: Green Convenience

As the hub for business and cultural activity for a metropolitan area, the downtown cluster will serve a diversity of early EV adopters as well as government EV users. Density and intensity of use may respond to a diversity of users, ranging from office worker commuters to downtown shoppers. This range requires a careful matching of EVSE to user behavior, such as implementing Level 1 chargers at transit stations, where users will stay plugged in longer. A blanket approach that places EVSE at high-profile locations, such as on-street parking or in front of City Hall, may balance utility and visibility.

Town centers of planned communities and TODs will serve EV users who seek the amenities of mixed-use, pedestrian-oriented and transit-oriented communities, with housing within a short distance from both a transit hub and commercial core. In such communities, EVs have the opportunity to build on existing sustainability practices and offer a real amenity to the residents who value green living.

Cluster Operations: Street-Level Management Meets Long-Term Goals

City fleet vehicles, public parking lots and garages, metered on-street parking, downtown destinations, downtown living, commuters and tourism all represent contexts for installing and managing EVSE in the downtown cluster.

Case Study: Columbia, Maryland

Columbia, Maryland, is an example of planned community development, built as a series of villages organized around town centers. Conceived and designed by real estate developer and urban planner James Rouse and opened in 1967, Columbia is now poised to transition a 21st-century networked community. Columbia is the most populous place in Maryland after Baltimore, with a 2010 population of about 99,600. A small city in itself, Columbia illustrates the sometimes blurry lines between clusters, potentially suitable as a downtown, retail or multi-family case study. Key characteristics of this community, including a planned, contained geography; mission-driven development; presence of a commercial core and proximity to multiple modes of transportation, all distinguish Columbia as an example of where different opportunities exist for EVSE deployment.

Columbia is in the early stages of considering EVSE deployment. However, lessons from a successful planned city and its administration may be indicative of processes and strategies for approaching the incorporation of EVSE in existing and new multi-use communities and perhaps demonstrate a model. Installation and planning for EVSE will occur through standard channels—a town planning board, represented by the Columbia Association; commercial interests and organizations and homeowners, tenants or condo associations would be the responsible parties for approving EVSE plans in Columbia. Furthermore, as a car-centric community (commuters can reach Maryland's MARC train at a station east of Columbia), Columbia may see in EVs a real opportunity to green the transportation sector.

Chick Rhodehamel, Phillip Nelson, Columbia Association, interview, July 19, 2012

Downtowns may benefit from direct or dedicated funding from city agencies or community or other associations that can be spent on infrastructure improvements, creating a relative ease for procurement in this cluster.

EVSE planning may be influenced by internal factors such as local sustainability goals and policies or statewide mandates or laws that require reporting on GHG reductions benchmarks. Because of the potential complexities associated with installing EVSE in the public right-of-way and bureaucratic challenges, another key consideration for successful downtown EVSE deployment is a public-sector advocate.

External Factors: No Town Is the Same

Cities of all sizes will plan for EVSE within the context of existing local and statewide transportation and energy plans and policies. However, the geography of large versus small cities may impact plans. Areas with shorter commute lengths and less traffic congestion may be ideal for certain municipal installation types (e.g., public commuter lots).

There are other external factors that may impact the likelihood of a successful downtown cluster. College and university towns, for example, may also have a higher concentration of early EV adopters. State capitals often create their own unique conditions by having a greater number of downtown municipal parking lots for state government workers than other cities. Planned communities, such as illustrated in the Columbia, Maryland, case study presented, often have a built-in mix of land uses that would support good levels of EV usage.

The downtown cluster is also susceptible to media and public pressure in a way that most others are not. Government installations will be expected to meet a high standard of utility due to the public expenditure involved.

Benefits: Public-Sector Leadership

Municipalities have the opportunity to act as intermediaries in implementing EVSE deployment, linking public benefit to private investment through partnerships and procurement. Procurement in this instance may refer to city fleet vehicles or the charging stations themselves. It is important to ensure that vetted EVSE models suitable for a variety of public applications are available for state and city contracts and bids. In the downtown cluster, a key idea is the activation of existing infrastructure; that is, city authorities and agencies will have the ability to work with existing electrical systems, parking infrastructure, on-street amenities such as phone booths or light poles that already draw power and other infrastructure components in order to develop innovative solutions for public infrastructure.

Summary

Downtown EVSE can serve a variety of uses and attract large numbers of visitors because of their central location and proximity to local activities. These EVSE will often be located in privately-owned lots, with installation locations driven by market forces. Locating EVSE in the TCI region's municipally-owned lots will require weighing the costs direct public investment and government staff time for planning, regulating EVSE with the benefits associated with environmental sustainability goals and local economic development opportunities, including branding of the downtown.

Similar to many of the other clusters profiled later in the report, user behavior (the presence of a market or potential market) will help local government determine the scale and nature of any EVSE installations.

Case Study: Municipal Parking in Baltimore, Maryland⁶

Baltimore, Maryland, is a mid-sized city with a range of neighborhood typologies and an existing interest in pursuing installation of EVSE. Baltimore has started to deploy EVSE, with installations of new EVSE in a number of lots and garages. The city is continuing to expand its publicly accessible charging network within a larger-scale EV planning framework (from the Maryland Department of Transportation Electric Vehicle Council); a bifurcated administrative approach to planning and implementing this type of infrastructure that is common to many cities with multiple authorities having jurisdiction over aspects of this process. An additional level of coordination must exist between city agencies and authorities that manage different aspects of the EVSE installation and pilot project process. Baltimore's public lots and parking authority lots fall under different management; city lots house municipal employees' and fleet vehicles while parking authority lots are those located specifically within a central business district to serve visitors. The city's Department of General Services received \$135,000 in funding from the Maryland State Energy Authority and the U.S. Department of Energy for EVSE installation.

These EVSE sites have been developed in the early stages of EV planning in Maryland, where the EV Infrastructure Council is developing recommendations for numbers and locations of charging stations by minor civil division (a district larger than a census tract but below county level), based on work done with independent consultants in collaboration with the Maryland Department of Transportation, including origin-destination trip modeling.

User- and Use-Based Hubs

Baltimore's parking authority sees a great deal of potential for EVSE throughout the lots and garages under its purview, with different locations ranking in priority for different user groups. For example, Baltimore's Amtrak and commuter rail station, Penn Station, has been cited as an excellent EVSE multi-modal transit hub. Alternately, city garages on the cusp of commercial and residential areas, such as a garage on Caroline Street downtown, would offer a high concentration of around-the-clock use. This idea of co-location, or of EVSE locations that can serve more than one destination, is a concern that Jill Sorensen, Executive Director of the Baltimore Electric Vehicle Initiative, expressed in her analysis of existing EVSE installations.

Baltimore also identifies user-focused hubs and sees early adopters at several locations that meet overall expectations regarding EV-driver demographics. Specifically, the city identifies Johns Hopkins University, with its large student body and employee base, as a representative educational institution. The university's position as the city's second-largest employer only increases its importance. Baltimore similarly identifies the University of Maryland Hospital System as another user-focused hub. The city also believes municipal garages and the parking authorities that operate them can attract early adopter drivers and identify new revenue sources by investing in EVSE deployments.

City Fleets in the Downtown Cluster

Approximately half of the city's roughly 5,800 fleet vehicles are sedans, meaning that existing models of passenger EVs could be appropriate substitutes. Included in this number are a pilot series of Leafs, Volts and Prius Plug-ins. However, the city sees the current price points as too high, even while some departments, such as Parks and Recreation, may be particularly good candidates for EV fleets. In general, opportunities to update Baltimore's "very, very old fleet" with EVs will therefore likely be based on city budgets and bottom lines. However, procurement opportunities for the city fleet may let the city set an interesting precedent; Baltimore's agencies typically rent vehicles from the city Department of General Services' Energy and Fleet Division, indicating that the route to deploying EVs in city service may be reasonably direct.

⁶ Andrew Farkas, Morgan State University, interview, September 10 2012; Paul Skorochod, City of Baltimore, Energy Division, interview, July, 13, 2012; Jill Sorensen, Baltimore Electric Vehicle Initiative, interview, September 10, 2012.

RETAIL CLUSTER



The **retail cluster** is defined by the opportunity to provide “peace-of-mind” charging to customers who seek value, appreciate sustainability and want the opportunity to charge on the go. The shorter-term nature of charging at retail locations and the ability in many cases to link EVSE to branding and market research strategies for retailers present unique challenges and opportunities for EV charging.

Approximately 21% of all EVSE locations across the TCI region are related to retail establishments.

Cluster Geography: Trade Areas Determine EVSE Potential

As with the downtown cluster, retail EVSE opportunities are widely varied and take on different forms depending on the size and type of location. This range of opportunities includes edge-of-town destination shopping such as big-box retail or shopping malls; smaller, more local shopping centers serving a portion of a community; downtown shopping districts; town center developments and retail outlets. Customer use patterns vary across all of these retail types.

However, the type of retail establishment will determine several important things about its customers—and its potential for EV-driving customers. First, VMT relate to the type of retail. Convenience shopping (such as grocery or drug stores that provide basic, everyday goods) typically draws consumers from within a relatively small travel radius or trade area. Comparison shopping (such as clothing stores, specialty food stores and restaurants) will likely draw people from a wider area. The travel patterns of consumers, and therefore their EV charging needs, relate to local geography and store type.



Figure 6: Rendering of EVSE installed in a Price Chopper Supermarket parking lot (Source: Price Chopper)

User Behavior: “Topping Off”

Retail EVSE will be targeted towards customers, not workers; therefore, dwell time is a key factor. Short-term charging and intensity of use at retail locations may encourage use of Level 3DC fast charging stations, but longer dwell time is also associated with greater sales per consumer. The diversity of the user experience impacts EVSE viability—having enough activities to occupy users at a site creates a strong value proposition.

Length of stay will depend on the retail category or configuration. Convenience retail, with the possible exception of large-scale supermarkets, may not present a strong potential for charging, with short errand trips in



Figure 7: Retail charging (Source: Flickr user Hawaii).

and out of shops. Comparison shopping locations, including malls, shopping centers and main streets, are more likely to capture customers for one or more hours. Short-term visits may result in EV drivers “topping off” the battery at a Level 2 charger, or in the future opting for a full charge via Level 3 or DC Fast Charging. At Price Chopper (a case study illustrated in this section), the average shopper parks for between 45 and 75 minutes.

Cluster Operations: High-Visibility Locations may have High Costs

The variety in retail (e.g., main streets, malls, big-box stores, corridor retail, destination locations) requires EVSE location and installation scenarios that fit the retail cluster location model (e.g., public garage, on-street). The retail cluster’s relationships to parking, leases and ownership structures are also important considerations. Retailers seeking to install EVSE will want to maximize the impact of EV charging on the company’s bottom line through marketing opportunities or by drawing more customers to the business. The high construction costs associated with installing EVSE in prominent locations—due to the typical distance of outdoor electrical panels from retail stores’ front doors—may be prohibitive.

External Factors: Consumer Demand Drives Retailer Choice

Retailers know their target markets, trade areas and consumer profiles; density and demographic studies pinpoint locations that maximize utilization. The consumer is at the heart of sales and service, and the retailer’s knowledge can help vet locations, monitor behavior and track impacts. As a result, retail cluster locations are highly dependent on context.

Benefits: EVSE Branding Opportunities

The retail cluster presents an opportunity to link EVSE to branding and marketing, as well as to create partnerships with charge networks. A number of retail and restaurant chains in the United States have had recent successes in implementing EVSE, including national brands such as Walgreens drug stores and Cracker Barrel restaurants.

Regional and national retail chains or developers are able to provide an amenity that links corridors through sequential locations, which provide ready-made networks for charging stations that create a “green halo” association for the firm. For example, in partnership with Blink, Cracker Barrel restaurants in the “Tennessee Triangle” and Dallas-Fort Worth areas have implemented networks of Level 3DC Fast charging stations in a pilot project. Cracker Barrel is known as a roadside travel stop with Middle America appeal—its EVSE installations represent a best practice in increasing visibility and awareness for EVs and a market leadership opportunity. IKEA, Kohl’s, Walgreens and Lowe’s are all participating in pilot projects that may help take EV charging mainstream.

Summary

User behavior and external factors, particularly those that deal with costs and profit potential, are most central to the retail cluster.

Retailers are interested in using EVSE for branding, and as a result, they can justify the provision of EVSE as a public amenity because they are gaining a marketing opportunity. Alternately, marketing opportunities transform EVSE into a tool to attract customers concerned with sustainable products and businesses.

Case Study: Price Chopper Supermarkets⁷

Price Chopper is a privately held chain of supermarket stores with locations throughout the Northeast. With 129 stores, Price Chopper reaches a broad consumer base across seven states. Price Chopper has recently installed three EV chargers at their Niskayuna, New York location. The decision to pilot the program at this location was impacted by the location's proximity to Price Chopper's corporate headquarters, traffic volume and demographic-based projections of increasing EV use in the area. Anecdotally, Price Chopper reported enthusiasm from the local planning board, which represented an enthusiastic, progressive and inquisitive community. The board believed the technology could "come into the community and advance a green agenda and differentiate the community." Price Chopper is seeking to build "the most densely networked electric vehicle charging station ecosystem on the East Coast, providing free charge to users until such a time as sustainable EV proliferation has been achieved."

Location Choice Connects Corridors

Stores "tend to hug primary transportation corridors," and locations are typically between 10 and 30 miles apart, depending on population density. Price Chopper has many shopping plaza locations, indicating an opportunity for shared charging strategies.

Parking Contributes to Bottom Line

Nearly all parking at Price Chopper locations is provided free of charge in surface lots. Price Chopper is often in control of its parking lots, giving the company the ability to test different priority strategies. For example, the chain has tried "new mom with baby" parking, as well as fuel-efficient vehicle (FEV) spaces. While Price Chopper received Leadership in Energy and Environmental Design (LEED) sustainable site credits for the FEV initiative, consumers pushed back against this designation, stating that premium spots restricted to Americans with Disabilities Act (ADA) and "new mom" patrons, were being underutilized.

Turnover rates in retail parking lots impact a store's viability and profitability. The layout and dimensions of lots impact feasibility, and, to a degree, a balance between long dwell times and higher turnover rates is weighed. Some stores feature cafes or bank locations, lengthening dwell time. While longer dwell times make EVSE more useful for consumers who want to boost their batteries, charging stations may not be considered feasible based on this type of calculation.

Critical Infrastructure and Local Development

Supermarkets are considered "critical infrastructure" by the Federal Emergency Management Agency, and as such, the agency requires that stores be regionally deployed in a strategic manner, not unlike fire stations. The regularity created by this designation, combined with the known location strategy/business model for the stores themselves, could make food stores a key piece in locating accessible and visible EVSE in locations that relate to both population centers and transportation corridors.

Retail locations, such as in Niskayuna, New York, can provide an opportunity for communities to differentiate themselves while bringing new development in a way that feels dynamic while "holding onto core community values."

Differentiation has design and, of course, marketing aspects: Price Chopper's EV charging stations incorporate a cantilevered parking canopy with co-branded media used to bring awareness of the technology and of the venture's partners, as well as to clearly define the EV parking area (Figure 6). The chain's environmental certification specialist described the need to make infrastructure easily identifiable as a "piece of critical infrastructure." The co-branding will feature information- and advocacy-oriented collaborators such as the New York State Energy Research and Development Authority, with the ultimate goal of developing a cost-neutral strategy while facilitating technology transfer.

⁷ Joseph Berman, Golub Corporation/Price Chopper Supermarkets, interview, July 23, 2012.

WORKPLACE CLUSTER



The **workplace cluster** currently composes 13% of existing EVSE locations in the TCI region. Workplace and office locations offer strong opportunities to extend EVSE accessibility and encourage EV adoption, particularly among drivers who would consider an EV but do not have access to residential charging.

Cluster Geography: Technology Firms are Hubs for Early Adopters

Establishing hubs for technology and innovation sector businesses will allow EVSE to fit seamlessly into high-tech communities, which will also likely promise a market for EV charging. General Electric, whose EV-sector efforts and workplace EVSE are profiled in a case study in this section, is an excellent example of a corporation whose business and employee interests are strongly aligned on EVSE.

However, other industry sectors or office types should not be excluded from this cluster. For example, office parks may be good candidates for EVSE deployment because of their suburban locational patterns that often require commuters to travel by car.

User Behavior: Everyday Users

EV drivers charging at work will likely be parked for up to eight hours a day, making both Level 1 and Level 2 charging viable options for this cluster. Level 1 charging may allow a more cost-effective initial approach for firms looking to assess EVSE popularity. An advantage for parking managers and procurement officers in the commercial office cluster is the predictability of the users. With the exception of visitors to an office lot or garage, firms will be able to easily assess and estimate the EVSE requirements of regular staff.

At-work charging in the commercial cluster may become a viable alternative for drivers lacking access to residential charging, and it may even become the primary charging location for some drivers.

Cluster Operations: Managing an Employee and Client Amenity

Charging in the workplace cluster is an employee and client amenity, and it may help companies promote their environmentally aware business practices. Internal organizational goals, such as a company's sustainability mission, may include EVSE. On the other hand, the decision to install EVSE may be purely employee driven, due to existing needs among EV adopters at a given firm.

Parking management in this cluster may present unique challenges in scenarios where multiple companies utilize the same parking area, and allotting EV charging space access and apportioning costs will require cooperation. Similarly, concerns have been raised by stakeholders about EV dwell time—a vehicle that just needs “topping off” may remain plugged into a charging station for the full workday's duration, limiting accessibility to others. This type of concern will likely be answered on a site-by-site basis by the host's management until clear EV charging etiquette develops. The EV Employer Initiative has established itself as a resource for businesses interested in providing charging points for their employees.⁸ Early members of the initiative, including Google and Apple, have implemented EV charging policies for their parking facilities.

Firms may want to plan to incorporate EVSE into a larger strategy to encourage intermodal transit; for example, by also offering shuttle buses to local public transportation stops. Finally, this cluster offers strong opportunities to incorporate EVs into corporate fleets (e.g., company cars).

⁸ More information on the EV Employer Initiative can be found at <http://evworkplace.org/>.

External Influence: Sensitive to Cost and Regulatory Barriers

Commercial cluster locations may be sensitive to subsidies and incentives in a way that the other primary charging locations are not. Residential charging for single-family homes is largely assumed to be necessary, and the marketability of retail charging may place the retail cluster in a different category in terms of necessary funding. An additional form of price sensitivity that applies to the commercial cluster is the applicability of daytime and peak electric utility rates.

Regulations may exist in the future that encourage or require either wiring for or the installation of EVSE in commercial garages. Zoning (e.g., Hawaii's mandate that all new parking lots and structures feature EVSE) or codes (e.g., Vancouver's building by-law amendment requiring a percentage of parking stalls in commercial buildings to be EV ready) are examples of regulatory tools that will be important catalysts for this cluster. Permitting processes for commercial buildings will also need to be addressed in many areas to support charging in this arena, much as TCI region cities and states have begun to consider residential permitting issues.

Benefits: Cutting-Edge Firms Provide Essential Charging Options

Businesses in the workplace cluster opting to provide EVSE for employees and clients demonstrate a commitment to sustainability and alternative transportation. Technology and automotive sector businesses also have the opportunity to expand their brand or even to showcase products and collect data with on-site demonstration installations, further positioning their firms as cutting edge. The primary benefit will be to those EV drivers who otherwise are unable to access regular, long-duration charging.

Summary

The workplace cluster will respond most strongly to a combination of user behavior and internal cluster operations factors when deciding to install EVSE. User demand will be an important consideration, as will decisions regarding how that demand is met and managed on a daily basis. However, firms may opt to install EVSE preemptively to encourage EV adoption and to send a message regarding their sustainability goals. A key external consideration will be the presence of regulations, such as prohibitive zoning or high commercial construction permitting fees that may pose barriers or add costs to equipment and installation.



Figure 8: San Diego's first EVSE, in a real estate company's parking garage. (Source: www.hybridcars.com).

Case Study: General Electric, Plainview, Connecticut⁹

The corporate campus in Plainville, CT is the headquarters for General Electric's (GE) Industrial Solutions unit. It is located in a hundred-year-old building housing a variety of business teams including, research, engineering, testing, sales and marketing working for Industrial Solutions, which largely handles low voltage distribution equipment but also designs and makes GE's EVSE products.

Several hundred GE employees work at the facility, with the vast majority driving personal automobiles and park in the campus' surface lot each day. A small percentage of the workforce operates GE fleet vehicles and drives Chevy Volts to work each day; typically 6–7 GE-owned vehicles are parked on campus at a given time, including a Prius Plug-in that is domiciled on campus. The sales team members are frequent users of these vehicles for customer visits. Additionally, one GE employee owns a Prius Plug-in and plugs into one of GE's 10 EVSE units located on campus.



Figure 9: General Electric's Solar Carport, installed in Plainview, Connecticut (Source: GE, courtesy of C|Net).

Most GE employees live within 20 miles of the facility. The surrounding area is largely characterized by single-family homes with attached garages, although some multi-family units are located nearby. Employees typically park their vehicle for at least 8 hours—between the hours of 8 AM and 5 PM—in the campus lot. The sales personnel who drive GE-owned Volts have a more varied schedule and shorter dwell times than the average employee.

The Industrial Solutions parking lot includes 500 spaces; including 40 spaces located under a 100kilowatt solar carport, six of which are equipped with EVSE (see Figure 9). The new carport is located close to a busy intersection in Plainville, highly visible from nearby public streets. Power from the carport's PV array supports LED lighting in the parking lot and EV charging. Carport PV generation totals 125,000 kWh per year and is sufficient to offset charging for 5,000 EVs per year.¹⁰ The GE facility is a Connecticut Power and Light customer and pays 12 cents per kWh for their electricity.

GE employees and visitors pay no fees to park in the lot or plug in their vehicles and there are no plans to move to a fee-based system. The first 4 EV chargers GE installed on the campus are available for public use and have seen such use; customer events on the site draw other EV users and contractors with EVs.

The second 6 chargers were installed under the solar carport and are intended for GE employees. GE personnel with other fuel efficient or alt fuel vehicles are also entitled to park under the carport. This is considered "preferential parking," though it is further from the entrance than other spaces. Coverage from the solar canopy provides shade in summer and protection from ice and snow in winter.

GE selected a diverse array of level 2 EVSE units to beta test in the carport area. These range in typical usage from retail settings to units more suited to workplace, university or residential settings. While no actual EV user data is collected—GE is seeking to make the pilot as seamless as possible for the user—equipment performance is monitored. The facility acts as "live lab" as well, with charging equipment is lab-tested with regular usage in the parking lot.

⁹ Seth Cutler, Kate Johnston, General Electric Industrial Solutions, interview, December 12, 2012.

¹⁰ Nissan Leaf or equivalent battery electric vehicle. This translates to over 13 EVs per day.

The bundled PV carport and EVSE installation is a fully functional demonstration model for GE equipment and cutting edge technologies, having brought attention to the industry and the charging equipment. The distribution equipment is primarily GE construction, though a third party produces the system's inverter. A similar carport/EVSE installation has been piloted at a GE facility in Atlanta. When the Plainville carport was under construction, curious passersby asked if GE was installing a gas station. The infrastructure is so visible from the street that members of the public would pull into the lot simply to inquire about the equipment. Shade analysis, not visibility, in large part determined where the carport was built, but the direct marketing to the public was an unintended, yet welcome, consequence of installing the GE-branded equipment so close to a busy intersection. While this outcome was not part of original calculus, it showed that GE "wanted to walk the walk, not just talk the talk."

GE leadership at the Plainville campus also recognized that the delivery of new Chevy Volts for the sales team would create an internal demand for EVSE and an opportunity to maximize EV mileage on the vehicles. While the decision to deploy the equipment was largely a local one, it was entirely consistent with GE's overall sustainability objectives. Employees at GE have the benefit of seeing the technology on a daily basis, which helps build awareness and receptiveness to EVs. Though the market suggests that range anxiety is the number one challenge for EV adoption, but GE's experience in Plainview has shown that the real challenge is a lack of education.

Case Study: New York Power Authority, White Plains, New York¹¹

The New York Power Authority (NYPA) is the principal occupant of a 420,000 sq. ft. LEED Gold office building in White Plains, NY. In the first quarter of 2013, NYPA will launch a pilot EV charging program for its corporate headquarters, with several feasibility goals including gauging user demand.

Level 1 Charging calculus: NYPA elected to install level 1 or “slow” charging equipment to serve the current and future electric vehicle charging needs of its employees. The primary rationale for using level 1 is the significant average dwell time at the workplace, providing enough charge for a majority of commutes. NYPA assumed most of the plug-in vehicles driven by its employees would be hybrids or extended-range EVs, which contain smaller batteries than battery-only EVs. Finally, NYPA found level 1 EVSE offered reduced cost and less complexity in connecting to existing infrastructure.

User Fees: NYPA’s intention is to only break even on electricity costs. As such users are expected to be charged \$15 per month for charging in a designated space, matching the estimated per user electricity costs. The pilot will begin with three designated parking spaces for employee charging at NYPA’s multi-level parking garage.

Charging Locations: The pilot will not offer users a preferential location, other than a covered and non-rooftop space, reflecting precipitation concerns. Eight to 10 employees already take advantage of NYPA’s hybrid-designated spots daily, though the spots are on average 25 feet closer to the entrance so proximity is probably not “determinative.” These priority hybrid spots are perceived to be uncontroversial; although there are no current plans for expansion.

The chargers—level 1 Clipper Creek units costing roughly \$600 each— will be installed along with sub-meters to measure individual kilowatt-hour use by an outside electrician. NYPA’s electricity costs are significantly cheaper than the local Con Edison rate at this location of 13.5 cents per kilowatt-hour.

NYPA EV Fleet: The NYPA EV fleet has level 2 charging available at this and other NYPA locations. This fleet is composed of three models—a Chevy Volt, a Ford Transit Connect and a Nissan Leaf—that any member of the NYPA staff can use for local travel, implying the Authority does function as a promoter of the technology.

Context and Outreach: This pilot was conceived as part of NYPA’s sustainability plan and not in response to specific employee/stakeholder inquiries. NYPA employees are generally interested in alternative fuel vehicles, particularly in the Energy Services Group. Hybrids were first observed in NYPA’s garage in 2004 or 2005.

Given the limited scale, this pilot can be described as NYPA “dipping its toe in the water” while reducing its overall carbon footprint. Potential users will be informed through internal NYPA e-mails to all employees and a one-page education piece on the benefits of electric vehicles. NYPA has not conducted any substantive research on employee use of hybrids or alternative fuel vehicles.

NYPA also plans to subsidize workplace charging at two private employer locations in New York State: General Motors in Tonawanda and IBM in Yorktown. NYPA will survey those facilities in advance of an RFP. Eight spaces at each location—available to fleet as well as employee vehicles—will be equipped with level 2 units, and the charging equipment will be bundled with solar canopies. In addition to these two private charging pilots, there are eight public use pilots at Metro-North Railroad locations, totally up to 100 spaces for passenger EVs.¹²

¹¹ John Markowitz, Evan Kolkos, New York Power Authority Electric Vehicle Transportation Program, interview, November 26, 2012.

¹² See Case Study: MTA Metro-North Railroad, New York and Connecticut for more information.

EV Driver Profile: Lara Kaye, Assistant Research Professor and Research Scientist, Center for Human Services Research, University at Albany Downtown Campus, Albany, New York¹³

Professor Lara Kaye is an Albany, New York, area resident, an academic researcher at the University at Albany, State University of New York (SUNY Albany) and mother in a family of three. Kaye ordered her Leaf in January 2012 and picked up her car in May of the same year, which made the Kayes a two-car family. Their first car, a Toyota Prius, is now reserved for weekends and longer trips. Their new Leaf is the “commuter car,” for driving to and from Albany and a limited number of excursions. Kaye’s typically uses the Leaf for her 50-mile round-trip daily commute. During some days of the summer months, Kaye travels 90 miles round-trip and notes that the hills in the area complicate typical range expectations. The Kayes are exploring the possibility of visiting Lara’s parents in Shushan, New York, several hours away.

Professor Kaye’s family carools in the Leaf 2–3 days a week. Kaye’s husband commutes to a public-sector job in Albany using the Leaf, and he drops Lara off downtown before taking their daughter to school. Committed to reducing impacts further, the Kayes also explored carpooling with other families using their Leaf, but logistics limited their options.

For charging, the Kayes use an outdoor 220 volt (V) charger at home. One day a week, Kaye will also charge at Honest Weight Food Co-op, where a 110 V “slow charge” outlet has been installed for EVs. Two hours of slow charge at the co-op provides her with an extra 10 miles of range. She charges while shopping and eating a meal with her daughter at the co-op.

Challenges:

- Kaye believes that an iPhone app is needed in order to reserve charge time at EVSE, because she expects that the demand for public charging infrastructure will soon outstrip supply.¹⁴
- Winter driving may also be a challenge in the Leaf because of the cold conditions, but Kaye intends to continue to commute using her EV.

Optimal Locations for EVSE:

- Restaurants and supermarkets.
- Student parking areas at the University at Albany, State University of New York, because the three-hour classes that she teaches offer an opportunistic charging opportunity.

¹³ Lara Kaye, University at Albany, Interview, August 1, 2012

¹⁴ Several smartphone apps do currently exist, developed by EV and EVSE manufacturers, as well as third-party sources. These apps generally allow users to locate EVSE and check whether they are in use. Future versions are expected to allow users to reserve specific charging times at EVSE, make payments and program EV charging behavior,

HIGHER EDUCATION CLUSTER



The **higher education cluster** is defined by campus landscape, sustainability goals and early adopter communities that together will guide integration of EVSE into the campus landscape. Across the TCI region, 9% of all current reported EVSE locations are tied to higher education institutions.

Cluster Geography: University Trendsetters

The role of colleges and universities within a municipality often varies according to the size of the town or city. Rural colleges and universities, such as Middlebury College, Ithaca College (see case study in this section) or Penn State, may shape the surrounding context in terms of demographics and political leanings. Institutions in more urban or suburban contexts may still play an important role in providing critical sites for EVSE.

User Behavior: EVSE Serves Faculty

Because higher education institutions will see faculty and staff as primary users of EVSE on campus, this cluster is primarily a work destination. Travel distance is likely to occur in a ring pattern—faculty and staff may live either close to the campus or at a further distance, as at Johns Hopkins University (JHU) in Baltimore, Maryland, where faculty are estimated to travel fewer miles (1–10 miles) than staff (5–15 miles). Many universities permit students to drive and park on campus, such as at the University at Albany, State University of New York (SUNY Albany), where about 6,000 resident and 11,500 commuter students are allowed to access parking.

Cluster Operations: The Campus Advantage

With their limited geographies, campuses provide an opportunity for contained fleet routes for vehicles such as campus security, maintenance or sanitation; all travel shorter distances within a contained geography. The financial structures of educational institutions enable a single decision-making body to make choices about fleets, creating an ease of procurement.

External Factors: Demographics in Place

College towns are well positioned as ideal early adopter communities. Demographics are present for successful implementation; college faculties in particular are expected to have high educational attainment and incomes, factors which are both correlated with increased EV ownership.¹⁵ Motivation for the higher education cluster, however, will likely be internally driven in contrast to the many clusters relying on external influences. Higher education institutions have the ability to create their own conditions to support EV usage.

Benefits: Long-Term Sustainability Goals and Student Attraction

Institutional concerns with sustainability mean that most U.S. colleges and universities now address sustainability in the materials they provide to prospective students, making it a powerful marketing tool. EV use can be a critical component of such strategies. According to the director of the JHU's Office of Sustainability (see case study in this section), the installation of EVSE today, even with minimal or no demand at present, is a critical strategy for building the campus' image in the future. In contrast, SUNY Albany "likes to benchmark itself, but it does not see EVSE deployment as a primary competitive advantage."¹⁶

¹⁵ See Appendix 1, OVERVIEW OF EV DEMOGRAPHICS, for more on the demographics of communities with EVs.

¹⁶ Rose Anne Dorsman, Indu, CEM, LEED AP and Mary Ellen Mallia, PhD, University at Albany, interview, July 23, 2012

SUNY Albany is currently participating in a pilot program to bring EVSE to campus, supporting 10% of the installation costs. As the university currently sees a majority of its students commute by personal automobile, incentivizing EV usage is a worthwhile tool for reducing carbon emissions as part of a sustainability strategy. However, institutions with less automobile usage find that campus buildings are the majority producer of carbon emissions, lowering the ceiling of effectiveness for EVs in a sustainability strategy.

Sustainability agreements such as the University Presidents Climate Commitment provide leverage for the EV community—including funders, government agencies, activists and owners—to hold institutions to their promises to reduce emissions.¹⁷ EVSE availability increases an institution’s marketability to prospective applicants, faculty and donors. College towns too are well positioned as ideal early adopter communities, because of their close relationships with institutions of higher learning.

Summary

For a higher education institution, the most important aspect of the decision to install EVSE is its ability to attract students as a statement about the school’s sustainability goals. Yet EVSE will also meet growing demand among professors who fit the early adopter profile for EV ownership. Faculty driving patterns and the setup of the parking facilities on campus will help determine the viability of a location within this cluster.

¹⁷ The presidents of 222 institutions throughout the TCI region have signed the American College and University Presidents Climate Commitment: American College & University Presidents’ Climate Commitment, Signatory List by State, accessed December 12, 2012, <http://www.presidentsclimatecommitment.org/signatories/list/state>.

Case Study: Johns Hopkins University, Baltimore, Maryland¹⁸

The university campus is a “natural early adopter” according to JHU’s Sustainability Director, Davis Bookhart, but there are no current short-term benefits associated with EVSE deployment. Instead, the future perception associated with the school’s status as an early EVSE adopter is valued because it can impact recruitment and student expectations..

Emerging markets among faculty, boards and trustees means that there are multiple roles within the EV ecosystem for the higher education cluster. At JHU, at least two professors (of biology and engineering) have inquired about on-campus EV charging options.

The Campus Advantage

From Bookhart’s view, EVs could be used for all of JHU’s utility vehicles because the type and capacity of available EVs fit with existing uses required on campus; importantly, however, this would require training for the campus auto shop. In addition to procurement, partnerships can be easily administered. At JHU, 18 parking spots are designated for use by Zipcar, suggesting a potential for EV-only parking spaces. A final factor in favor of JHU being well situated as an EV cluster is that the campus offers a captive audience, contained by both a property boundary and campus security.

Challenges

JHU’s parking facilities and use patterns indicate issues may emerge around juggling implementing visible and accessible EVSE infrastructure and managing the demand for premium parking spaces. This hints at some disadvantages associated with tiered usage in the higher education cluster. Similarly, the university’s five 220 volt level 2 chargers are located in the visitors’ garage, which Bookhart describes as “not terribly convenient” to all likely destinations on campus or in town.

In addition, despite a clear marketing opportunity for universities and colleges, the implementation of EVSE infrastructure will not be easy to monetize for this cluster. The competitive edge gained by the institutions in this type of marketing is against other schools in the same category; therefore, it does not win the institution additional tuition funds and acts more as an indicator of institutional values for prospective students than provides real service to the student body. Further, the potentially high cost of garage construction may result in location choices for EVSE that may not coincide with existing user behavior; for example, the receipt of a grant at JHU made it possible to install EVSE in the visitors’ garage, a parking lot located close to public facilities but far from campus buildings. As a result of these factors, EVSE parking facilities in the higher education cluster are likely to be operated on a break-even model.

¹⁸ Davis Bookhart, Johns Hopkins University, interview, July 11, 2012

Case Study: Ithaca College, Ithaca, New York¹⁹

Ithaca College is a mid-sized private college located in Tompkins County, New York. The college is situated on a largely residential campus with a student body of approximately 4,000, as well as 489 full- and 260 part-time faculty and 1,085 non-faculty staff members. The college closely tracks its carbon emissions and actively engages in initiatives to reduce its environmental impacts.

The campus conversation regarding EVs has been driven in part by the school's growing sustainability profile—many students “are drawn to the college because of its green branding”—and an internal insistence that EVSE deployment be a part of the planning process for new facilities. Faculty members have also inquired about charging station installation in or near faculty lots.

The campus has 13 designated on-site parking lots, not including a residential complex. Employees are provided with free parking on campus and approximately 70% of drive to work. Students pay a fee for on-campus parking and their spaces, and a majority of students pay for this privilege. The collected revenue from these fees is an important profit center for the college, and a fee-based system for guests and staff is currently under consideration. Additionally, significant numbers of visitors come to campus for night classes, conferences and use of the library, the pool and gym.

The college has so far installed EVSE at three locations on campus. The first is located at the Circles Community Building, which opened in August 2012 and principally houses upperclassmen. It is the most expensive student dormitory on campus and it sees high rates of car ownership among its residents. The college has not decided on a charging scheme for the building's EVSE. This must be decided before the college can plan new EVSE deployments

The second is located at the LEED Platinum-certified home of the Park School of Business and Sustainable Enterprise. This building draws visitors from beyond the campus for conferences and special events, but its EVSE has seen very little use. As with all LEED-certified buildings on campus, “low emission vehicle” spots are designated nearby.

The final EVSE is located at the Grounds and Maintenance building which also hosts EVSE for the college's small fleet of neighborhood electric vehicles from Global Electric Motorcars. These vehicles are principally used by students for campus projects—the garden club, for example, uses them to transport student members and supplies to a community garden off campus.

Faculty buy-in is seen as essential for encouraging the college to deploy additional EVSE units, and incentives geared towards them are seen as the most effective way to increase EV ownership and usage. Faculty members are seen as ideal EV users, with high current Prius ownership, on-campus dwell times of approximately eight hours, and average commute distances to campus of 17 miles according to the 2011 College Climate Action Assessment.

The college owns approximately 30 vehicles—roughly 15 passenger vehicles and 15 vocational/cargo vehicles. Though vehicle purchases are viewed as marginal to the college's overall sustainability planning, public goodwill and perception are helpful to the college. Incorporating branding on Ithaca College-owned electric vehicles would be of great value to the college and its sustainability profile.

¹⁹ Michelle Jones, Ithaca College, interview, November 20, 2012.

FLEET AND FREIGHT CLUSTER



The commercial **fleet and freight cluster** is complex and offers vast potential because it provides long-term financial benefit to fleet operators as well as local environmental benefits to communities. Fleet vehicles deliver products and services in the public and private sectors throughout the TCI region.

Cluster Geography: Service Areas Determine Viability and Distribution of Benefits

Any company, institution or government agency with a fleet of professional vehicles is considered part of the fleet and freight cluster. University campuses that use EVs as security or utility vehicles are a great example, as are New Jersey's plug-in hybrid police cruisers. Major freight delivery companies employ EVs in their fleets, including FedEx and UPS—two examples that have impacts on the entire TCI region. The case study in this section highlights Frito-Lay's operations in a major metropolitan area. Many more localized examples exist as well. In New York City, Duane Reade drugstores will soon roll out a pilot adding five EV delivery vehicles that will serve specific stores. In each case, the fleet and freight cluster geography is defined by the route.

Fleet vehicles with zero tailpipe emissions offer environmental benefit directly to the communities the fleets serve. Air quality issues are particularly severe in densely populated urban areas and main transit corridors, many of which are considered "non-attainment" areas by the U.S. Environmental Protection Agency (EPA) due to their inability to meet certain federal air quality standards.

A consideration for EVSE in the fleet cluster is the potential need of EVs to access mid-route charging or lane designations that help EV vehicles reach their destinations without wasting charge. At present, EV fleets are best suited for the dense service areas that their emissions reductions most benefit.

User Behavior: Defined Routes Vary by Vehicle and Use Type

Fleet vehicles perform a variety of tasks; driver behavior will vary widely, depending on whether vehicles are deployed on delivery routes or for other applications, such as maintenance, security or sanitation. For deliveries, route length, typical store size, payload and unloading time (the commercial equivalent of dwell time) impact use decisions. For example, "bulk delivery" trucks deployed in urban areas have an ideal profile for EVs; the more numerous "Town or Route Delivery" trucks are still best served by conventional gasoline and diesel engines. Bulk delivery routes may offer opportunities for range-extension charging in route, enabling less dense cities to be considered for EV deployments. Overall, the types of commercial vehicles that are well suited to be replaced EVs are those with fixed routes of less than 50 miles, and "domiciled" at a single location.

Cluster Operations: Calculable Fuel Savings May be Limited by Technology

Fleets are a prime candidate for EV deployment because their defined routes offer calculable fuel savings. Commercial fleets may experience a variety of transition issues in replacing fleets. First, fleet managers will aim to minimize impacts on a distribution network, which may mean ruling out EVs for certain routes until battery technology improves or in-route charging is in place. Second, the lack of appropriate technology (e.g., EVs capable of delivering a firm's typical payload) may limit applicability at the present time. Third, fleets employing EVs may find that hardware, battery and maintenance costs remain high. An additional operational consideration for fleets is the need for a one-to-one ratio of EVSE to EVs for overnight charging.

Beyond vehicle type, company type is also important. Unlike FedEx or UPS package delivery services, where vehicles moving products are the source of profit, manufacturers such as Frito-Lay profit based on the sales of their products, with the means of distribution adding to operational costs.

Government fleets also present strong conditions for EV deployment, though cash-strapped states and municipalities may find it difficult to justify purchasing vehicles with initial costs approaching twice that of conventional vehicles. Introducing EVs into public service is also a way to publicize their use, encouraging greater consumer adoption in areas where fleet EVs are already a presence. Public transit buses, agency vehicles and parks maintenance are just a few examples of current and future opportunities. In many cases, the EVSE these vehicles require for overnight charging can be offered for public use during daytime hours.

External Influence: Ongoing Subsidies Needed

Geography, density and topography are determinants for applicability of fleet EVs and range-extension charging locations. For example, cold weather conditions, hills and highway driving will determine “best fit” routes for electric trucks. Other external factors include customer demand for green transport and lowering emissions, making EVs a good sustainability strategy for meeting emissions reduction goals as well as green branding for the company. Lastly, the availability of subsidies and programs to support this cluster will be particularly important for its growth. The high cost of EV trucks of all sizes may still be prohibitive, especially for small businesses that have less upfront investment potential. Subsidies and tax benefits have been important for EV uptake among fleet managers.

Benefits: Dual Impact of Fuel Savings and Air Quality Improvements

Fleet managers and initial studies indicate that EV fleet vehicles (e.g., Smith-Newton trucks) produce 70%–75% fewer GHG emissions than traditional gasoline and diesel vehicles, based on utility averages.²⁰ This is a strong measure of benefit, but it does not capture the impacts witnessed by local communities from the reduction in tailpipe emissions. Frequent truck trips to distribution hubs and commercial centers by conventional delivery vehicles result in significant negative externalities in surrounding communities—externalities that can be mitigated through aggressive and targeted subsidy programs. Targeting commercial fleets for EV use and EVSE deployment allows government to direct incentives, credits and capital toward the elimination of the most polluting vehicles on the road. Subsidizing fleet conversions can both reduce the commercial fleet carbon footprint in a given community and eliminate the transportation-related particulate matter that poses significant health risks to vulnerable populations.

Summary

For fleets using EVs, the benefits accrue not just for fleet managers who are able to plan for long-term fuel savings, but also in the communities they serve. Reductions of tailpipe emissions of GHGs and other pollutants from EV-use can dramatically decrease health risks, but the effect is greatest among fleet vehicles, especially older models, which are the worst polluting vehicles on the road. External influences, such as cost, model availability and fleet regulations based on air quality impacts represent the most important determining factors for EVs’ viability in this cluster. Secondary drivers of viability include suitable routes, local benefit, sustainability missions, and branding opportunities.

²⁰ Percentages from National Grid for the New York metropolitan area. Source: Steve Hanson, Frito-Lay North America, interview, July 6, 2012.

Case Study: Frito-Lay, Bronx, New York²¹

Frito-Lay is a multinational food processing corporation that relies extensively on large-scale fleet operations for sales and distribution of its products. The use of EVs as an alternative fuel fleet vehicle is part of a corporate strategy that considers multiple possible routes to emissions reductions, including fuel sources and vehicle design. Frito-Lay distribution facilities in five cities house a total of 47 electric-drive Smith-Newton delivery trucks, with an additional 40 vehicles expected to serve an expanded delivery range by the end of 2012.

Fuel Displacement and Efficiency

Battery technology and vehicle range are important efficiency considerations for fleets. Fixed routes and “right-sized” batteries may mitigate the need for range-extension charging along truck routes in dense urban areas. For Frito-Lay’s Bronx-based fleet, equipment costs, the local subsidy regime and route lengths determined the choice of a specific battery pack size. In its first five New York City delivery trucks, Frito-Lay deployed battery packs with a capacity of 40 kilowatt-hours, enough for 28-mile routes. Frito-Lay finds its GHG-emission reduction efforts have been even more effective than the New York metropolitan area average—with realized reductions of 90%. Company-wide, the EV delivery fleet has displaced 280,000 gallons of fuel.

Implementation of the company’s “dynamic routing” model in these areas may require opportunistic charging at delivery locations. The 2.5–3 hours of unloading time that Frito-Lay allocates per stop on bulk delivery routes may offer opportunities for range-extension charging, enabling less dense cities to be considered for EV deployments by the company. Still, not every market or route will work with current technology at a feasible price. Frito-Lay’s fleet managers have ruled out EVs for 10% of their routes.

Installation Considerations for Fleet Cluster EVSE

Their first EVSE in the New York City area did not require a permit, because of the industrial location’s existing electrical capacity (such locations often benefit from pre-existing heavy power). Working with two electrical firms for scoping and engineering work, Frito-Lay installed EVSE at a one-to-one ratio to its new trucks. Frito-Lay’s per-unit EV infrastructure costs ran as high as \$25,000 initially, over time falling to \$20,000, with funding provided by the New York State Energy Research and Development Authority and the U.S. Department of Energy. Frito-Lay has expressed interest in separate EVSE electrical service and meters to avoid extra demand charges and participate in utility programs such as demand-response.

Corporate Benefit Meets Public Benefit

Frito-Lay brought electric trucks to New York City to “make a statement in the largest city in the U.S.,” though has been helped by EV and EVSE funding through New York State. Frito-Lay indicates that voucher-style grant funding is most effective in inducing EV fleet conversions for its operations.

At least two Frito-Lay customers in the supermarket sector have issued sustainability goals and guidelines for their suppliers. Frito-Lay suggests tracking these guidance memos as they may provide an approach to identifying prospective early adopters in a given supply chain as well as EVSE locations with a high probability of regular utilization. At some delivery locations, individual store managers liked the EV initiative enough that they provided more floor space for the company’s products. Frito-Lay has also found the electric truck is an advertisement for the company’s green initiative during unloading times.

Frito-Lay presented clear reality for publicly traded companies that must demonstrate economic viability and return on investment. Because of high costs, companies cannot be green for the sake of being green. Frito-Lay anticipates that “EV cost parity with diesels [is] five years out.” Recognizing the cost disparity in the short term, fleets are an ideal context for ongoing incentive funding to aid the private sector in meeting costs that are still prohibitive.

²¹ Steve Hanson, Frito-Lay North America, interview, July 6, 2012.

LEISURE DESTINATION CLUSTER



The **leisure destination cluster**, representing a wide array of sites across the region and an equal number of different activities, presents strong opportunities for EV charging when markets—and marketing plans—align with institutional interests.

Cluster Geography: Regional Destinations

The leisure destination cluster includes a range of destinations and activities, including stadiums and performance venues, such as those profiled in the case studies in this section. However, more broadly, leisure destinations are places that visitors are willing to travel a bit longer to reach because they expect to spend time participating in and enjoying an experience. From the art-house cinema in a New England town to an ice hockey arena in Long Island, from zoos to museums to amusement parks, venues large and small with regular and varied schedules; destinations for arts, culture, sports and nature are all included in this cluster.

User Behavior: Longer Dwell Times Support EV Charging

This cluster is characterized by longer visitor lengths of stay (from three hours to overnight), and the potential for visitors willing to travel longer distances than for retail. As a result, range anxiety plays a role in whether visitors demand EVSE. Use patterns that relate to event schedules or seasons help to inform the proper scope of EVSE installations in this cluster. These characteristics may also group venues such as convention centers and destination shopping malls into this cluster.

The EVSE consumer may not only be visitors, however. Leisure destinations are often employment centers, and they periodically accommodate vehicles owned by performers, athletes or other talent professionals who are early EV adopters.

Cluster Operations: Heavy Traffic with Seasonal Limitations

Management issues are the most important consideration for leisure destinations. Parking facilities most appropriate for EVSE in this cluster are usually for dedicated use and employ traffic and parking attendants. However, other locations, such as state parks, may have limited parking amenities. In many cases, these venues already draw significant power from the grid, and the addition of EVSE does not strain systems. Leisure destinations have great variation in seasonality, operating hours and schedules, and as such, EVSE use varies accordingly. However, the predictability of use and large volumes that such venues offer yield advantages for energy use and market capture.

External Influence: Trade Areas and Patron Preferences Determine Viability

Geography and driving distance is the critical factor for leisure destinations, as it relates to both range anxiety and the physical limitations of battery technology. Certain leisure destination cluster locations, such as those within urban



Figure 10 : EVSE at FedEx Field in Landover, Maryland (Source: www.teslamotorsclub.com).

centers that provide a regional draw, may offer convenience or “peace of mind” charging. Locations in the leisure cluster often have relationships with trade associations that bring large traffic volume on a set schedule or seasons of heavy use.

Many locations in this cluster have an appeal that cuts across demographic lines, but certain venues may be identified as strong candidates for EVSE based on a significant number of patrons representing the early adopter profile: affluent, more urban or suburban and interested in the environment.²² Demographics, geography and fuel cost may combine, for example, to identify vacation island destinations as good leisure cluster candidates for EVSE.

In addition to geographic and demographic patterns of use, policy considerations may be important for venues—such as the Camden Yards stadium complex in Baltimore, Maryland, further explored in a case study on the following page—that operate under a state authority.

Benefits: “One Charge Away”

The leisure destination cluster may benefit from sustainability planning and marketing, as well as the cachet brought by early adopter clientele attracted by an EVSE amenity. Leisure-time destinations 50–75 miles (within EV range) from population centers can rebrand and repurpose themselves as EV destinations for early adopters. Vacation venues marketing themselves as “one charge away” could ignite a revival of close-to-home vacation destinations. As such, hotels may be ideal locations that allow a host to capture value associated with EV charging, while providing an opportune location for overnight charging.

The most significant benefit of EVSE to leisure destination hosts may be the branding and joint marketing opportunities that venues can share with advertising partners.

Summary

As commercial and cultural destinations providing an amenity, leisure cluster locations depend on user behavior factors to determine sites, level of charge and scope of EVSE installations, whether for visitors, staff or talent. Once a market has been determined, either to serve or attract with EVSE, secondary considerations include how best to incorporate management of EVSE into on-site parking management. Finally, EVSE offers excellent branding opportunities and potential for marketing revenue.

²² The document *Assessment of Current EVSE and EV Deployment* identifies more early-adopter characteristics.

Case Study: Camden Yards Stadium Complex, Baltimore, Maryland²³

Baltimore's Camden Yards stadium complex is home to two major league sports teams: the Baltimore Orioles and the Baltimore Ravens. In total, the complex covers 92 acres and includes two stadiums—Oriole Park and M&T Bank Stadium; a mixed use “warehouse” facility with retail, office and distribution; the Babe Ruth Museum; a hotel and a convention center. The Maryland Stadium Authority (MSA) manages the complex and parking infrastructure. Located within walking distance of the city's Inner Harbor—the historic port district that has been held up as a model for waterfront revitalization projects—the Camden Yards stadiums attract millions of annual visitors.²⁴ The location has strong transportation options, including good highway and inner city driving connections and, significantly, a stop on the MARC light rail system.

Stadiums present a unique scenario of low regular parking use combined with regularly scheduled heavy use. On a daily basis, approximately 340+ cars (including those belonging to the 65 regular full-time employees who work at the stadiums and the 300+ cars in lots serving other users) are parked in the lots controlled by the MSA, which has a total of 4,500 spaces in seven lots. Most employees live within 25 miles of the complex, and on game and event days, fans travel from throughout the state and as far as southern Pennsylvania.²⁵ Surface parking lots may have multiple uses at such facilities; M&T Bank Stadium uses its parking to extend programming, including 10 football games and 200 catered events a year, as well as concerts and high school proms. The flexibility required of the event spaces may restrict the number of viable locations for EV charging.

The Right Thing to Do

Currently, green branding is not strongly associated with both teams' marketing strategies, and with “every game a choreographed show,” EVSE would need to be incorporated into a marketing campaign leveraging automakers, for example. The MSA has expressed interest in the potential behind extending sustainability initiatives, which include applying for LEED certification for existing parking facilities. According to the MSA, EVSE is an appealing idea for real sustainability reasons: “Not for LEED points, not for government...we are centrally located near highways. This is the right thing to do.”

Centralized Stadium Authority Has Many Options to Capture Early Adopters

The MSA sees further potential for EV charging in the players' lots, an interesting concept for providing EVSE to early adopters that could be applied to other similar venues that provide parking for talent.

Because of the multipurpose/multi-tenant scenario at the complex, several of the lots that serve adjacent facilities, such as the University of Maryland, Baltimore campus, the mixed-use warehouse, hospitals and other businesses in the area, are 50% utilized on non-game days, indicating a regular group of drivers for EVSE. Integrating a commuter cluster scenario at the MARC train station to share costs and use is another opportunity. Despite a multiplicity of tenants throughout the complex, the MSA provides an organizational hub for coordinating infrastructure improvements. The market for EV charging may not be significant enough for any one tenant to provide it, but together, the MSA could plan for EVSE deployment that serves all tenants. The MSA is well positioned to balance needs across the complex.

²³ Jeff Provenzano, Maryland Stadium Authority, interview, July 2, 2012.

²⁴ M&T Bank Stadium brings an average of 65,000 visitors to each professional and college football game: Caber, Towson University and Stage Policy Group, Inc., *The Impact of M&T Bank Stadium on Maryland's Economy* (Maryland Stadium Authority, August 2007), <http://www.mdstad.com/images/stories/ravens407.pdf>

²⁵ National Household Travel Survey, “Average Vehicle Trip Length (miles, Travel Day) Average Vehicle Trip (VT) Length by Purpose,” Federal Highway Administration, U.S. Department of Transportation, 2009, http://nhts.ornl.gov/tables09/fatcat/2009/avtI_WHYTRP1S.html. According to the 2009 National Household Travel Survey, which is the U.S. inventory of daily travel, social or recreational vehicle miles traveled account for only about 8.4% of daily vehicle travel. However, U.S. drivers are willing to travel, on average, greater distances for social or leisure purposes than for other catalogued reasons. Americans travel an average of 15.8 miles (one way) for recreation, longer than they travel, on average, to work (13.4), school (9.3), shopping (6.2), or medical facilities (10.3).

Case Study: Tanglewood, Lenox, Massachusetts²⁶

Tanglewood is a music venue located on an estate in Lenox and Stockbridge, Massachusetts, in the Berkshires. Operated by the Boston Symphony Orchestra (BSO), the venue hosts primarily classical music performances. It is home to the annual Tanglewood Music Festival.

Tanglewood's parking facilities accommodate up to 5,000 vehicles at a time and the venue sees between 300,000 and 350,000 patron visits annually, generating about 100,000–150,000 parked cars each year. As a rural destination, Tanglewood's 15 parking lots are grass covered.

During the summer season, 700 employees also add vehicles to the mix. An estimated 95% of employees drive to work. Yet despite this volume, the short season for the venue directly impacts the level of demand and return on investment.

Patterns of visitor use at the venue depend strongly on the day of the week, with weekends being the busiest times. Events are scheduled all day, making parking a necessity morning to night.

During events, patrons park on average for six hours, while staff vehicles may be parked for 12 hours or more. Tanglewood predominantly draws visitors from its home state of Massachusetts, as well as from Connecticut, New York and New Jersey. Since a significant proportion of these patrons are traveling distances beyond current EV ranges, EVSE in visitor lots would only be useable to a subset of current and potential EV owners. Meanwhile, staff members generally travel a total of 10–15 miles per day, distances well within EV range.

Despite the high likelihood of matching the demographics of early adopters, Tanglewood has not yet received any inquiries into installing EV charging facilities at the venue from visitors or staff. As a result, there is no economic incentive at present for the venue to act on EVSE, despite seeing an environmental and goodwill benefit. However, the increasingly prominent presence of hybrid vehicles at Tanglewood's facilities in the past three years, including among staff members, may be an indicator of future EVSE demand. Facilities Manager Bobby Lahart indicated that the strongest opportunity may be for staff parking.

Another challenge for EVSE installation at a venue such as Tanglewood is the maintenance that would be required during the offseason, which is during the winter. Lahart notes that only those lots and interior roads that are in use are plowed during winter months.

However, year-round maintenance and electrical capacity for facilities use, based on the current location of electrical panels, may indicate an opportunity for this or similar venues to consider EV fleet vehicles. Currently, Tanglewood has several Global Electric Motorcars vehicles in its fleet. However, according to Lahart, "The jury's still out on EVs due to [their] limitations. Jitneys run for 12 hours and must travel to the remote lots" at the facility to shuttle patrons. Although there is interest throughout the Tanglewood and BSO organizations in minimizing the carbon footprint, the right opportunity to incorporate EVs may be far into the future.

While Tanglewood's concern with its carbon footprint is real and an important fact to represent to the public, EVSE and EV deployment will depend on demand from the public and, potentially, employees.

²⁶ Brian Lahart, Tanglewood Performing Arts Center, interview, July 17, 2012

REGIONAL TRANSIT CLUSTER



The **regional transit cluster** presents planners of EVSE a direct opportunity to incorporate EVs into a regional transportation network, increasing the overall sustainability by removing legs of commuters' journeys that are still powered by petroleum. Bringing EVSE to regional rail stations, park-and-ride lots and other transit hubs makes EVs a component of the intermodal transportation system, increasing EV viability for drivers who live farther from public transit stations. Siting EVSE at these locations has the potential to encourage public transit use among EV adopters and thus reduce overall VMT.

Cluster Geography: Regional Hub Connects Modes of Transportation

The regional transit cluster is composed of commuter rail stations, park-and-ride lots, bus depots, regional rail hubs and end-of-the-line subway stations, among others. Regional transit cluster destinations are nodes connecting the intermodal transit connections within a regional market.

User Behavior: Round-Trip Commutes and Full-Day Use

Parking lots at intermodal facilities are fertile venues for EVSE deployment due to regular travel behavior and relatively short distances from the home. Regional transport cluster charging is logical from the perspective of developing a network, but it may be best in terms of offering "peace of mind" or emergency charging with a predictable location pattern. As noted previously, EV owners are more likely to charge at home, overnight where possible. Yet these facilities can also serve as primary charging locations for EV owners whose homes present more challenging EVSE installation scenarios, such as multi-family buildings and older homes more frequently found in the TCI region than other parts of the United States.



Figure 11: Solar canopy with EVSE at light rail station in Portland, Oregon (Source: Portland Development Corporation).

The typical dwell time for this cluster is the duration of the workday. Dwell time for traditional commuters may make this cluster a challenge for monetizing investment because of the inefficiencies associated with providing EVSE at high-traffic locations where only a limited number of vehicles will remain plugged in all day. Because of the long dwell times, level 1 EVSE are likely sufficient in this context.

Cluster Operations: Transit Hub Typology Determines Patterns of Use

The dwell time/efficiency issue is a challenge that can be taken up through new business models or parking management. Traffic to regional transit cluster locations will vary based on type; for example, end-of-the-line park-and-rides would experience less vehicle turnover during the day than multi-use municipal lots connecting to intercity public transit.

TODs integrate land use and transportation to minimize negative impacts and costs; newly planned TODs should seek to incorporate strategically located EV charging infrastructure in their design. This type of

new development strategy can help link public transit to intermodal EV connections for commuters traveling by EV to a transit hub from neighboring towns.

Ease-of-procurement opportunities exist in areas where a transportation authority or railroad is in charge of commuter parking. Difficulties may arise where commuter lots are in the hands of every separate town along a rail line. Similarly, owner/manager relationships, such as those at many lots along the New York metropolitan area's Metro North Railroad, profiled in the case study in this section, may involve more than one party, requiring different types of business models or installation scenarios from lot to lot within the same regional transportation network.

External Influence: Successful Hubs Will be Located in Strong EV Markets

Because the cluster is centered on the idea of the transit hub, user demographics and local geography will play important roles in terms of choosing sites within the regional transit cluster for EVSE deployment. First, the hub must serve likely adopters of EVs in order to be successful. Secondly, the distance traveled by commuters to their public transit connection will determine whether EVSE will be required for the typical commuter to consider EV adoption based on round-trip range. In addition, plans and policies favoring EVs from within the local transit authority or government can help identify EVSE as an opportunity to meet environmental or other goals.

As with workplace cluster locations, a challenge to capturing value in this cluster is that EV charging would coincide with peak daytime demand, representing not only a higher cost per charge but also an increased burden on local utility transformers.

Benefits: Enhancement of EVs' Role in Regional Transit System

Regional transit cluster locations face challenges with efficiency but remain a clear opportunity to connect EV drivers with public transit, which is an important part of incorporating EVs into regional transportation networks and planning. Prominently located EVSE will be seen by thousands of people each day. EVSE deployment at commuter rail stations may also build ridership for transportation authorities due to increased options and sustainability marketing. In addition, commuter rail stations may present an incentive for individuals without home EVSE access to consider an EV, especially where opportunities exist to develop shared 24-hour parking scenarios, such as in transit garages adjacent to multi-family housing in a TOD.

Summary

The regional transit cluster is less oriented toward one or two primary categories of assessment criteria. In general, the presence of user behavior that generates demand for EV charging is most critical. The number of vehicles and the distance traveled will help scale installations in this cluster. The existence of strong trends in multiple directions indicates that the regional transit cluster may require policy direction to spur EVSE deployment.

Case Study: MTA Metro-North Railroad, New York and Connecticut²⁷

The Metro-North Railroad (Metro-North) is a commuter rail service run by the Metropolitan Transportation Authority of New York State, in cooperation with the Connecticut Department of Transportation. As the busiest railroad system in the country, Metro-North serves nearly 280,000 passengers each weekday. The system includes on 121 stations on six lines, covering 765 track miles in two states.²⁸ This wide ridership combined with limited capital funding for new projects and a genuine interest in expanding sustainable, consumer-friendly options and reducing impacts, highlights many of the internal organizational tensions that can arise when interest and capacity do not completely align.

Metro-North owns approximately 40% of the nearly 130 parking lots connected to their stations, though it does not operate any. These lots range in size from 50–2,000 spaces. The remaining parking facilities are owned and operated by local municipalities or New York State. The ownership and management structure of parking at Metro-North stations presents some data collection issues because not all of the stations are operated by the same entity.

Metro-North sees opportunities to prioritize locations within the commuter rail system. Local predisposition to EV adoption would be one factor, while park-and-ride lots operated by the New York State Departments of Transportation make for strong candidates. The distances of the first and last legs of commuters' daily commutes vary considerably throughout the system, but in general tend to be longer further from New York City. In lower Westchester, directly north of New York City, driving distances are shorter, while in Putnam and Dutchess Counties, and west of the Hudson River, 30-minute drives to the stations are not uncommon. Current EVSE Projects

Metro-North has already begun taking steps toward incorporating EVSE into five stations through a NYPA-funded pilot project.²⁹ The charging stations at Cortlandt³⁰ and Tarrytown stations are solar powered and represent a fraction of the potential available funds through the NYPA pilot, which could fund up to eight additional locations with up to eight EVSE spaces each. Space availability is the top consideration for determining which stations will receive chargers as part of the pilot; Metro-North and parking partner LAZ Parking view sacrificing spaces in crowded locations as a non-starter. EVSE paired with solar panels require additional considerations—the need for sites with adequate sun exposure is the primary concern. Sets of ten EVSE have been installed through other NYPA-funded pilot projects at the Brewster North, Chappaqua, North White Plains and Southeast stations.

Capacity and Utilization

Metro-North reports that for LAZ-operated facilities, parking utilization ranges from 73%–80%, depending on the fee structure (permits and meters, respectively). Because some lots are located in central business districts, those with excess capacity are often utilized by off-peak customers during daytime hours, though this usage is not necessarily encouraged by Metro-North. Echoing concerns widely expressed in other contexts, Metro-North regards parking or charging restriction enforcement as a challenge. Currently, few LAZ facilities offer designated parking spaces.

Outside funding and expressed customer demand would be the primary motivators for additional resource expenditure on electric vehicle infrastructure. Given the current constraints on capital funding within the organization, it is unclear whether Metro-North or the MTA would be able to invest its own

²⁷Wendy Johnson, Todd Lange and Phillip Petillo, Metro-North Railroad, interview, August 9, 2012.

²⁸ The Weisman Center for International Business Zicklin School of Business, "Table 12.II.E," Baruch College, February 29, 2012, <http://www.baruch.cuny.edu/nycdata/travel/metronorth-stats.htm>.

²⁹ The NYPA/MTA EVSE pilot project will run for a period of five years, after which the MTA can decide whether to maintain the charging stations. The maintenance for the EVSE is provided free of charge during the pilot.

³⁰ Cortlandt, NY is home to a new "green community," and the station also features new premium hybrid spaces for permit-holding commuters.

resources for encouraging EV usage. In this light, Metro-North identified grant funding as the most instrumental incentive, in conjunction with technical support.

Green Standards for Growth and Renovation

In addition to its limited pilot projects, Metro-North uses its Green Guidelines and Checklist for any facilities it builds or expands. The existing guidelines account for charging stations as an option in the design phase of station renovation planning, indicating a preparedness and interest when and where funding is available. Metro-North representatives agreed that the incorporation of additional EVSE would support the railroad's sustainability mission and contribute to the green branding of the railroad and its facilities, while also better serving the its ridership. Metro-North also encourages an intermodal transit strategy, but it views EVSE as only somewhat helpful in integrating intermodal transportation.

Metro-North recognizes its essential role in encouraging the early adopter. "Commuters are the key" if widespread EVSE deployment is going to happen, and Metro-North can facilitate early adoption. Commuters are the key.

MEDICAL CAMPUS CLUSTER



The **medical campus cluster** focuses on opportunities for targeted EVSE deployment in high-traffic areas that serve professional communities that match early adopter demographics. Despite the potential for early adopter use, at present, the total number of EVSE locations within the medical campus cluster is relatively small—just 15 locations, or 3% of the total regional publicly accessible EVSE. Because medical campuses typically rely on revenue from parking facilities to support related staff and maintenance, market factors are likely not yet in place for this cluster.

Cluster Geography: Defined Geography with Dispersed Facilities

Similar to the higher education cluster, the medical campus cluster has a defined geography. Similar to the downtown cluster, this cluster likely includes many different parking typologies. Parking facilities may be dispersed throughout an urban area, such as Philadelphia’s University City hospitals, or Boston’s Longwood Medical and Academic Area, profiled in the case study in this section. Alternately, the campus may be more isolated and well contained for security purposes, such as the National Institutes of Health in suburban Maryland. For the purposes of this report, the medical campus cluster includes individual hospital and outpatient medical facilities, medical and biomedical research institutes and multi-institution medical campuses.

User Behavior: Early Adopter Hub

The strong perception of an early adopter community among medical and scientific researchers, faculty and staff makes the availability of EVSE in medical campus cluster parking lots a key amenity that campuses may be willing to offer. The medical and engineering professions have been identified as likely early adopter indicators; the consumer profile of many hospital staff and researchers makes medical centers a key location for EVSE deployment that can both serve existing needs and raise awareness. At these institutions, the primary market is represented by staff, not patients or visitors, based on both user demographics and behavior, including intensity of use and dwell time. Overall, campuses are also places where political and consumer profiles meet. Physicians and researchers working at a facility would seek at-work charging opportunities for 8 hours or more.

Cluster Operations: EVSE Adoption will be Demand Driven

For larger, particularly urban medical cluster locations, managing operations of shared parking facilities will absorb staff time and resources. Facility ownership will play a role in determining the best locations for EVSE within a cluster location’s parking. Because parking fees, charged monthly for employees or hourly for visitors and patients, are often profit centers for medical institutions and facilities managers, EVSE will not be placed in highly visible locations that impede other users.

Due to the 24-hour operation of hospitals and many medical facilities, the medical cluster may be the primary charging location for some users, particularly for staff working overnight, with users benefiting from off-peak utility rates.

Use of fleet vehicles for emergency and patient transport is a growing opportunity as appropriate vehicles hit the market (e.g., emergency and patient transport vehicles and visitor and employee parking shuttle buses).

External Influence: Employee Travel Patterns May Influence Long-Range Facilities Plans

Medical campuses will likely have master plans or other long-term development strategies that will need to be updated to include EV planning. Geography and demographics do not present particular opportunities or challenges, but awareness of driver behavior (i.e., average VMT of commuters) may help planning for EVSE because facilities in the medical cluster are regional destinations.

Benefits: Uniting Ideas about Public Health

Medical campuses are economic engines, bringing together the resources of academic, research and other related organizations. There is an opportunity to highlight EV benefits to a broad audience in this context. As high-traffic locations, reduction of air and noise pollution make medical campuses better neighbors. While direct public health benefits will likely not be realized in this cluster, including EVSE as part of an intermodal employee and visitor transportation system in the medical campus contexts can send the right message about environmental health.

Summary

The medical campus cluster provides an early adopter market that may grow to demand workplace charging opportunities at hospitals and research centers throughout the TCI region. Factors that make this cluster work for EVSE are primarily operational—parking management and internal demand. However, clear associations with the economic function of medical campuses, their likelihood of strong sustainability goals and their association with public health issues are also key factors.

Case Study: Longwood Medical and Academic Area, Boston, Massachusetts³¹

Boston's Longwood Medical and Academic Area (LMA) comprises a unique concentration of 24 institutions representing medical, academic, research and cultural organizations that draw more than 105,000 people to the combined campus every day. Located on a 213-acre site three miles outside of downtown Boston, the LMA is a prime example of the **medical campus cluster**. The Medical Academic and Scientific Community Organization (MASCO) was founded in 1972 to plan, develop and enhance the LMA, and it includes members from 24 area institutions.³²

In its development role, MASCO operates the LMA's parking facilities. Its portfolio includes 3,500 regional, off-site park-and-ride spaces exclusively for LMA employees; a 750-car owned and operated garage in the LMA for regular use, primarily by patients and visitors; weekday leased parking at Fenway Park, for which MASCO provides shuttles for employees and several additional outdoor leased lots of various sizes. MASCO manages parking facilities shared with Red Sox fans, local residents and businesses. Revenue is an important factor in all of MASCO's parking facilities operations. Parking fees both contribute to revenue and lessen idle time in spaces, increasing user turnover and efficiency.

MASCO also monitors usage and transportation patterns within the LMA, which has recently experienced some important shifts toward more sustainable transportation habits among commuters including a high level of use of public and alternative transportation. LMA has shown that drive-alone commuting dropped by 20% between 2000 and 2008, with 6% more staff members biking and 9% more staff members using mass transit to get to work. In addition, operators at MASCO parking facilities have noticed a significant number of Priuses, and, while no clear critical mass of early adopters has been reached for hybrid use, there has been a noticeable increase in hybrids in the last 3–4 years—an important finding when considering the pace of EV adoption in the same area.

Into this mix, MASCO has added "EVE," the "Electric Vehicle Energizer" that was installed in the fall of 2011. EVE is one dual unit provided by Coulomb and installed by a MASCO electrician. The system was fully operational in February. At the time of the interview, one driver was utilizing the EVSE. MASCO opted to install the unit one parking deck level below grade, pointing to hesitance to install the EVSE in prominent locations that would impede use of highly accessible spaces for non-EVs. MASCO stressed that parking is at a high premium in its facilities, and that management would be unable to absorb lost revenue on monthly spots if they were designated for EV-only use at present.

Nonetheless, MASCO is thinking ahead to the future market it would seek to serve in its parking facilities. Personnel are at the top of the list. Visitors are seen as "not consistent enough" for a full charge to be possible. Currently, anyone with monthly parking access can use the existing charging station free of charge, because of MASCO's two-year commitment to provide free charging through the Coulomb ChargePoint grant that provided the unit. An important future consideration for MASCO's aging off-site facilities is that they would all require rewiring to accommodate necessary electrical capacity for EVSE. Because of MASCO's leasing relationships, this would have to be done in partnership with site owners.

An additional opportunity for expansion into EV use would be to incorporate EVs into MASCO's fleet, which includes 39 shuttle buses and one additional vehicle in service of the parking facilities. The bus fleet uses ultra-low diesel, supported by a 2002 EPA grant. When new buses are scheduled to be purchased in 2014, the organization will consider hybrid electric vehicles, as there are few current options for plug-in vehicles.

³¹ David Eppstein, Medical Academic and Scientific Community Organization, Inc., interview, July 10, 2012.

³² For more information the LMA, see: <http://www.masco.org/system/files/downloads/thelma/LMAfactsheet.pdf>

MULTI-FAMILY HOUSING CLUSTER



The **multi-family cluster** is a high priority for regulators and planners seeking to encourage EV adoption through EVSE deployment. There is a need to resolve outstanding issues associated with providing EV charging locations that are accessible to individuals who live in homes without dedicated garage access. Of EVSE locations identified for this study in the TCI region, only 3% are in multi-family housing developments. Because residential charging will be the primary source of power for EVs (unless commercial and transit clusters are able to make up the difference), this is an important market failure that should be corrected.

Cluster Geography: Multi-Family Housing Varies in Typology

The multi-family cluster includes any multi-unit dwellings. These dwellings may or may not have access to dedicated or shared parking facilities. In many dense urban areas, on-street parking is either the only or most ideal option for residents due to the high cost premium of city parking spaces. In buildings that do have accessory parking, facilities may be structured garages either above or below ground or surface parking lots. The typology of the parking structures (or lack thereof) will indicate the best approach to overcoming barriers to EVSE installation.

User Behavior: Adapting to the In-Place Consumer

The multi-family cluster poses the question of how development can adapt to a consumer that is already in place. This cluster will be concerned primarily with one type of user behavior and need: at-home, overnight charging. Evidence from interviews in this cluster indicates a willingness to develop or add EVSE to existing construction, provided the landlord sees a market or experiences specific requests from tenants.

Cluster Operations: Demonstrated Development Markets and EV Owner Tenure are Key Factors

The decision to include EVSE in multi-family housing is the responsibility of the developer or homeowner and will be driven by the developer's bottom line or immediate user need more than environmental or economic impact. Where landlord interest and markets coincide, high EVSE potential exists, but the ownership and structure of lots and garages in the multi-family cluster will sometimes create conflict. For example, some landlords contract out with parking management companies.

User tenure is a challenge in the multi-family cluster. For rental units, lost opportunity costs associated with designating dedicated EVSE



Figure 12: EVSE in the parking garage of The Fitzgerald, a 2011 multi-family development of the Bozzuto Group. (Source: SemaConnect <http://semaconnect.blogspot.com/2011/06/charging-landscape.html>).

charging spaces may be too high for developers. In denser urban areas with many multi-family units, designated parking spaces are not always a guarantee. In this case, the multi-family cluster will interface with the municipal cluster in order to provide equitable charging options.

A final operational challenge for this cluster is the ongoing question of how best to approach utilities and metering. The installation of split or smart metering would alleviate headaches around utility bills in shared facilities. In some areas, regulations about the resale of electricity would potentially pose problems for multi-unit buildings.

External Influence: Sensitive to Market Demands

The multi-family cluster is particularly susceptible to market, regulatory and policy forces. Outside of direct tenant or homeowner demand, there is little incentive in this cluster to build EVSE without subsidies or minimum EVSE parking requirements. Most incentives target incorporating EVSE in new development. A gap exists in policies that support bringing EVSE into existing multi-family housing; some jurisdictions are approaching this gap through codes and zoning.

Benefits: Developers Capture Value through Marketing to “Green” Residents, and Residents Access Overnight Charging

Developers can be incentivized to drive the market for EV adoption through programs such as tax credits and subsidies within this category of housing. Incentives through LEED points are one example—EVSE installation becomes a cost-effective way to increase LEED ratings.

In development marketing, EVSE infrastructure can be a draw for a certain type of consumer. Residents of new multi-unit dwellings with EVSE infrastructure may be more likely to consider adopting an EV—even if that infrastructure does not create a tipping point in terms of that consumer’s willingness to sign a lease. The “green halo” effect of EVSE infrastructure may increase the marketability of individual developments or entire communities, while integrating EVSE with high-tech infrastructure will make systems more efficient overall.

Summary

Cluster operations and the costs and benefits to developers, not drivers, will be the decision-making factors for the multi-family cluster. Developers may be independently interested in providing EVSE as an amenity, but without the demographics and demand, this EVSE cluster will continue to be slow to develop.

Case Study: Avalon Bay Communities³³

Avalon Bay Communities is a multi-family housing developer based in the Northeast, Mid-Atlantic and West Coast regions. The company's national portfolio includes approximately 34,000 apartment units in 111 communities, with East Coast properties in Washington, DC; Maryland; Virginia; New York and Rhode Island. Typically, Avalon Bay seeks to develop in tight urban or exurban markets, specializing in areas that include denser areas with high rates of population and rent growth that present challenges for other multi-family developers, a business model which contributes to the developer's bottom line.

With the focus on bottom line outcomes, Avalon Bay sees little incentive to build EVSE-ready lots or garages without either a subsidy or a requirement. Currently, just one Avalon Bay development, in Seattle, Washington, has EVSE installed. While Avalon Bay's residents fit many aspects of the early EV adopter profile—the typical resident is 25–50-years-old, college educated, with an average income of \$85,000—rental tenants' transient nature make EVSE or similarly substantial tenant-focused incentive a difficult value proposition without clear demand.

Tenant Demand Will Drive EVSE Deployment

To date, Avalon Bay's management has heard very little demand from tenants across the company's portfolio. Avalon Bay indicates, however, that tenant demand would "hold the most weight" in convincing the company to develop EVSE as a tenant amenity. At present, vendor interest is driving inquiries to the developer. Roughly 15% of cars in lots belong to non-residents, but Avalon Bay does not view these other users and demand-drivers.

Avalon Bay does cite a likely opportunity for EVSE rollout in the future, based on existing initiatives in providing lifestyle (i.e. nonsmoking communities) or sustainability (i.e. solar panels and Energy Star or LEED certification) changes. However adding cost is a key concern for any amenity, as it will ultimately be transferred to tenants. The threat of increased rents or parking fees poses a barrier to tenant demand.

The lack of developer initiative for a company that has a presence in the country's hotter EV markets may indicate a possible market failure that subsidies or scoping requirements for new development (such as through building codes or parking ordinances) should continue to support or amend.

Parking Typology and Urban-Suburban Divides

Construction costs for parking vary widely among markets and structural typologies. With construction costs composing the bulk of EVSE installations at present, providing EVSE in denser, urban areas with more enclosed or sub-grade parking structures may be far less feasible from a cost perspective. Further, getting less than optimal usage out of EV-reserved parking spaces may be untenable. Avalon Bay has developed a number of urban housing communities, with buildings of note including in Manhattan's Lower East Side, Downtown Brooklyn, Boston's Prudential Center and Center Place in Providence.

Mixed-Use and Co-located EVSE

Another key take away from the Avalon Bay case study is the potential to accommodate EV charging at mixed retail and residential parking lots. Such mixed-use and transit-orient development is of great interest to Avalon Bay. This is, however, not because of altruistic motives but because high-density areas that require mixed-use (such as by zoning, consumer preference or profitability of commercial rents) constitute the preferred markets for Avalon Bay's business model.

Avalon Bay is piloting car-sharing programs in a partnership with Zipcar that presents interesting long-term opportunities, both for solving multi-family development issues in terms of prioritizing placement of parking spaces, and for creating a private business-to-business partnership that can aid larger communities in incorporating EVSE into the urban landscape. Zipcar is currently in 14 Avalon Bay communities so far, with 52 available vehicles on both coasts.

³³ Lyn C. Landsdale, Avalon Bay Communities, interview, July 19, 2012.

SUMMARY

This study highlights nine potential EVSE deployment location types or “clusters.” Based on assumptions about market demographics and travel patterns, and substantiated by data from the TCI region Clean Cities Coalitions and government sources, many of the EVSE installations currently deployed in the region fall within these hotspot clusters or similar categories. Each cluster is impacted differently by common concerns regarding EVSE deployment: patterns of use; EVSE host facility operations; external influences such as demographics, local regulations and policies and benefits to private companies and the public. The case studies on the previous pages have profiled organizations, institutions and businesses either currently or potentially engaging in EVSE deployment within the TCI region. By looking closely at the qualitative criteria that impact the cluster case study locations’ respective processes of making decisions about EVs and EVSE, this study has identified several key opportunities and challenges that can help guide next steps in prioritizing the deployment of EVSE in the TCI region through policy, planning and financing.

Key Findings

1. **The market for EVSE deployment is reactive.**

Few clusters—as indicated by responses to case study questionnaires—revealed interest in proactively providing charging without outside funding. In fact, except for GE, which is itself an EVSE manufacturer, case study interviewees have not independently funded installation of EVSE to date. EVSE costs remain high in publicly accessible installation scenarios in particular, and cost parity for EV fleet and equipment replacements is several years away. As a result, the ongoing monetary support of infrastructure deployment will be necessary. However, clusters where the user behavior criteria do not factor, based on the case studies, are prime areas for early EVSE deployment. Higher education and medical campuses have internal drivers strong enough to allow the long-term benefits of EVSE to outweigh their initial costs.

2. **Important clusters for primary EV charging opportunities are under-deployed in the TCI region.**

There is a need to fill market gaps by providing funding for EV infrastructure in high-priority and under-deployed areas, such as multi-family housing. The multi-family housing cluster would provide the primary source for EV charging for multi-family housing occupants; this cluster represents only 3% of the non-single-family home EVSE deployment in the TCI region.

3. **Market-based opportunities already exist in the region.**

Contrary to what one might expect, the main financial drivers behind most EVSE installations to date are not monetizing electrical usage but attracting new customers to retail and improving brand reputation by linking to sustainability concerns. Marketing and branding opportunities are key aspects of nearly every discussion regarding EVSE deployment. In this study, where EV use exists or is anticipated by local conditions, there are opportunities to utilize EVSE charging in order to jump start deployment and stimulate further EV uptake by other potential EV adopters.

4. **Local, municipal deployment is leading EVSE deployment and should continue to do so.**

The greatest number of EVSE locations in the TCI region occurs within the downtown cluster. EVSE on downtown, municipally-owned property and in privately operated parking garages creates strong incentives for EV adoption in congested areas with air quality concerns.

5. Intermodal connectivity is a transportation policy priority.

Several clusters reveal opportunities to impact an important part of the EVSE deployment discussion that is often missing from EV-ready planning: intermodal transportation connectivity. The downtown cluster, particularly where it overlays with the regional transit cluster in TOD communities would be ideal locations for encouraging EV adoption.

Municipal and state governments and regional transit authorities should consider costs and benefits in light of the larger scope of plans and policies about increasing viable transportation alternatives, increasing walkability and reducing emissions.

6. Management is seen as consistently problematic across the clusters.

Case studies suggest that complex ownership, fee and physical arrangements with respect to the parking facilities that house EVSE create problems that discourage EVSE installation.

Public-private partnerships in parking management have helped to bring EVSE to downtowns, retail locations and workplace cluster locations. Similarly, as with the Medical Academic and Scientific Community Organization’s parking facility management or the Maryland Stadium Authority’s marketing management plan for Camden Yards, private-sector partnerships should help expand capacity but may also add complexity to decision making.

Next Steps and Policy Recommendations

Public and private investment in EV charging infrastructure will establish locations within clusters and anchor EVSE deployment in areas that are already settings for EV use. However, not all clusters are created equal—as the case studies have illustrated—in terms of opportunities that deliver strong return on investment, either in the form of financial or social benefits. Because EVSE is decentralized infrastructure, establishing EVSE planning partnerships with projected early-adopter institutions and destinations is crucial. Several policy-focused recommendations rise to the top:

1. **Micro-targeting of public investment** should seek out “sweet spots” that present the greatest opportunities for frequent use, raise public awareness, and generally provide assurances of charging options for those with range anxiety.

Public benefits will include economic development in terms of local job creation; however, the cluster case studies profiled for this study only deal indirectly with economic development issues. More critical is the need to optimize local air quality and carbon emissions mitigation benefits. State and municipal governments should seek to incentivize deployment opportunities that maximize emissions reductions in communities with disproportionate shares of vulnerable populations and high rates of respiratory disease affliction.

The fleet and freight cluster in particular emphasizes the reduction of local pollution by removing the dirtiest vehicles from the road. The regional transit cluster can be used to further encourage intermodal transportation, reduce travel by cars and, in general, have a great ability to encourage EV ownership and usage. While many private-sector business models may struggle to monetize EV charging at commuter facilities due to length-of-stay issues, there is nevertheless a strong argument to be made for public investment. Locations in park and ride facilities as well as in the workplace cluster can serve as primary charging locations when home charging is infeasible.

2. Public investment should also directly **encourage or require** (such as through regulatory measures) **EVSE deployment in clusters that offer private benefits and significant potential to expand EV ownership and usage** in conditions with significant barriers to EV adoption.

The **multi-family cluster** is a prime example of a location with impediments to EVSE deployment. Eliminating unnecessary installation requirements and encouraging EV-ready new

construction are proven tactics to stimulate the market for early followers of EVs, particularly in affluent urban or exurban areas.

3. To most effectively combat current or anticipated “range anxiety,” **EVSE should be located at destinations which people desire to go to and spend time**, particularly in the downtown, retail, and leisure clusters. Through marketing efforts bringing highly visible signage and branding, public investment can maximize the positive associations with these private and public EVSE installations.

Distinctive and visible signage along with universal EVSE locator apps and websites will also be crucial in conveying sustained public- and private-sector support and endorsement of the technology. Planning for a comprehensive network among clusters represents an opportunity for planners and policy makers in the TCI region to work closely with private-sector organizations.

These are preliminary policy recommendations that arise out of the cluster analysis and seek to answer the question: How can cities and towns throughout the TCI region envision ways to maximize investment in infrastructure and prioritize EVSE rollout? Investment in infrastructure will need to be carried out by public- and private-sector entities that do or will provide charging opportunities for EVs. Strategies that prioritize placement of EVSE in locations within the clusters that create the greatest benefits for EV drivers, EVSE hosts and the community at large will be a part of the next steps in local planning for EVSE deployment. Targeting locations for EVSE rollout through this cluster approach can help create a mutually beneficial system of EV charging in the critical early stages of the industry.

APPENDICES

1. OVERVIEW OF EV DEMOGRAPHICS

This demographic overview provides information on both hybrid early adopters and information on electric vehicle (EV) early adopters in the Transportation and Climate Initiative (TCI) region. Among the findings that underpin this report's assumptions are the following data points:

Income

First-generation hybrid drivers had **higher incomes**—considerably higher than the average car buyer. A 2007 study by Scarborough Research of approximately 1,000 drivers of all models of hybrids revealed that 42% have an income of greater than \$100,000.

Many automakers and organizations planning for EVs have made quantitative assumptions regarding the characteristics of potential EV owners. At present, these efforts are for planning and marketing purposes, such as those for Ford, which assumes the typical household income for EV owners is between \$120,000 and \$140,000. BMW suggests that its ActiveE customers “are affluent, mostly urban individuals who put a high value on social responsibility and environmental friendliness,” presumably similar to other BMW owners.³⁴ The Delaware Valley Regional Planning Commission considers those census block groups with household incomes of more than \$150,000 and current hybrid or EV ownership as strong predictors of local EV ownership.³⁵

Age

Early adopter hybrid drivers were several years older than the average car buyer—closer to 50 rather than the average age of 40. J.D. Power's 2007 review of auto industry marketing showed that only 2% of hybrid owners were 24 or younger; while 29% were between the ages 45 and 54 and 33% were 55 and older. The 2007 Scarborough Research survey reported that 23% of hybrid drivers were 50 or older.

Populations of EV communities skew younger than non-EV communities in the TCI region, but not too young. Communities with EVs are home to significantly more 20- to 35-year-olds and fewer 55- to 75-year-olds in communities with EVs. These trends are even more pronounced for communities with three or more EVs.

Education

There is also strong evidence that hybrid early adopters had higher levels of education. “Hybrid car drivers have a level of education higher than any group of car drivers that I've ever seen,” said Walter McManus of the University of Michigan's Transportation Research Institute.

The association between EVs and education looks to be similarly strong, as EV communities have 31% more bachelor's degrees and 47% more graduate degrees than non-EV communities, with communities with three or more EVs having 46% and 81% more bachelor's and graduate degrees, respectively.

³⁴ Herman K. Trabish, “Will BMW's Solar-Wind Package Tap New Target Car Market,” Greentechmedia.com, August 3, 2012, <http://www.greentechmedia.com/articles/read/will-bmws-solar-wind-package-tap-a-new-target-car-market/>³⁴

³⁵ Delaware Valley Regional Planning Commission, *Southeastern Pennsylvania Preliminary Electric Vehicle (EV) Grid and Transportation Network Analysis* (July 10, 2012). Meanwhile, Honda's EV Readiness Assessment at <http://automobiles.honda.com/fit-ev/ev-readiness-assessment.aspx> is more logistically focused, defining the ideal factors for EV ownership as locations in select, urban markets; commutes of less than 50 miles; and a private garage accommodating of a Level 2 EVSE.

Lifestyle

The 2007 Scarborough Research survey, which focused on hybrid owners within a broader lifestyle study of 110,000 adults, sheds some light on other consumer behavior and political patterns. According to Scarborough, hybrid early adopters were the following:

- Twice as likely to claim to go skiing or hiking or practice yoga as non-hybrid owners.
- More likely to consume organic food, yogurt and decaffeinated coffee than the general population.
- More likely to be tech savvy. Nearly one-third either used their mobile phone for text messaging or taking photographs, while more than one-third used a digital-video recorder, satellite TV or a video game system.
- Politically, 14% called themselves Republican, 38% identified themselves as Democrat and 34% identified themselves as independent.

This report's analysis applies a similar approach to understanding the characteristics that define different locations for the physical distribution of electric vehicle supply equipment and the users who frequent it.

2. DESCRIPTION OF DECISION-MAKING CRITERIA

DECISION-MAKING FACTORS BY CATEGORY	NOTES ON APPLICATION OF THE CRITERIA
USER BEHAVIOR	
Density of Use (Volume)	Describes the volume of vehicles charging at the cluster's electric vehicle supply equipment (EVSE)
Intensity of Use (Throughput)	Describes clusters in which frequency of use is a consideration
Vehicle Miles Traveled	Clusters where trip length is a consideration in assessing EVSE demand
Dwell Time	Describes the length of stay for parked vehicles that is typical of the cluster location
Diversity of Experience	Clusters where electric vehicle (EV) drivers may need more than one activity in order to dwell long enough to achieve a beneficial charge by today's Level 2 standards
CLUSTER OPERATIONS	
Procurement	Some scenarios may offer opportunity for public procurement, cooperative purchasing or large-scale institutional control over vehicles and systems
Internal Interests	Requests for EVSE or EV use originate from within an organization or place
Parking Management	Fee structures for parking, preferred parking, permitted parking and proximity preference are examples of tiered parking systems and determine where EVSE might be best located
Location Ownership	Where a landlord-EVSE host relationship is an asset
EXTERNAL INFLUENCE	
User Demographics	Clusters where favorable demographic profile factors into the institutional/host decision to implement EVSE
Geography	Favorable geographic conditions, such as a closed campus, offer an advantage, or where factors such as routes and range are important
Electricity Cost	Where cost is most likely passed on to drivers via some model for monetization, where metering may be complex, or where scale of application may present higher electricity charges
Fuel Cost	Representative of large-scale savings that may impact vehicle choice
Regulatory Ease: Permitting, Zoning	Local and state regulations will impact decisions to install EVSE; in some clusters, a more typically smooth regulatory pathway will help the feasibility of an EVSE infrastructure project. For example, on government-owned land, EVSE can be installed without typical permits
Plans and Policy	EVSE can fit within existing planning frameworks and can also be bolstered by them where appropriate; this is important for public and institutional clusters and where developers seek incentives in exchange for EVSE
HOST/PUBLIC BENEFIT AND VALUE CAPTURE	
Public Health	Direct benefit due to replacement of more harmful vehicles and high concentration
Marketing Opportunity	Assesses whether the installation of EVSE can be seen as a branding asset or a marketing platform, adding financial or identity incentive
Sustainability Goals	EVSE helps a government, institution or business meet standards, such as for emissions or green practices
Economic Development	Potential impacts associated with EV use that point to creation of jobs, increased spending and development of a public amenity



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