Maryland Electric Vehicle Infrastructure Council

Final Report
to the
Governor and Maryland General Assembly
by the
Electric Vehicle Infrastructure Council

December 1, 2012

Staffed by:
The Maryland Department of Transportation
in cooperation with
the Maryland Energy Administration and
the Maryland Public Service Commission

Electric Vehicle Infrastructure Council - Final Report

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Executive Summary

Maryland's Electric Vehicle Infrastructure Council (Council), created by legislation introduced by the Governor in 2011, was charged with planning the successful integration of electric vehicles into Maryland's communities and transportation system. The Council, which met sixteen times between August 2011 and December 2012, is comprised of representatives of automobile manufacturers and dealers, manufacturers of electric vehicle charging equipment, utilities, electrical workers, State and local governments, and environmental and energy experts. As required by the Council's enabling legislation, this Final Report includes the following:

- An Action Plan to expand the adoption of plug-in electric vehicles (PEV);
- An Infrastructure Plan to help guide the development of a statewide charging infrastructure network; and
- Various policy and programmatic recommendations to help coordinate State and local policies that will continue to make owning an electric vehicle convenient and economical, help create green jobs, and achieve a cleaner, healthier and more energy independent Maryland.

The future of electric vehicles in Maryland will depend on many factors - highlighted below are some of the Council's core findings and recommendations.

Action Plan

Many of the Council's recommendations should be pursued within the context of an overarching goal of widespread PEV adoption and are intended to provide sufficient support to reach an ambitious goal of 60,000 PEVs on the road in Maryland by 2020, or 2.3% of the State's passenger vehicle fleet. With that goal in mind, these efforts will necessitate continued oversight and coordination. To that end, the Council's primary recommendations are:

- Continue the Council through June 2015
    - Engage more extensively with local counties and municipalities on education, outreach and planning initiatives.
    - Create a task force under the Council to study issues and opportunities for workplace and urban charging and continue the development of solutions and best practices.

- Establish goals for the State vehicle fleet to increase the number of its zero-emission vehicles through the normal course of fleet replacement, so that at least 10% of fleet purchases of light-duty vehicles are zero-emission by 2020 and at least 25% of fleet purchases of light-duty vehicles are zero-emission by 2025.

- Explore the potential for the leasing of PEVs, bulk purchase agreements with local governments, and bulk purchase or lease agreements with the other Northeast Corridor states to reduce purchase costs.

- Extend current incentive programs:
    - Excise tax credit – extend the program's expiration date for an additional three years to July 1, 2016.
    - Electric Vehicle charging station income tax credit - extend the program's expiration date for an additional three years through December 2016.
    - Extend the HOV lane use permits for PEVs from September 30, 2013 to September 30, 2020.

- Establish a grant program to assist in the funding of Electric Vehicle Support Equipment (EVSE) installation and the initial procurement of transaction management software for multi-unit dwellings including apartments, condominiums and managed community parking.

- Implement an Education and Outreach plan, that includes
    - A State website for Maryland-specific PEV information and resources;

- Educational workshops and webinars for developers, property managers and homeowner associations about the benefits of providing charging for residents;
- Guidance documents for local governments (Infrastructure Planning Guide for Local Governments; Urban and Multi-unit dwelling charging solutions and best practices for local governments, etc)

Infrastructure Plan

The Council's research and analysis indicate that, absent a market catalyst such as a sustained period of extremely high gasoline prices, a rapid shift to PEVs will require substantial government support. As of November 2012, 778 electric vehicles have been registered in Maryland. Based upon current consumer patterns and projected future trends, PEVs are not likely to enter the mainstream until there is a robust network of charging options. Given a State goal of widespread electric vehicle adoption, the Council determined that the establishment of a visible charging network should be a State priority. While many purchasers will charge mainly at home, with the workplace as the second most likely charging location, without a balance of public fast charging, workplace and multi-unit dwelling charging solutions, PEV adoption will be significantly delayed. Such strategies will require engaging all levels of government in a collaborative approach to PEV-friendly plans and policy development consistent with State and local Smart Growth goals. This effort requires integrating PEVs and charging infrastructure planning into existing regional and local planning processes, such as regional transportation plans, regional air quality action plans, local comprehensive plans, zoning, building codes and other related ordinances and regulations.

State Charging Station Recommendations

The State should promote the establishment of adequate PEV charging infrastructure to support an ambitious goal of 60,000 PEVs on the road by 2020. The State should monitor the installation of private sector charging facilities across Maryland and continue to add charging infrastructure at State facilities in underserved areas.

The Council recommends that the State continue to allow access to the public charging stations at State facilities free of charge until June 30, 2014. In the interim, host agencies will continue to collect data on usage and electricity consumption from each station in order to facilitate planning for future installations, electrical infrastructure and cost recovery.

Urban Charging Infrastructure Recommendations

Since all PEV owners do not have access to a private garage or parking space at their home, as in urban areas and multi-dwelling unit communities, State and local officials, utilities, businesses and property managers should discuss options for wiring existing garages and parking lots for charging. Parking managers could then incorporate that service into long-term parking agreements with urban area employers.

The Council also recommends that the State work with the local counties and/or municipalities to conduct various pilot projects in order to demonstrate the options for the shared use of existing parking facilities. These facilities could allow urban residents to park and charge at night in facilities that are primarily used for business and employment during the day.

Technical Workshops – The Council recommends that the Public Service Commission (PSC) hold technical workshops to gather information on innovations in the interface between PEVs and the electrical grid, including both technical feasibility and costs/benefits. Workshop topics should include Vehicle-to-grid (V2G) and Vehicle to Home concepts and the potential for the use of down-cycled batteries for power storage.

Investment – The State should continue to foster emerging PEV technologies and their potential for a role in electrical grid management through existing financing vehicles, such as InvestMaryland.

Financing – The State should explore opportunities to reduce the upfront costs of PEVs and charging infrastructure installation through public/private financing to allow for the provision and underwriting of low-interest, low-risk loans to energy projects that further the State's energy goals, and to link EV charging to renewable energy and grid management.

The Council looks forward to continued collaboration and support throughout the ongoing process of planning and implementing Maryland's goals for widespread PEV adoption. The Council recognizes that the future of PEVs in Maryland depends on many factors and that ultimately the coordination must take place at not only the local and State levels but also on a regional basis as well. It will be imperative to stay informed and engaged with the regional planning efforts along the Northeast Corridor that are working toward the development of a coordinated regional electric vehicle network and tackling greater policy issues such as the impact of PEVs on the transportation infrastructure system, interoperability of charging station providers, pricing and price display standards.

I. Background of the Council

The 2011 legislature of the Maryland General Assembly adopted, and Governor O'Malley signed into law, Senate Bill 176[1], Chapter 400 Laws of Maryland, which establishes an Electric Vehicle Infrastructure Council (Council).[2] Specifically, this law requires the Council to:

1. Develop an action plan to facilitate the successful integration of electric vehicles into the State's transportation network.
2. Assist in developing and coordinating statewide standards for streamlined permitting and installation of residential and commercial Plug-in Electric Vehicle (PEV) charging stations and supply equipment.
3. Develop a recommendation for a statewide charging infrastructure plan, including placement opportunities for public charging stations.
4. Increase consumer awareness and demand for electric vehicles through public outreach.
5. Make recommendations regarding monetary and nonmonetary incentives to support electric vehicle ownership and maximize private sector investment in electric vehicles.
6. Develop targeted policies to support fleet purchases of electric vehicles.
7. Develop charging solutions for existing and future multi-dwelling units.
8. Encourage local and regional efforts to promote the use of electric vehicles and attract federal funding for State and local PEV programs.
9. Recommend policies that support PEV charging from clean energy sources.
10. Recommend a method of displaying pricing information at public charging stations.
11. Establish performance measures for meeting PEV–related employment, infrastructure, and regulatory goals.
12. Pursue other goals and objectives that promote the utilization of electric vehicles in the State.

The law took effect July 1, 2011 and is in effect for a period of two years, through June 30, 2013. The Council held sixteen meetings, chaired by Darrell Mobley, Acting Secretary of Transportation, beginning with the inaugural meeting on September 12, 2011. The enabling law required an Interim Report to the Governor and General Assembly on or before January 1, 2012, and a Final Report of the Council's work and recommendations to be submitted to the Governor and General Assembly on or before December 1, 2012. The Council submitted an Interim Report on January 1, 2012 that provided recommendations to the Governor and General Assembly that the Council requested be considered in the 2012 Legislative Session. At that juncture, the Council's immediate recommendations focused on providing utility grid stability and regulatory certainty to the operators of PEV charging equipment and stations. In response to the Council's recommendations, in the 2012 Legislative Session, the General Assembly enacted the following:

- **SB 998/HB 1279, Chapters 334 and 335, Acts 2012: Motor Vehicle Administration - Plug-In Vehicles - Disclosure of Personal Information**

This bill addresses concerns expressed by the utility companies and other stakeholders over the potential for PEV clustering and the maintenance of local grid reliability. As more and more people buy PEVs, utilities may face localized reliability problems resulting from home charging by PEV customers clustered in particular neighborhoods where PEV adoption is more popular. This legislation helps alleviate that concern by requiring the Motor Vehicle Administration (MVA) to share PEV registration information necessary for grid planning purposes with the appropriate utility, specifically (1) the street address and (2) type of PEV purchased. When an PEV is registered with the MVA, the MVA can provide the residential address of the owner to the electric utility to ensure that the utility can make any necessary upgrades to the transformers and maintain safe and efficient load distribution. A copy of the bill can be found here: http://mlis.state.md.us/2012rs/chapters_noln/Ch_335_hb1279T.pdf

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[1] Senate Bill 176 – Maryland Electric Vehicle Infrastructure Council, Maryland General Assembly (2011), http://mlis.state.md.us/2011rs/bills/sb/sb0176e.pdf
[2] Appendix F: List of Council members

- **SB 997/HB 1280, Chapters 631 and 632, Acts 2012: Electric Vehicle Users and Charging Stations – Exclusions**

This bill provides regulatory clarification for owners and operators of PEV charging stations and PEV charging station service companies or providers by excluding them from the definition of an "electricity supplier" or a "public service company" as defined in law and regulated by the Maryland Public Service Commission (PSC). The bill also makes it clear that these entities continue to remain within the definition of "retail electric customer."

The elimination of regulatory uncertainty removes a potential barrier preventing PEV investors and industry participants from entering the market in Maryland. With this new level of regulatory certainty, Maryland's PEV market will be better poised to significantly grow beyond its existing infrastructure and is a signal of Maryland's commitment to the development of a vibrant PEV market.

A copy of the bill can be found at: http://mlis.state.md.us/2012rs/bills/hb/hb1280t.pdf
Since the Interim Report, the Council has completed an Action Plan to encourage increased PEV sales in the State, as well as a Statewide Infrastructure Plan for the development of an infrastructure network. In addition to those plans, what follows in this Final Report, is a discussion of the Council's findings, its recommendations for future actions and the rationale behind these recommendations.

II. Context: Why Encourage Plug-in Electric Vehicle Adoption

Transportation and Oil: The Statistics

Americans love to drive. In 2009, the nation's fleet of registered vehicles numbered 254.2 million vehicles, or one third of all motor vehicles worldwide. Passenger car ownership in the U.S. is now the equivalent of more than one car for every two people, [3] and car ownership in Maryland follows a similar trend.

And it's not just the number of vehicles on our roads, but the number of miles we drive. Passenger cars and trucks account for the bulk of vehicle-miles traveled (VMT) in the U.S., with per capita passenger miles at about 11,600 per year. [4] In 2010, drivers in Maryland traveled 56.2 billion vehicle miles.[5]

The U.S. transportation sector is a major consumer of petroleum products, using 13.46 million barrels per day in 2010. This represents 70.2% of the nation's total petroleum consumption.[6] While other uses of petroleum products (heating, power, electricity generation, etc.) have decreased in the U.S. in recent decades, the use of petroleum for transportation continues to rise. [7]

There are many well known reasons to reduce the transportation sector's dependence on oil. National security, economic stability, climate change and air quality are among the most important. PEVs represent an opportunity to reduce our dependence on foreign energy sources and reduce tailpipe emissions of greenhouse gases (GHG) and other air pollutants.

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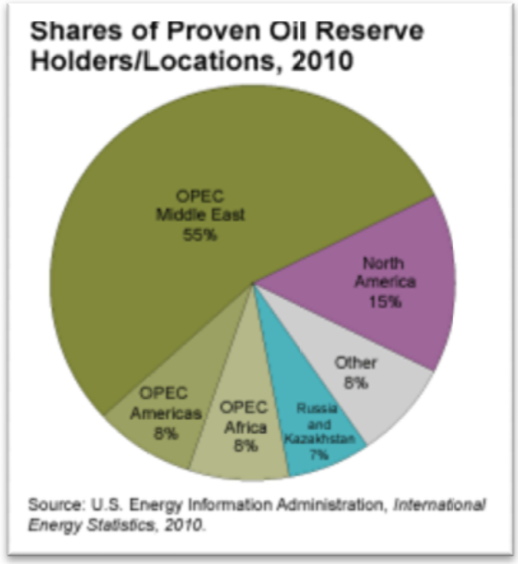
[3] National Transportation Statistics 2011, Bureau of Transportation Statistics, U.S. Department of Transportation
[4] Annual Energy Outlook 2012 (Early Release), U.S. Energy Information Administration
[5] Maryland Department of Transportation, 2012 Annual Attainment Report
[6] National Transportation Statistics 2011, Bureau of Transportation Statistics, U.S. Department of Transportation
[7] U.S. Oil Demand by End Use Sector, U.S. Energy Information Administration

National Security: The U.S. currently imports almost 10 million barrels of crude oil per day, nearly double the amount we produce, a potentially precarious dependence in an increasingly unstable world. We also rely on a complicated geopolitically diverse mix of sources. About 13% of U.S. oil imports still come from the Persian Gulf. Another 19% come from Africa, mainly Nigeria and nearly half now originates in the Western Hemisphere, mainly Canada, Mexico and Venezuela.[8] As of 2010, the Organization of Petroleum Exporting Countries (OPEC) members held over 70% of proven world oil reserves. While potential new sources of domestically produced fossil fuels have been discussed, the delivered price is uncertain due to concerns regarding recovery of these new sources. Since fossil fuels are a world-wide commodity, even new domestic sources will be influenced in pricing by the ever-increasing demand from Asian markets.



Continuing political unrest in the Middle-East and Africa has the potential to disrupt the flow of oil imports from those regions without warning, while spikes in piracy in the Gulf of Guinea could disrupt the contribution of West Africa to global oil supplies. Shipping distances for oil originating outside of the Western Hemisphere also increase the potential for losses to piracy or terrorism.

While much of the electricity generated in the U.S. is still produced using fossil fuels (coal and natural gas), the U.S. can, if need be, meet its electricity needs with domestically produced resources. The continual expansion of renewable resources will increase supply and lower greenhouse gas emissions for the electric power sector.

Economic Stability: One of the biggest factors affecting future oil prices is future oil demand. There is significant controversy and uncertainty about how much recoverable resource remains. While there are certainly still vast fossil fuel reserves left in the ground, the volume of oil that can be commercially exploited at manageable prices, without undue environmental damage, is limited. Rapid development in Asia has led to increased competition for oil supplies that will continue to contribute to the rise in global oil prices. China and India contributed half of the global oil demand growth over the past decade, despite accounting for only about 8.2% of global oil demand at the beginning of that time frame. This trend is expected to continue.[9]

Increasing demand can be expected to keep oil prices high, while geopolitical volatility creates uncertainty in supply. The diversification of the national fleet to reduce its dependence on oil can help to protect both our security and our economy.

An additional consideration, as demonstrated by the major storms in 2011/2012, is the issue of access to power or fuel during major weather events. In the aftermath of recent storms many Marylanders were without power for up to 5 days, while Hurricane Sandy led to hours-long waits at the gas stations in New Jersey, due to gas shortages and the inability of gas stations without power to pump gas. There is no way to guarantee the availability of electricity or gasoline in every situation; however, the addition of PEVs and public charging infrastructure to the State's assets expands the options available to Marylanders in these types of extreme circumstances.

[8] U.S Oil by Country of Origin, U.S. Energy Information Administration
[9] China and India – GrowthDrivers for Global Oil Demand, *PetroMin*, SEPTEMBER/OCTOBER 2011

Climate Change: Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period (decades or longer).[10] The growing realization that anthropogenic climate change is a reality has focused the attention of the scientific community, policymakers and the general public on the rising concentration of greenhouse gases (GHG), especially carbon dioxide (CO_2) in the atmosphere, and on the significance of the carbon cycle in general.

Global carbon emissions soared 5.9% in 2010, the largest increase ever recorded, according to the Global Carbon Project (GCP), an international collaboration of scientists which tracks carbon emissions. The increase comes after a short-lived decline in emissions in 2008 and 2009 and is a sign that global CO2 emissions are again on the rise as world economies recover from recession. The jump of more than five billion tons of CO2 emissions from 2009 to 2010 was likely the largest absolute increase since the Industrial Revolution, according to the GCP. Emissions in the U.S., after dropping 7% in 2009, rose by 4% last year, according to that same report.[11]

The largest source of CO2, and of overall GHG emissions in the U.S. is fossil fuel combustion, with the two largest contributing sectors being electricity generation and transportation. Transportation activities accounted for 32% of CO2 emissions from fossil fuel combustion in 2010. Virtually all of the energy consumed in the transportation sector came from petroleum products and nearly 65% of the emissions resulted from gasoline consumption for personal vehicle use.[12]

Despite the fact that electricity generation is the largest contributor to GHG emissions, the Union of Concerned Scientists (UCS) contends that nationwide, PEVs charged from the electricity grid produce lower emissions than the average compact gasoline-powered vehicle (with a fuel economy of 27 miles per gallon (mpg))—even when the electricity is produced primarily from coal in regions with the "dirtiest" electricity grids.[13] Maryland's energy grid actually falls into the "Best" and "Better" categories in this study, where a PEV charged from the grid would produce emissions comparable to a gasoline-powered vehicle with a fuel economy of 41 to 51+ mpg. A joint study by the Electric Power Research Institute and the Natural Resources Defense Council supports this conclusion, finding that PEVs charged from power plants with current coal technology (2010) produce 28% to 34% lower GHG emissions compared to conventional vehicles. [14]

This is true even though about 50% of the electricity consumed in Maryland is generated from coal. The comparative climate benefits of driving a PEV in Maryland will increase as renewable energy's portion of the region's power portfolio grows, driven in part by renewable portfolio standard (RPS) mandates in Maryland and other PJM[15] states.

Several recently published studies have demonstrated that PEVs, over their lifetime, have lower carbon footprints than their gasoline powered counterparts. A study by LowCVP, jointly funded by the British government and the auto industry and presented at the LowCVP Annual Conference 2011 [16], has been widely misquoted as indicating that PEVs simply shift emissions from exhaust to manufacturing. In fact, that study states that while PEVs produce more emissions during manufacturing, that initial bump in emissions is more than offset during the vehicle's life.

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[10] U.S. Environmental Protection Agency – Climate Change Science

[11] Global Carbon Project, Carbon Budget 2010, an annual update of the global carbon budget and trends, 12-5-2011.

[12] U.S. EPA 2012 Inventory of U.S. Greenhouse Gas Emissions and Sinks

[13] *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings Across the United States*, The Union of Concerned Scientists, April 16, 2012.

[14] EPRI-NRDC, Environmental Assessment of Plug-In Hybrid Electric Vehicles, July 2007.

[15] PJM Interconnection LLC (PJM) is a Regional Transmission Organization (RTO) which is part of the Eastern Interconnection grid operating an electric transmission system serving all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

[16] Ricardo Study Finds Electric and Hybrid Cars Have a Higher Carbon Footprint During Production Than Conventional Vehicles, but Still Offer a Lower Footprint Over the Full Life Cycle, http://www.greencarcongress.com June 8, 2011.

Air Quality: In addition to GHGs, a conventional vehicle emits other pollutants including volatile organic compounds (VOCs) and "criteria" pollutants such as fine particulate matter (PM), nitrous oxides (NOx) and carbon monoxide, directly through the tailpipe, as well as through evaporation from the vehicle's fuel system and during the fueling process. NOx and VOCs are the key precursors to the formation of ground level ozone. These pollutants can harm human health, the environment and property. The EPA has established human health-based and/or environmentally-based criteria (science-based guidelines) for permissible levels for criteria pollutants. In Maryland, electricity generation and vehicle tailpipe emissions are major sources of the State's criteria pollutants. Among these, ozone and particulate pollution are the cause of the State's most significant health threats.[17]

Localities that consistently exceed permissible levels for one or more criteria pollutant are designated by the EPA as "non-attainment areas." Both the Baltimore and Washington metropolitan areas are designated non-attainment for both ozone and PM. Other areas in the State are in non-attainment for one or the other. In addition to the implications for environmental quality, such designations can have fiscal impacts. If State governments do not pursue rigorous strategies to correct their emissions profile, the EPA may withhold all or part of federal grants related to transportation projects or air pollution planning and control programs.

PEVs produce zero direct emissions. By eliminating tailpipe emissions, PEVs eliminate unhealthy local concentrations in urban areas and along roadways, and focus emission reduction efforts on the power plant sector rather than on millions of tailpipes.

Maryland's Vision for a Healthy Environment and Economy: As PEVs begin to comprise a larger share of Maryland's fleet, they have the potential to reduce oil dependence, reduce GHG emissions, improve local air quality, increase support for renewable energy and support the creation of green jobs, all factors compatible with Maryland's energy goals.

***Climate Action*:** The Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) requires Maryland to reduce greenhouse gas emissions 25% by 2020, relative to 2006 levels. Maryland is finalizing its GGRA Action Plan, which includes implementation of State and regional electric vehicle initiatives. Maryland is also one of nine states currently participating in the Regional Greenhouse Gas Initiative (RGGI), a multi-state cap-and-trade program designed to achieve a 10% reduction in carbon dioxide (CO2) emissions from electricity generating plants by 2018.

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[17] These pollutants, to which children are most susceptible, cause a variety of cardiovascular conditions and respiratory illnesses such as asthma. In the Northeast, vehicle emissions are the largest source for the chemical precursors to ozone. Vehicles, and particularly diesel vehicles, are also major sources of particulate matter. The burning of fossil fuels releases air pollutants, and the concentration of vehicles in a small area leads to a high concentration of pollutants. High population density amplifies the adverse health impacts as more people are exposed to these pollutants. In sum, air quality problems resulting from a high level of ozone, particulate matter, or other pollutants, are especially prevalent in areas with high population density and significant traffic congestion.

Clean Cars: The Maryland Clean Cars Program, enacted by the Maryland General Assembly in 2007, adopts California's stricter standards for a number of vehicle emissions including VOCs, NOx and GHGs. The Program requires auto manufacturers to provide an increasing percentage of Zero Emission Vehicles (ZEVs) for Maryland consumers. Plug-in hybrids, electric vehicles and fuel cell vehicles all count towards this ZEV requirement.

Renewable Energy: Maryland has enacted a Renewable Portfolio Standard (RPS) that requires electricity suppliers to include a specified percentage of renewable energy in the energy they supply to their customers. For 2013, the renewable requirement is 8.1% for Tier 1 sources (solar, wind, biomass and other specified sources). This requirement increases to 16.5% by 2020 and 20% by 2022. A portion of the energy purchased by Maryland consumers for PEV charging and other uses is derived from renewable sources or approved alternatives that also support the development of renewable supplies.

Maryland electric customers have the option to purchase their energy from a retail electricity supplier of their choice, provided the supplier is licensed to do business in Maryland. Several of the retail electricity suppliers offer renewable electricity supply options including up to 100% renewable electric supply. Electric customers can simply elect to purchase a renewable supply option to power their PEV.

Green Jobs: In 2009, Governor O'Malley announced his Smart, Green, and Growing legislative agenda, which set a target to create 100,000 new green jobs in Maryland by 2015. As Marylanders take advantage of more opportunities to "go green," numerous jobs, such as those in the solar installation and energy efficiency sector, are being created, thereby contributing toward achievement of the State's green goal.

Replacing gasoline and diesel burning vehicles with those that can be charged during off-peak hours, at least partially from night-time wind and other renewable sources, will assist the State in meeting its energy use and climate change goals. PEVs are increasingly being linked with promotion of renewable energy in ways that have the potential to drive both industries forward. The General Motors electric motor plant in White Marsh, Maryland is the first by a major U.S. automaker dedicated to making the critical components for vehicle electrification.

An EV charging system that collects and stores solar energy is being installed at the White Marsh plant, designed and manufactured by a Maryland company. This is the first integrated configuration that enables solar energy to power a local building, EVs, as well as the power grid. The Maryland-based SemaConnect develops and produces networked PEV charging stations and station management software. As the market for PEVs, solar chargers and other innovative technologies grows, Maryland will be well positioned to occupy the forefront of these emerging job markets.

Zero Emission Vehicle Program*: The Maryland Clean Cars Act of 2007 required the Maryland Department of the Environment (MDE) to adopt regulations implementing the California Clean Car Program (also referred to as the California Low Emissions Vehicle Program or Cal LEV) in Maryland. An important component of the Cal LEV program is the Zero Emission Vehicle (ZEV) program. The ZEV program requires manufacturers to produce and deliver for sale a growing number of zero (or near zero) emission vehicles. The current regulation began phasing-in in 2009 (Maryland's first year participating was 2011) with a minimum requirement of 11% of new motor vehicles being 'ZEVs'. By 2018 this percentage is to increase to 16% of new motor vehicles. The ZEV program provides credits to manufacturers for pure zero emission vehicles, such as Battery Electric and Fuel Cell vehicles, as well as credits for Partial Zero Emission Vehicles (PZEVs), such as hybrids, plug-in hybrids, clean conventional vehicles, and compressed natural gas (CNG) vehicles. The ZEV requirements for each model year can be met through a combination of the credits from the differing technologies.*

III Issues Affecting Adoption

Through its research, the Council identified several challenges that will need to be addressed in order to develop a dynamic and vibrant market for both electric vehicles and PEV charging station providers and operators.

For Consumers:

Up-front cost of vehicles

In his 2011 State of the Union Address, President Obama announced an ambitious goal to reach one million electric vehicles on the road in this country by 2015. Thus far, PEVs have remained only a small part of the national fleet. The high purchase price of PEV's has been cited as the greatest barrier to adoption. According to the industry, the high up-front cost stems from the cost of PEV components — principally electric batteries. Speaking at a forum on green technology in California, Ford's CEO, Alan Mulally, noted that PEV manufacturers must pay between $552 and $650 per kilowatt-hour (kWh) for electric vehicle batteries. As an example he cited the Ford Focus Electric, which contains a 23 kWh battery pack. The car's retail price is currently $39,200.[18]

The U.S. Department of Energy has challenged manufacturers to reduce the cost of batteries — and therefore the vehicle purchase cost — to approximately $300 per kWh. As advances are made in reducing the battery purchase cost and more vehicle models enter the market, it is anticipated that the price of PEVs will begin to fall. Automakers plan to introduce more than 30 electric drive models over the next several years (Baum & Associates 2010). Until that price reduction becomes a reality, it is likely that financial incentives, time-of-use rate structures and innovative financing solutions will be needed to level the playing field between PEVs and conventionally powered vehicles.

One leveling factor is the comparative cost of operating electric and conventionally fueled vehicles. Driving on electricity instead of gasoline can save thousands of dollars in fueling and maintenance costs over the life of a car. In April 2012, The Union of Concerned Scientists released a report entitled *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings Across the United States.* The report concludes that electric vehicle owners could save between $700 and $1,200 each year on fuel costs compared with owners of average new compact gasoline-powered vehicles. The report gives the following comparison as an example: A typical midsize PEV driven 30 miles daily will require about 10 kWh of electricity to be fully recharged each day, or about 300 kWh per month. An owner of a compact vehicle with average fuel economy will buy more than 6,000 gallons of gasoline and spend $18,000 on this fuel over the vehicle's 15-year lifetime, assuming a gas price of $3.50 per gallon. Using their example, but with the Maryland average price for electricity of about 14 cents/kWh, a typical midsize PEV could save over $10,000.[19] Most electric vehicles being offered by automakers today are small to midsize cars, a trend expected to continue over the next few years, so fuel-cost savings from PEVs are compared with the average new compact gasoline vehicle, which has an EPA city/highway fuel economy rating of 27 mpg. Even compared with the cost of fueling a 50 mpg gasoline vehicle, a PEV could save nearly $4,000.[20]

Range anxiety

Another often cited barrier to more widespread market penetration of PEVs is range anxiety. At present most all-electric vehicles have a range of approximately 100 miles before charging is required while plug-in hybrids have varying ranges. Most PEVs on the road in Maryland are the Chevy Volt gas-plug-in hybrid, followed by the all-electric Nissan Leaf. Other models currently available in this area have similar ranges.

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[18] Smart Planet, *Ford's CEO Reveals True Cost of Electric Vehicle Batteries,* April 23, 2012

[19] It should be noted that at this writing most PEV batteries are warranted by manufacturers for 8-10 years.

[20] *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings Across the United States*, The Union of Concerned Scientists, April 16, 2012.

Vehicle	Range in miles[21]
Chevrolet Volt	38 + gas
Nissan Leaf	100
Tesla Roadster,	244
Fisker Karma	32 + gas
Mitsubishi i-MiEV,	62
Think City,	100
Toyota Prius Plug-In	15 + gas
Ford Focus Electric	100

As of November 2012, there are over 778 PEVs registered in Maryland. In light of the relatively low level of market penetration in Maryland some have asked whether developing a network of PEV charging stations is premature. It has been suggested that the sight of unoccupied charging stations would draw public criticism, especially if public funds were used to install them. Conversely, studies of potential PEV purchasers have cited "range anxiety" and the fear of being unable to find charging when needed as one of the main barriers to PEV adoption. Based upon reviews of current consumer patterns and projected future trends, PEVs are not likely to enter the mainstream until there is a robust network of charging options. While many purchasers will charge mainly at home, with the workplace as the second most likely charging location, without a balance of public fast charging, work place and multi-unit dwelling charging solutions, PEV adoption will be significantly delayed.

Given a State goal of widespread adoption of PEVs, the Council determined that the establishment of a visible charging network should be a State priority.

Need for education and experience

Another challenge to the widespread adoption of PEVs is a lack of public understanding about PEVs, even five years after their rebirth. Arun Banskota, president of PEV services at NRG Energy, noted the results of an NRG consumer interest survey, saying that only one third of those surveyed were inclined to purchase a PEV. "But after we show them how it works, where they can recharge, and the cost benefits, that share doubles," he said. "Education is critical." The need for a robust, dynamic public education program to spur PEV adoption cannot be overstated.

Because of the small number of PEVs currently on the road, few drivers have had hands-on experience with this technology. In addition to passive education, opportunities to provide the public with hands-on experience with PEVs will be vital in dispelling consumer wariness.

For Fleet Operators:

Fleet operators share many of the concerns of individual consumers in adopting PEVs. In order of importance, the following were identified as key issues that commercial fleet operators consider when making acquisition and replacement decisions:

- ***Acquisition Cost*** – Because research and development costs are imbedded in factory invoice pricing from manufacturers, the acquisition cost of Alternative Fuel Vehicles (AFV)s continues to be much higher than traditional internal combustion engine vehicles. Manufacturers are also touting significant MPG/environmental improvements in their internal combustion vehicles.

- ***Alternative Fuel Vehicle asset gaps*** – The commercial market has shifted away from sedans toward more light/medium duty trucks, to provide greater utility with fewer vehicles. The AFV truck options available to fleet operators are still somewhat limited.

[21] The actual range may vary considerably based on the terrain, weather, outdoor temperature and driving style.

- ***Regional solutions*** – Many fleet operators across the U.S. consider their local geography in determining which vehicle is more economically feasible for them. For example, the Southwest considers Compressed Natural Gas (CNG) to be a more viable solution, while an East Coast operator may consider an electric vehicle a greater asset; Regional terrain is also a factor to consider. Areas with more frequent elevation changes will typically get fewer miles to a charge, necessitating more frequent access to charging, especially fast-charge.

- ***Technology improvements*** – As with all emerging technologies, some fleet operators adopt new alternative fuel vehicles (AFV) regardless of cost, while others take a wait and see approach as the technology improves, additional vehicle models and capabilities are developed, and costs come down. For PEVs, electric batteries are expected to become less costly and more efficient, adding to vehicle range.

- ***Infrastructure support*** – Convenience and driver productivity are of paramount concern to most fleet operators. Many companies have downsized sales and service personnel through the recession and are doing more with less. The perception (and reality) of a lack of AFV infrastructure—range, reliability, fueling and maintenance—to support driver productivity serves as a disincentive to the inclusion of AFVs in a fleet asset mix.

- ***Remarketing concerns*** – Fleet operators are concerned about remarketing of assets – how well will they hold their value relative to internal combustion assets. Specific to electric vehicles the concerns heard most often center around battery disposal, including the likely cost and process for disposal.

Some of these items will be mitigated by the market as PEVs become more commonplace, while some will be helped by public policy interventions. The 2025 Corporate Average Fuel Economy (CAFE) standards announced by President Obama in 2011 will require a fleet-wide average of 54.5 mpg by 2025. The new CAFE standards also include incentives for automakers to advance specific technologies, including electric vehicles, and plug-in hybrids. These machines already garner very high CAFE ratings, as they use little or no gasoline, but to encourage their sales, the government will factor each sale of an electric vehicle by 2.0 in model year 2017. In other words, if an auto company sells 10,000 electric vehicles—either battery powered or fuel cell—they will be counted as 20,000 when calculating that company's fleet fuel economy. This factor will phase down to a multiplier of 1.5 by 2021. For plug-in hybrids, the factor will start at 1.6 in 2017 and phase down to 1.3 in 2021.[22]

For residents of urban and multi-dwelling unit environments

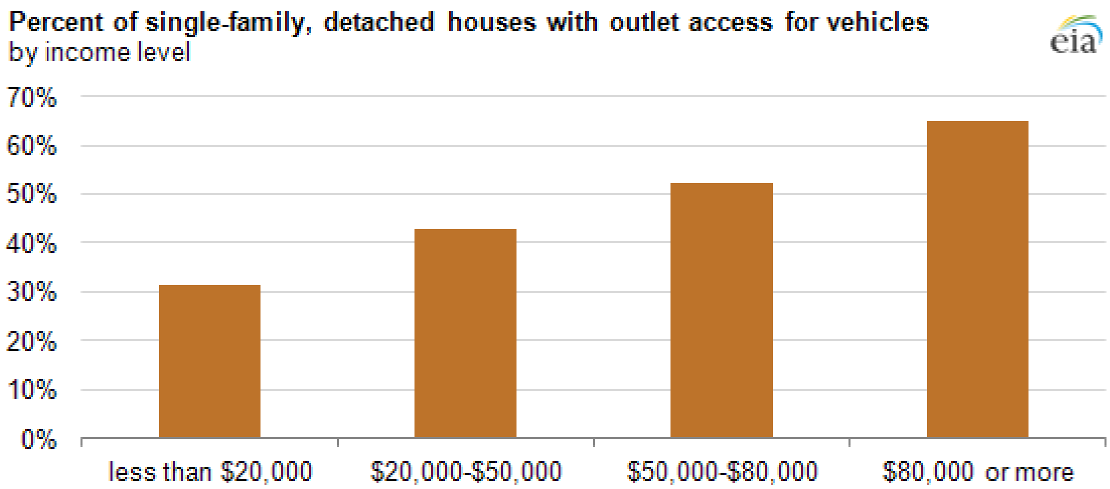
A more complex issue identified as a barrier to widespread PEV adoption involves charging opportunities for PEV owners who do not have access to a private garage or parking space at their home. Urban dwellers, residents of apartments and condominiums and even suburban dwellers with only on-street or driveway parking may have limited options for recharging PEVs.

Sixty percent of respondents to a U.S. Energy Information Administration, Residential Energy Consumption Survey, who live in single-family detached housing and have at least one vehicle, park within 20 feet of an outlet. The percentage drops to only 14% of respondents in apartments. Newer houses tend to provide better access to electrical outlets. Differences based on the age of the housing unit exist, but the major increase in outlet access did not occur until the 1990s.

Income and location in urban areas also influences access to outlets for charging vehicles. About 65% of respondents from single-family detached housing units with annual incomes greater than $80,000 are able to park with access to an

[22] Car and Driver, November 2011. The CAFE Numbers Game: Making Sense of the New Fuel-Economy Regulations

electrical outlet (see chart below). Only 47% of respondents in urban areas have such access compared to 55% in rural areas, reflecting the prevalence of apartments in the urban housing stock. [23]



Source: U.S. Energy Information Administration, Residential Energy Consumption Survey.
Note: Excludes the 11.2 million households without a vehicle. [24]

Unless charging opportunities are provided in the urban and multi-dwelling unit family settings, the high purchase price of the vehicles coupled with the link between income and access to charging infrastructure will likely fuel a public perception of PEVs as a luxury or an option only for the wealthy, rather than a practical vehicle.

The Council's urban/multi-dwelling unit work group convened stakeholder meetings in 2012 to identify barriers and possible solutions to PEV charging in these communities.[25] In addition, a representative of the Council met with a local homeowner's association to explore the challenges and issues associated with providing PEV charging access for a current resident. Based on its research and stakeholder outreach, the Council identified a number of unique issues that arise for PEV users who do not have access to parking with an electrical supply for their exclusive use.

Urban and multi-dwelling unit communities may, or may not, have exclusive use of parking. Parking options fall into the following three categories:

- Assigned spaces for which monthly fees are assessed, separately or as part of rent or condo fees
- Unassigned spaces in parking garages or adjacent to structures
- Unassigned spaces in lots or on-street parking

In most cases, residents will not have the right to unilaterally install charging equipment, nor will procedures to bill residents for use of electricity from existing outlets have been established.

[23] U.S. Energy Information Administration, Residential Energy Consumption Survey,
[24] U.S. Energy Information Administration, Residential Energy Consumption Survey,
[25] The Maryland Department of the Environment (MDE) Deputy Secretary Kathy Kinsey, the work group chair, convened the meetings. The June 13 meeting focused on PEV charging in the urban setting. Participants included the Baltimore City Parking Authority and Department of Planning, BGE and PEPCO, the Public Service Commission (PSC), the Maryland Energy Administration (MEA) and MDE. The July 10 meeting focused on multi-dwelling unit communities with shared off-street parking facilities. Participants included The Tower Companies, Bozzuto Development Company, Baltimore Electric Vehicle Initiative, BGE, Baltimore City Department of General Services, MEA, MDE and Coulomb Technologies.

Physical hazards represent another important consideration in the urban context. The proximity of a parking space to adjacent sidewalks and walkways can create a range of safety, security and liability concerns (e.g., trip hazards, theft of extension cords or PEV charge cords, shock hazards). This warrants a further differentiation of parking spaces:

- Adjacent to existing 120V outlets (Level1) without intervening sidewalks or trip hazards.
- Adjacent to buildings/walls where use of charging cords would not be a trip hazard.
- Adjacent to sidewalks or on the street where additional PEV structure would have to be built (i.e., a stand alone charging station) to avoid trip hazards to pedestrians.

In nearly all cases, a public space must be crossed between where the resident lives and where the vehicle is parked and charged.

Finally, there is a human social factor involved with PEV Level 2 charging in communal spaces. Level 2 chargers can fully charge the typical PEV commuter in a few hours, but this can lead to social sharing problems and car movement/exchange issues during the day and night. This is not as much of a problem with PEV Level 1 charging from standard 120V outlets, which takes 8 or more hours typical of overnight charging in a dedicated space.

Charging Options

Level 1 *provides charging through a 120 volt (V) AC outlet, or a typical household outlet, and adds 2 to 5 miles of range per hour of charging.*

Level 2 *equipment offers charging through 240 V AC electrical service and typically can add 10 to 20 miles of range per hour of charging.*

Direct Current or DC Fast Charge *can add 60 to 80 miles of range to a light duty vehicle in as little as 20 minutes.*

Multi-dwelling Unit Buildings with Dedicated Parking
In multi-dwelling unit buildings with dedicated garages or parking lots, there are a number of unique issues; including:

- Ownership of PEV charging stations.
- Responsibility for installation and maintenance, particularly if the charging equipment is installed for the benefit of a single resident.
- Challenging PEV charging and metering configurations .
- Allocation of installation costs and electricity charges if charging equipment is installed for the use of all residents and visitors; and
- Payment process for use of existing 120V outlets for charging.

Non-resident owners may lack incentive to rewire or install charging stations for their residents in apartment buildings. Many parking facilities may not have adequate electrical wiring to support multiple charging stations, even at Level 1. The first several charging stations may use up most of the available electrical capacity, and upgrades to the electrical infrastructure may be necessary to accommodate the loads of additional charging or Level 2 charging stations. Residents in multi-dwelling unit buildings may have assigned parking spaces that are not located near electrical outlets. For example, some condominiums attach a specific parking space to the owner's deed. Property managers may lack the authority to approve or arrange for PEV charging station installations, and many do not want the administrative burden of managing PEV parking, charging and billing at their facility.

Public and privately owned garages and parking lots all share the following challenges:

- Ensuring that charging stations are available for the use of multiple vehicles needing a charge, where a limited number of Level 2 PEV charging stations must be shared with multiple PEV owners.

- Locating dedicated PEV parking spaces near electricity distribution sources, and in safe and reasonably convenient locations for the users.

- Establishing procedures for use of existing 120V outlets and assuring adequate circuit isolation from other potential 120V convenience outlets on the same circuit. Some parking spaces in multi-dwelling unit buildings may be located in close proximity to existing 120V electrical outlets that are available for Level 1 charging. However, these outlets were usually installed for convenience and are frequently wired to the same circuit breaker. Although this wiring configuration may comply with the applicable Electric Code Standard for convenience outlets, two or more PEVs charging at separate outlets simultaneously could trip breakers or other faults. Re-wiring of the circuits may be necessary in order to accommodate multiple PEV users.

- Ability to transmit usage, billing and control signals and data to and from PEV charge providers/networks in underground garages, and control signals.

Legal Issues

Apart from physical and administrative challenges, a number of legal issues were also identified:

- **Restrictive Covenants**: Housing units subject to governance by home owner/condominium associations (HOA/CAs) may have restrictive covenants prohibiting or significantly restricting installation of PEV charging stations, or requiring approval of the association. Restrictive covenants are commonly put into place by subdivision builders, developers or homeowner and condominium associations to preserve property values and foster harmony among homeowners by enforcing standards of neatness and uniformity in the community. Restrictive covenants typically govern use of common areas, architecture, paint colors, building materials, fences, outbuildings and other exterior structures. As a general rule, they cannot be modified without the consent of a majority of the property owners who are subject to the covenants.

  Enforcement of restrictive covenants in a way that would significantly restrict or prohibit installation of PEV charging stations in such communities is widely recognized as a potentially significant barrier to PEV adoption. In furtherance of its policy to promote the use of PEVs, California has recently enacted legislation (SB 209 and SB 880) that prohibits homeowner associations of "common interest developments" from placing unreasonable restrictions on the installation and use of PEV charging stations in common areas that are reserved for the exclusive use of the owner. Hawaii enacted a similar statute in 2012 (HB 2799).[26]

- **Funding Installation and Operation of Charging Equipment:** HOA/CAs may face significant challenges in determining who should, or how to, fund the PEV charging installation, maintenance and ongoing services under the term of their existing by-laws.

- **Historic District Requirements:** Historic District restrictions may prohibit installation or restrict locations of PEV charging stations. Historic buildings and historic districts may impose restrictions on the visual appearance, placement and design of PEV charging stations. Projects that involve federal actions (such as funding or issuance of a permit) require protection of properties listed on the National Register of Historic Places. This can include historic districts. Trenching in previously undisturbed ground could trigger this federal law, as could visual impacts. Visual impacts could matter if the view of a listed historic structure changes in a way that compromises the basis for its listing on the National Register. The surrounding property or landscaping, as well as the structure itself, could be protected by the listing.

[26] Both the California and Hawaii laws amend their state laws governing "common interest developments." The California law covers "condominiums, cooperatives, apartment projects, and multi-unit communities," while the Hawaii law covers "multi-family residential dwelling or townhouse units," but not rental units. Both laws require the PEV resident to maintain and repair the PEV charging stations.

- **Zoning:** Zoning restrictions may prohibit installation of PEV charging stations or create ambiguity by failing to explicitly address the issue.

- **Local Government Authority:** Municipal or county authority over sidewalks and installation of street-side equipment may add complexity to PEV station permitting and use.

Despite the many challenges faced by the urban dwelling PEV owner, PEVs can be especially practical to drive in more densely developed areas. The closer proximity to shopping, schools, employers, etc. make it more likely that even in PEV hybrids, most trips will be all-electric, and therefore more economical.

To increase PEV market penetration, strategies must be developed to make PEV charging easily accessible to those residents that do not have private garage parking at their property. The optimal approach may be to provide adequate PEV chargers in, or conveniently close to, urban neighborhoods and adjacent to parking spaces. For city dwellers without exclusive use of a charger, the workplace may replace the home as the primary location for charging. Such strategies will require engaging all levels of government in a collaborative approach to PEV-friendly plans and policy development consistent with State and Local Smart Growth goals. The integration of PEVs and charger infrastructure planning into existing regional and local planning processes, such as regional transportation plans, regional air quality action plans, local comprehensive plans, zoning, building and other related ordinances and regulations will be imperative.

Workplace Charging

Many of the issues encountered in multi-dwelling unit charging will also apply to workplace charging. Many of the same obstacles must be overcome to ensure that employers, local governments, and garage/property managers are prepared to provide charging opportunities.

Industry Issues

Pricing and Display Standards

The Council held a presentation and discussion regarding PEV pricing displays and the method-of-sale to be used for PEV customers. The discussion focused upon what would be the most effective means to present PEV pricing display information. One method-of-sale discussed would base the pricing display upon kilowatt hour (kWh) usage, which would attempt to acquaint customers with how much electricity they are drawing from the station, irrespective of the time they spend charging their vehicles. Many members felt that this method-of-sale, was not the best approach and could hinder planned business models for PEV charging. The Council did not reach consensus on this issue.

Currently, the Council does not have official PEV pricing display standards from which to draw. On August 29th, 2012, the National Institute of Standards and Technology (NIST) convened a working group to solidify standards for PEV charging stations. The NIST Working Group will discuss two major topics: the devices' technical standards and the method-of-sale displays. The Working Group will discuss whether the second topic should be based upon kWh usage or the number of hours a PEV user plugs in at the charging station. Both topics will likely be presented and voted on at next year's National Conference of Weights and Measures meeting agenda, scheduled for July 2013.

Interoperability

Another issue that awaits the adoption of standards relates to interoperability and public access to charging stations. Charging service companies provide a range of value-added services to the station owner and the consumer, including billing software and authentication, charger reservations, energy management and asset management. At the moment there are two principal business models for public charging in Maryland. One is a subscription model, the other is the pay-as-you-go model.

The first, as exemplified by NRG eVgo, allows consumers (individual, workplace or multi-unit dwelling manager) to purchase subscriptions from a charging company that provides a turnkey solution for installation, permitting, maintenance, and repair of the charging equipment, as well as unlimited public charging at a network of stations for a fixed monthly fee. This has the advantage of relieving the customer of the upfront cost of charging equipment, and provides a single point of contact.

The pay-as-you-go model, similar to that of gasoline service stations, may feel more familiar to some consumers, but currently under pay-as-you-go consumers must use a proprietary card to access the charging stations of each company. In markets with multiple suppliers of charging stations this has resulted in consumers signing up with multiple service providers, carrying multiple cards for charger access and payment, and visiting multiple websites to locate and reserve charging stations.

The National Electrical Manufacturers Association (NEMA) has convened an industry collaborative in an effort to standardize certain aspects of electric vehicle charging service provider operations. This effort addresses issues related to "roaming," essentially allowing the PEV owner to charge their vehicle at any pay-as-you-go charging station, regardless of network. NEMA expects to have drafted protocols for this effort by the end of 2013. Once standards are developed, any State funded charging options would have to make access equally available to all members of the traveling public and so would require some level of interoperability. An example of this is EZPass which allows consumers to use one electronic toll collection device to access many different public and private toll facilities, but paying the rates set by different providers.

Electrical Grid Issues

The immediate concerns regarding grid reliability were addressed by the legislation, referred to earlier, passed in the 2012 General Assembly Session addressing the potential for PEV clustering and the effect of clustering on the local grid**.** The Council also considered a proposal to provide early notification to utilities on Electric Vehicle Charging Station (EVCS) Installation Applications. Currently, electricity utilities receive notice of the installation of EVCSs following the electrical inspection and certification. Members of the Council representing BGE and PEPCO, the State's two largest electric distribution companies, have expressed a need for the earliest possible notification of applications for EVCSs in order to ensure adequate and reliable electricity service. While this is not currently an issue, as the number of PEV charging stations increases to service a growing number of plug-in PEV owners, localized system reliability problems could develop due to demand on the system. However, because the period between the time when a contractor submits an electrical permit application and completion of the work is so short, the Council does not see much value added by requesting local government inspection offices to send copies of all applications for EVCSs to the electricity suppliers prior to issuance of the certificates.

A remaining issue that may require special attention from utilities is DC fast charging. Currently there are three charging levels available: Level 1 Alternating Current (AC), Level 2 AC and Direct Current (DC) fast charging. Level 1 uses 120-V supported by a standard wall socket. The additional load to the grid from charging the car using Level 1 AC is equivalent to that used by a portable heater. Level 2 AC charges using a 240-V socket, much like the dedicated circuit one might have for an electric clothes dryer. Home charging is generally limited to Level 1 or Level 2.

DC charging equipment requires higher voltage, larger cables, and larger conduit, and thus has greater potential than Level 2 charging to impact utility infrastructure. While DC fast charging is not yet being used for residential PEV charging because of its high voltage and amperage levels, interest in the technology for public charging stations is growing. Thus, it is essential that utilities are informed of specific deployment plans for DC fast charging infrastructure so that the appropriate equipment may be installed and nearby customers will not be impacted.

IV Action Plan: Making Maryland's PEV Vision a Reality

American society and its built environment have been structured around the internal combustion engine automobile for the last 100 years. Habits established over generations do not change quickly unless significant catalyzing pressure is behind that change. The number and complexity of barriers to PEV adoption will only be overcome by a coordinated multi-pronged approach. Research and analysis conducted for the Council to support recommendations for a statewide Infrastructure Plan indicate that, absent a market catalyst such as a sustained period of extremely high gasoline prices, a rapid shift to PEVs will require substantial government support.

The following recommendations for State action are intended to provide sufficient support to reach an ambitious goal of 60,000 PEVs in Maryland by 2020, or 2.3% of the State passenger vehicle fleet.

Some of the recommended actions require only shifts in policy with little immediate fiscal impact and can be undertaken right away (Phase I). Others will require substantial new funding and may have to be implemented over several years as funding becomes available (Phase II). Still others represent potential benefits, but may not yet be ripe for action and will require additional time for study and/or additional resources (Phase III).

Continued Coordinated Action Through the Council:
Many of these recommendations should be pursued within the context of the overarching goal of PEV adoption and will require continued oversight and management with that goal in mind. Therefore the Council's primary recommendations are:

1. To continue Maryland's Electric Vehicle Infrastructure Council until June 30, 2015, (Phase I) and
2. To create a Task Force within the Council to study the issues and opportunities presented by workplace and urban charging and develop solutions and best practices (Phase I).
3. To create a State Agency Task Force to develop policies for PEV charging at State facilities by State employees, including the use of existing electrical outlets, where feasible (Phase I).
4. To identify dedicated staff to implement the Council's recommendations (Phase II).

Policy Direction: (Phase I)

5. The State should place increased emphasis on the electrification of transportation, and its accompanying potential for energy storage and peak load management, as a specific component of the State's overall energy goals. The mandates of State programs and funding sources directed toward petroleum use reduction, GHG emissions reduction, and/or support for renewable energy should be reassessed to ensure support for the advancement of electric vehicles.

6. Develop goals for State agencies to increase the number of zero-emission vehicles in the State fleet through the normal course of fleet replacement so that at least 10% of fleet purchases of light-duty vehicles be zero-emission by 2020 and at least 25% of fleet purchases of light-duty vehicles be zero-emission by 2025. The Department of Budget and Management (DBM) should be directed to investigate:

    - Potential for leasing PEVs
    - Bulk purchase agreements, with local government
    - Bulk purchase or lease agreements with the North East corridor states.
    - Such goals should not apply to vehicles that have special performance requirements necessary for the protection of the public safety and welfare.

7. Integration of EVs into State and regional plans and policies: State government should promote EVs through engaging all levels of government in a collaborative approach to EV-friendly plans and policy development consistent with State and Local Smart Growth goals. Policy should include integration of EVs and infrastructure planning into existing regional and local planning processes, such as regional transportation plans, regional (nonattainment area) action plans, local comprehensive plans, zoning, building and other related ordinances and regulations.

Incentives

The Council has identified vehicle price and range anxiety as two principle obstacles to expanded adoption. A review of the available literature indicates that PEVs will continue to face strong competition in the marketplace from new less expensive conventional and hybrid vehicles, especially as those vehicles achieve better and better fuel economy. To counter the high purchase price, it is likely that a variety of incentives will be needed to more quickly achieve a critical mass of consumer and commercial acceptance. Maryland has had several incentivizing initiatives that address the costs of vehicles and charging equipment. Some programs are completed, while some are scheduled to sunset in 2013.

It is the recommendation of the Council that currently active incentive programs be extended/expanded and new incentives be instituted as outlined below.

Recommended Incentives

8. PEV Excise Tax Credit The PEV Excise Tax Credit expires July 1, 2013. The Council recommends that the Legislature extend and expand the current statute. Recommended Actions:
   - Extend the statute expiration date to July 1, 2016 (Phase I).
   - Remove the 10 vehicle limit placed on businesses (Phase II).
   - Consider turning the credit into a point of purchase rebate to reduce the consumer's cash outlay (Phase II).
   - Consider expanding beyond the 8500 pound weight limit (Phase II).

9. PEV Charging Station Income Tax Credit The Council recommends that the Legislature extend the program for an additional 3 years (Phase I), and remove the 30 charging stations per business entity limit imposed in the statute (Phase II).

Past and Current Maryland Incentives

Electric Vehicle Infrastructure Program (EVIP) *–Complete: This grant program aided the installation of PEV charging stations. Two grants were issued under this program totaling $594,000. Eighty-one public stations were installed.*

Maryland Hybrid Truck Initiative (MHTI) *– Complete: MEA partnered with Maryland Clean Cities and ARAMARK, Efficiency Enterprises, Nestle Waters North America, Sysco Corp. and United Parcel Service to implement a heavy-duty hybrid truck project. This project used $5.9 million in grant funding to help offset the cost to purchase 143 Freightliner hybrid electric vehicles and Freightliner Custom Chassis hydraulic hybrid vehicles designed for local goods movement fleets. One hundred and nineteen of 143 vehicles have been deployed.*

HOV Lane Use *–The HOV Lane Use statue, enrolled in 2010, allows the use of high occupancy vehicle lanes by certain PEVs. (Sunsets June 30, 2013)*

Electric Vehicle Tax Credit *– In 2010 the General Assembly passed a credit against the motor vehicle excise tax for certain PEVs. Each vehicle is eligible for up to $2,000. (Sunsets July 1, 2013)*

Electric Vehicle Supply Equipment (EVSE) *Charging Station Tax Credit – Enrolled in 2011 this statute allows a State income tax credit of up to $400 for tax years 2011, 2012, and 2013 for 20% of the cost of electric vehicle charging equipment placed in service by the taxpayer. Business entities are capped at 30 chargers per business.*

Maryland Electric Truck (MET) Voucher Program *- This Program, announced in October 2011, is funded by MDOT and administered by the Maryland Energy Administrtion (MEA) in partnership with MDOT, Maryland Department of the Environment (MDE) and the Maryland Motor Truck Association (MMTA). The Program provides vouchers to Maryland-registered motor truck carriers to offset the increased cost of acquiring, by purchase or by lease, higher priced one hundred percent (100%) electric, zero-emission, medium and heavy duty trucks.*

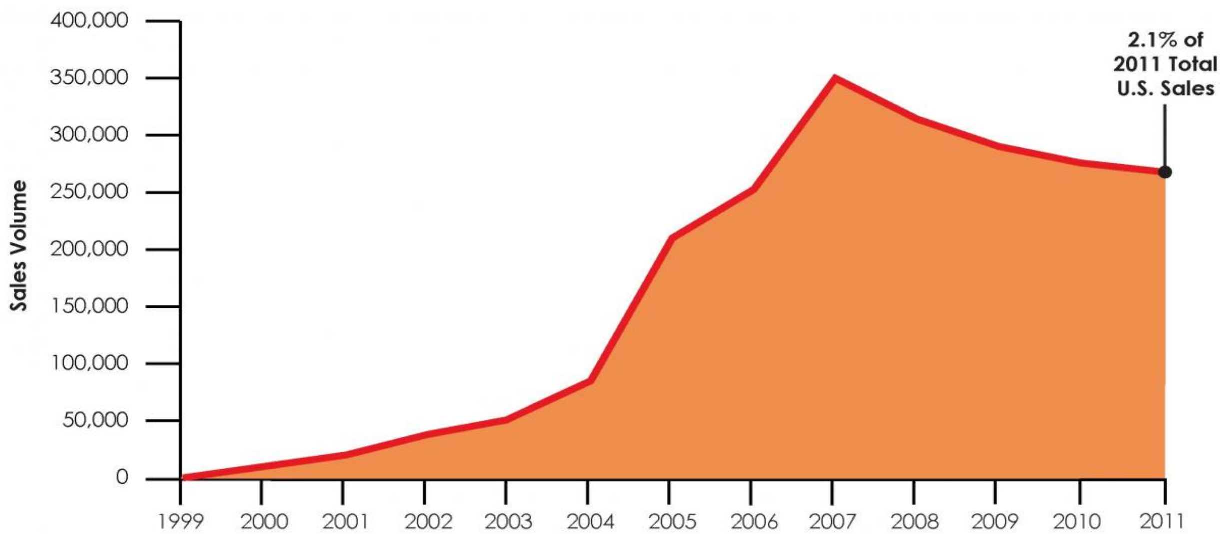
10. Support extension of the Federal Section 30C tax credit for alternative fuel infrastructure: The IRS Code Sec 30C alternative fuel vehicle refueling property credit (commonly referred to as the infrastructure or 30C credit) originally provided 30% of the cost of any property for storing (at the point of dispensing) or dispensing alternative fuel placed in service after 2005 and before the end of 2009. These credits were extended through 2011 (Phase I).

11. Extend the HOV Lane Use Permits to 2020, continuing the caveat to consult with the Maryland State Highway Administration (SHA) on potential congestion management (Phase I).

12. Multi-dwelling Unit Charging Grant Program: Establish a grant program to assist in the funding of Electric Vehicle Support Equipment (EVSE), installation and the initial procurement of transaction management software for multi-unit dwellings, including apartments, condos and managed community parking (Phase II).

Education and Outreach

Consumer and commercial acceptance will play a central role in the expansion of the electric vehicle market. Non-plug-in hybrids have been in the U.S. market for over 10 years and while they are now considered mainstream by most people, in reality hybrids are still in the earliest phase of acceptance reaching just 2.1% of total U.S. sales in 2011.[27]



Given the consumer and commercial wariness typical with any significant innovation, it is vital that the State's outreach be broad enough to accomplish the following goals:

- Succinctly state the reasons for the State's support for PEVs;
- Inform potential buyers of the benefits of PEVs;
- Increase Marylanders familiarity with PEVs as part of "the norm;"
- Inform potential buyers of real costs and incentive programs;
- Provide information on available charging options;
- Dispel misinformation/rumors;
- Allow the State to gauge the consumer's level of interest and understanding; and
- Create a resource for businesses and communities interested in implementing sustainable programs.

[27] Driving Fuel Economy.com, a project of the Association of Global Automakers, a Washington D.C.-based trade association that represents international motor vehicle manufacturers, original equipment suppliers and other automotive-related groups.

The Council's recommendation for a full outreach plan includes the following necessary components:

13. ***Logo*** (Phase I)
Adopt a specific symbol or logo to identify State funded or supported PEV equipment, technology or materials, i.e., a StatePEV website, posters, newsletters, materials etc. This logo would be prominently displayed on Maryland State Fleet Vehicles that are PEV. If a PEV License Plate or decal becomes a requirement to utilize public charging parking spaces (if spaces become regulated) or use HOV with one occupant, etc. the logo would be used on the license plate or decal.

14. ***Website*** (Phase I)
For most people the internet is now the primary source of information. According to the Pew Internet and American Life Project, up to 84%of all Americans now expect the Internet's World Wide Web to provide them needed information on government, news, and commerce. A State website should be developed for Maryland specific PEV information on any incentives, regulations, and programs, with links to other PEV sites. The site can be used to promote any related State priority, such as choosing renewable energy for consumers' electricity generation. Samples of potential website layout and navigation, along with estimated costs for site development and maintenance of the types of sites suggested, are contained in the Outreach and Communication Plan attached as Appendix A.

15. ***Workshops*** (Phase II)
It is recommended that educational workshops or webinars be conducted for developers, property managers and homeowner associations about the benefits of providing charging for residents. Provide information about best practices and ways to implement charging programs. Cover applicable regulations, any incentives available, real world costs of charger installation, the most cost-effective options, the possibilities for using renewable energy in support of charging, and the types of charging options and management services available. Workshops should provide models for dealing with issues such as the allocation of electricity and maintenance costs, reservation of parking spaces, installation issues, and policies for visitor use. Workshops should also provide a showcase for charging and management service businesses active in Maryland. Workshops/webinars could be provided through partnership with PEV non-profits.

16. ***Guidance Documents*** (Phase I)
In order to enable local governments and urban property owners and managers to incorporate infrastructure in an orderly manner, the Council recommends that a series of guidance documents be developed to provide examples. The Transportation and Climate Initiative (TCI)[28] and other initiatives have produced guidance documents that could be the basis of Maryland guidance documents, along with the findings of the Council's workgroups.

- <u>EV Infrastructure Planning Guide for Local Governments</u>**:** To include model documents and guidelines for permitting, siting and design, building codes, and zoning, including historic district overlays, and parking ordinances.

- <u>Guidance Document for Local Governments:</u> Pertaining to the issues and complexities of providing urban charging and potential solutions.

- <u>Guidance Document on Charging in the Multi-Unit Dwelling Setting</u>**:** Using information developed by the EVIC Workgroup, provide information on best practices in the implementation of charging programs. The document should cover applicable regulations, available incentives, real world costs of charger installation, the most cost-effective options, the possibilities for using renewable energy in support of charging, and the types of charging options and management services available. It should provide models for addressing issues such as the

[28] The TCI is a regional collaboration of 12 Northeast and Mid-Atlantic jurisdictions that seeks to develop the clean energy economy and reduce greenhouse gas emissions in the transportation sector. Current TCI documents are attached as Appendix C.

allocation of electricity and maintenance costs, reservation of parking spaces, installation issues, and policies for visitor use. (This document could be used in conjunction with recommended workshops.)

Guidance should include templates or "sample policy" documents that homeowner associations, condo associations, apartment complexes, etc. can use in adopting their own policies.

17. ***General Information Materials*** (Phase II) An E-Newsletter, printed brochures and presentation materials for use at venues such as Maryland Association of Counties (MACO) and Maryland Municipal League (MML), and events such as the Motor Trend International Auto Show, the State Fair and the annual Green Festival will also be needed. Existing advocacy organizations such as BEVI and Plug-In-America, and chambers of commerce could be enlisted to partner in these events.

Ongoing web meetings can provide current information on emerging technologies, smart grid applications and the benefits of installing charging in new construction.

Promotion of Infrastructure

Governments and the private sector have invested heavily in the physical and transactional infrastructures that support fossil-fueled vehicles. The private sector has invested in a complex vertical infrastructure that on the retail level is manifested by abundant service and fueling stations. Governments have invested in public road access to fueling stations, public lands for crude oil extraction and pipeline location, and assorted other investments and regulations that underpin the vast market for fossil-fueled vehicles. The sunk costs of such infrastructure still provide huge financial benefits that are in turn barriers for private sector investors in and purchasers of alternatively-fueled vehicles. Public investment in infrastructure for PEVs, charging stations and upgraded grids for example, are justified as a way to rebalance public support for vehicular transportation and spur the entry of PEVs. Public investment in PEV infrastructure also helps mitigate the negative externalities of fossil-fueled vehicles, such as air, water and noise pollution, which are incurred by society-at-large.

Worthwhile infrastructure investments should be made after careful study and planning. Poorly planned charging station locations could result in underutilized facilities and meager or no returns to public and private capital. They could also have negative impacts on public policy, trip distribution and travel mode choice, and have implications for local zoning and land use. These concerns and potentially wide-ranging impacts have led to a thorough assessment and thoughtfully developed statewide infrastructure plan, supporting policies and recommendations, and calls for further research.

As part of the Council's charge to develop a recommendation for a statewide charging infrastructure plan, including placement opportunities for public charging options, the Council, through Maryland Department of Transportation, completed technical analysis to support the recommended plan. The full plan resulting from that analysis is attached as Appendix B.

This analysis included assessments specific to Maryland for:

- likely PEV market penetration;
- forecasting of daily PEV travel demand;
- forecasting of demand for chargers by type (Levels 1, 2 and DC Fast charging) and geographic location for non-home charging needs; and
- optimal locations to provide charging for through trips and tourism oriented trips.

The future of PEVs in Maryland will depend on many factors, as discussed both in this report and in the attached Infrastructure Plan. As part of the technical analysis, three possible scenarios were developed for Maryland:

- Low Adoption Scenario – Relies on market forces only, assuming reasonable market penetration for a new technology with phased out institutional support.

- **Medium Adoption Scenario—A goal of 60,000 PEVs by 2020 and 300,000 by 2030, assuming continued stable market conditions and institutional support.**

- High Adoption Scenario—Assumes stable market conditions and institutional support as well as other economic forces –such as a substantial sustained increase in the price of gasoline and/or periodic shortages.

For the purposes of this Action Plan, the Medium Scenario was selected as the Council's recommended goal, both for the level of support and infrastructure needed. This scenario provides charger infrastructure slightly in advance of demand in order to alleviate range anxiety and spur adoption.

The recommended plan assumes that the majority of PEV owners with dedicated parking will charge primarily at home, however, as noted earlier, a significant number of Marylanders do not have access to dedicated parking at home, and many have commuting patterns that will make an interim charge desirable if not necessary. The Plan's recommended levels of infrastructure assume that workplace charging will be the second most important location for charging, after the home, and includes numbers and target areas for both workplace and public charging. The Plan's infrastructure goals are based on the assumption that drivers of plug-in hybrid vehicles (such as the Chevy Volt) will want to recharge at work, while drivers of battery-only vehicles (such as the Nissan Leaf) who need a charge to complete their daily tour will also charge at the workplace and other locations (i.e. shopping centers, etc.).

The Plan estimates the demand for charging equipment across the State by county and Minor Civil Division (MCD). MCDs are administrative subdivisions of counties with comparably sized populations used for presenting statistical/geographical data in the U.S. Census. Maryland's 290 MCDs roughly corresponded to election districts and assessment districts.[29] Chargers are also allocated by equipment type (Level 1, Level 2 and DC Fast Charge). The total number of chargers, excluding home chargers, statewide that would be needed to support 60,000 vehicles was estimated at 35,190. Of these, 120 locations were identified to accommodate tourism and through travel in locations such as rest areas, along major roads, and at tourism destinations serving more than 500 visitors per year.

It is anticipated that many of these chargers would be installed by private sector parking managers driven by consumer demand in locations such as parking garages and shopping malls. Employers that provide parking and managers of commercial parking lots will typically charge a fee for the service, while some commercial establishments may allow free charging as an inducement to customers. Thus far in Maryland Walgreens has been the leader in this type of effort, installing charging stations at 23 of its stores in the State, obtained from the Maryland-based start-up manufacturer, SemaConnect.

As of November 2012, seventy-three charging stations have been installed at state facilities. Twenty-eight Level 2 chargers are located at transportation facilities, such as BWI Airport, the BWI MARC Station, and several MTA and SHA Park and Ride facilities. Forty-one chargers have been installed by the University of Maryland at the various University facilities throughout the State, two have been installed at the Maryland Department of the Environment (MDE) and two are located at the Capital Complex garage in Annapolis. Many of these stations were provided by the Baltimore Electric Vehicle Initiative (BEVI) through a Grant from MEA/Clean Cities. Under the terms of that grant these stations must be free to the public through the grant period which expires March 31, 2013.

In order to spur adoption, it may be necessary for the State to provide a sufficient network of public chargers to allay drivers' range anxiety and allow PEV drivers to travel safely across the State. If the private sector does not perceive public charging stations as supporting sufficient profit in certain locations, there may be insufficient stations to meet the

[29] For this report the MCDs at the time of the 2000 Census were used.

public need. It should be noted, however, that care should be taken to keep State-provided chargers from out-competing commercial chargers.

State Charging Station Recommendations:

18. The State should promote, through new and existing programs, and incentives, and in conformance with the State's goals for Smart Growth, the establishment of adequate PEV charging infrastructure to support a goal of 60,000 PEVs on the road by 2020 (Phase I).

19. There are currently seventy-three charging stations accessible by the public installed at State facilities. The Council recommends that the State monitor the installation of private sector charging facilities across the State and continue to add charging infrastructure at State facilities in areas that are underserved (Phase I).

20. Many of the stations currently located at State facilities were obtained from the Baltimore Electric Vehicle Initiative (BEVI) through a grant from MEA/Clean Cities. Under the terms of the grant, these stations were required to be free to the public until March 31st, 2013 and to collect certain data on utilization through operating software subscriptions, also obtained through the grant. The Council recommends that the State retain the data collection software and continue to allow public access to these charging stations, free of charge until June 30, 2014.

    In the interim, host agencies shall collect data on the usage of the stations and the amount of electricity used in order to facilitate planning for future installations, electrical infrastructure and cost recovery. Utilization data will be available to the public (Phase I).

Urban Charging Infrastructure Recommendations

21. Urban Charging**:** In urban areas, State and local officials, along with utilities, businesses and property managers should discuss options for wiring existing publically and privately owned garages for charging. Parking facility managers could then incorporate that service into long-term parking agreements with urban area employers for daytime use by employees and make the spaces available to urban residents for charging at night. As part of this effort, third party EV charging service providers should be encouraged to work with parking facility operators to make charging available (Phase I).

22. Pilot Projects: Recognizing that up to 46% of Maryland residents do not have private access to an electrical outlet, pilots could demonstrate options for shared use of existing parking facilities, allowing urban residents to park & charge at night in facilities that are used for business or employment during the day.

    Urban Residents Demonstration Projects (Phase II):

    - Work with a local county or municipality to install and make available charging stations in government parking garages for city resident charging.
    - Work with county or municipality to identify off-street outdoor parking locations where local resident PEV charging can be provided (Level 1 and Level 2).
    - Work with a business or institution to make Level 1 and/or Level 2 PEV charging available to nearby residents.
    - Work with a multi-unit dwelling owner or property manager to make Level 1 and Level 2 charging available for one or more spaces in a shared parking facility and arrange for tracking and billing for electricity usage by residents.

Charging Solutions
Local governments will likely need to provide public charging in urban areas to accommodate urban dwellers and other users, in much the same way that they now provide public parking. Baltimore City and Baltimore County have already begun to install charging equipment in municipal garages. Employers and apartment complexes are other entities likely to begin to provide charging to meet demand. Due to the complexity involved in installing and managing chargers in existing facilities with multiple users, it may be necessary to provide incentives or assistance to some of these entities to ensure sufficient early adoption to support PEV purchasers who do not own their own parking. In the meantime, a number of public policy measures and best management practices should be considered.

Local Government Solutions

23. Revision of Zoning and Planning Codes: Municipal zoning and planning codes should be amended to permit and regulate on-street PEV charging, require PEV parking spaces in new developments and re-development initiatives and include siting and design guidelines for PEV charging stations, Level 1 outlets and parking spaces.

24. Historic District Restrictions: State and local zoning and historic district codes should be reviewed for the existence of provisions that could effectively prohibit the installation of PEV charging stations and outlets in historic districts or in close proximity to historic properties. The adoption of code amendments that prohibit unreasonable restrictions on the installation of charging equipment in historic districts while conforming to the federal requirements may be necessary to ensure the location of an adequate number of charging stations and outlets in these communities. Reasonable alternatives, such as siting charging stations in adjacent public and/or business parking areas should be considered and encouraged.

25. On-Street Parking: Building on the municipal parking permit model for residential on-street parking, local government-owned and maintained PEV charging stations (Level 2 charging) and 120V outlets (Level 1 charging) can be installed and made available in designated on-street spaces for use by residents who purchase a PEV upgrade to their on-street parking permit.

26. Measures to Discourage Overstaying: There are a number of possible measures that, if adopted, can discourage overstaying. Limiting the number of hours a car can occupy the parking space, with associated fines, is one option. Rate structures can also be an effective disincentive. Usage of a pricing mechanism that is based on hourly rates and charges progressively higher rates once the vehicle is fully charged, alone or in combination with the automatic assessment of additional "inconvenience fees," is another option that could encourage drivers to move their vehicles once they are fully charged.

Multi Dwelling Unit Solutions

27. Charging and Metering Configurations: To address challenging parking and metering configurations at multi-dwelling unit properties property owners and managers should consider the addition of Level 2 chargers at unassigned shared parking spaces in configurations that maximize the number of spaces that the charging cord can reach.

28. Clustering Level 1 Charging: Assigned parking spaces can be reassigned to locate parking for PEV drivers in clusters close to 120V outlets.

29. Allocation of Costs and Responsibility for Installation and Maintenance of Charging Stations: Installing necessary panel and wiring upgrades and maintaining the PEV equipment in good repair, and tracking and paying for the electricity usage is a threshold issue for all multi-dwelling unit residents and property owners. The following strategies should be considered:

    - Use of a business model in which a charging station provider, at its own expense, installs, maintains and owns the charging station and rebates the cost of electricity usage back to the property owner. The PEV owner pays for access to charging in the network through a monthly membership fee. (www.PEVgonetwork.com)

    - Installation of charging stations by the property owner who recovers the cost of the station and electricity usage through add-ons to leases or, in condominiums or cooperatives, through a special assessment for PEV drivers.

    - Future State and/or local government programs to support the installation of PEV charging in these more challenging environments and reduce the cost to the property manager/owner.

Permit Streamlining - No Action required

The Council's enabling legislation included the directive that the Council "assist in developing and coordinating statewide standards for streamlined permitting and installation of residential and commercial PEV charging stations and supply equipment." In Maryland, electrical permitting is administered and managed by the local governments. Thus each jurisdiction has established its own separate permitting requirements and application forms.

Based on extensive outreach to the Chief Electrical Inspectors from the local jurisdictions, including regional meetings and an on-line survey, the Council concluded that there are no significant existing barriers to the permitting of EVCS in the State, and thus, makes no recommendations for changes to the current permitting processes. Summaries of the existing permit processes, and a more detailed account of the Council's outreach efforts is attached as Appendix B, while the survey questions and responses are attached as Appendix C.

Pricing Display (Phase III)

The Council recommends that no action be taken to fix a pricing display model for Maryland until after the national standard has been developed and adopted by the National Institute of Standards and Technology (NIST), as those standards are anticipated in July 2013.

Changing Technology: *PEVs, the Electricity Grid and Renewable Energy*

Much like the rapid evolution of personal computing or the cellular telecommunications industry, the plug-in electric vehicle, its attendant charging industries and the interface with the emerging smart electrical grid[30] have the potential to create new synergies and fundamentally reshape the way we use resources. Public and commercial support of research on more efficient batteries and infrastructure, battery ownership, connected vehicles, air quality and trip modeling, human factors, and their economic impacts should result in benefits to public knowledge, health and safety, as well as transportation and power systems efficiency, while promoting PEV market acceptance.

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[30] A Smart Grid is an electricity network that uses digital monitoring technologies to efficiently deliver electricity wherever and whenever it is needed. Smart meters are equipped with sensors, switches and communications capabilities which enable connection to a PC or directly to smart appliances in the home and office, enabling installations to be controlled automatically. The meter is in communication with the grid company, allowing for remote control by the company and providing instant access to electricity consumption and pricing information to customers.

Maryland's goals for grid reliability, the implementation of a smart grid and the expansion of the State's renewable energy portfolio have thus far been independent from its PEV efforts. Integrating PEVs and other forms of energy storage into the electrical grid, while continuing the shift to renewable energy generation, may prove synergistic. Smart grid deployment began in Maryland in 2011 with the Public Service Commission's (PSC) approval of plans from the State's two largest electricity utilities, BGE and PEPCO. Delmarva Power has begun implementation of its approved plan, and Southern Maryland Electric Cooperative (SMECO) currently has an application under review for approval by the PSC. Smart grid will allow more sophisticated implementation of automated demand-response[31] programs for load management, such as BGE's "Peak Rewards" and Pepco's "Energy Wise Rewards". Under these voluntary programs electricity customers allow their utility to control their use of air-conditioning during peak load times in the summer months in return for rebates. Emerging technologies and communications between the grid and PEVs could eventually enable PEV owners to opt into programs that apply demand-response to PEV charging.

In PEV demand response scenarios, charge rates could increase or decrease to match intermittent renewable generation as well as rewarding off-peak charging. These demand response programs, which might allow consumers to charge their PEVs based on utility price and energy availability signals, could improve load predictability. This in turn could help balance intermittent wind generation, optimize the use of thermal power plants, and produce net cost benefits.

"Smart charging" technology supported in the EVSE could eventually enable a suite of services, including demand response, load shaping, remote utility operation, Vehicle-To-Grid charging (V2G), renewable generation integration, and more. Companies such as Coulomb Technologies, NRG, ECOTality, GE, Siemans and the Maryland-based SemaConnect represent companies that have already developed the EVSE hardware and software to network and manage charging infrastructure, provide billing systems and enable services for driver and grid applications.

In addition to the load-shaping benefits of demand response programs, automotive-grade batteries themselves (in use onboard a PEV or in stationary applications) may represent a flexible source of additional electrical capacity that could potentially be used to optimize grid resources. When PEV batteries retire from vehicles, up to 70% of their original storage capacity may remain, and they may be repurposed for stationary storage applications. Developing and proving clear, valuable secondary applications for PEV batteries may help to reduce production costs and end-of-life costs, expand the battery markets, and improve the resale value of PEVs. In turn, PEV lease rates would likely decline, along with lifetime costs of PEV ownership.

Ideally, wide-scale adoption of electric vehicles has the potential to provide a new asset for Maryland's electricity grid that can enable positive load management, energy storage and other services to integrate cost-effective renewables into the grid.

At this point there are many unknowns. The cost durability of vehicle batteries, their ability to compete in electricity markets, and the feasibility of battery second-use applications on a large scale remain to be proved. Appropriate technology, standards, and communication protocols still need to be developed to enable these potential applications. Additional research and demonstration projects are needed to establish the case for secondary use applications for PEV batteries. Many potential markets for secondary use of vehicle batteries will not materialize until the first generation of PEVs begins to retire, perhaps at the end of the decade.

For PEVs to achieve their enormous potential for GHG reduction, PEV charging infrastructure must be networked and equipped with communication capabilities to allow for appropriate metering and billing of electricity to PEVs, to accommodate grid contingencies, to shift charging off peak when feasible and appropriate, and otherwise assist in managing loads to promote utilization of low-carbon energy and avoid the costs of upgrading or adding new non-renewable generation to the grid.

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[31] Demand response allows for maximization of the electrical grid through the reduction or shifting of customers' electricity usage during peak periods in response to time-based rates or other forms of financial incentives, better balancing supply and demand.

The role of PEVs in the overall electricity market will require standardized development and coordination from all stakeholders, including grid operators, utilities, automakers, PEV charging service providers, and consumers. EVSE services enabling load management of PEVs to create a grid benefit—such as aggregation and active charge management—should be eligible for any existing or new programs, incentives or market services that reward load curtailment or energy storage.

Maryland policy should continue to support and encourage innovation and private sector investment in PEV technologies and services. Sustainable job growth in the PEV sector will come largely from industry supply chains, including PEV design and manufacturing; component and subcomponent part design and production; charging infrastructure development, installation, and maintenance; research and software development for smart charging; and supplier services. Rapid advancements in technology have the potential to eliminate the need for subsidies in a relatively short time.

The primary technology initiative currently underway in Maryland is the **Electric Vehicle Pilot Program** mandated in the Public Utilities Article, 7-211. The Electric Vehicle Pilot Program requires the Public Service Commission (PSC) to establish a pilot program for charging electric vehicles by June 30, 2013. This program requires participants to include incentives for residential, commercial, and governmental customers to recharge electric vehicles in ways that will accomplish specified goals namely modifying behavior so that recharging occurs during off peak hours. The PSC must report to the Governor and the General Assembly on the program by February 1, 2015. The intent of this pilot is less to encourage PEV purchase than to encourage off-peak charging, but if it results in Time of Use rates for PEV charging, that could represent an incentive to PEV purchasers.

With several new standards coming online in the 2013 -2015 timeframe, along with the results of the PSC Pilot Program, many aspects of this industry will then become ripe for policy decisions. The State should continue to encourage innovation in PEV technology and to examine the economics of emerging technologies. In addition to the Task Force on Urban/Workplace Charging, the Council also recommends:

30. Technical Workshops: The Council recommends that the PSC hold technical workshops to gather information on innovations in the interface between PEVs and the electrical grid, including both technical feasibility and cost/benefit. (Phase I)

    Workshop topics should include:

    - Vehicle –to-Grid (V2G);
    - Vehicle to Home; and
    - Potential for use of down-cycled batteries for power storage.

31. Investment: The State should continue to foster emerging PEV technologies and their potential for a role in electrical grid management through existing financing vehicles, such as InvestMaryland. (Phase I)

32. Financing : The State should explore opportunities to reduce the upfront costs of PEVs and charging infrastructure installation through public/private financing to allow for the provision and underwriting of low-interest, low-risk loans to energy projects that further the State's energy goals, and to link EV charging to renewable energy and grid management. (Phase II)

Measuring Success – Performance Metrics

- PEV sales per year;
- Non-state charging station installations;
- Forecast of emissions from statewide transportation planning model with PEV deployment; and
- Growth in jobs in PEV related industries.

Future Research Recommendations

- ***Impact of PEVs on the transportation infrastructure system and methods for PEVs to contribute to the Transportation Trust Fund.*** A recent Congressional Budget Office (CBO) study concluded that the currently proposed new CAFE standards for fuel efficiency will cause a 21% drop in revenues for the federal Highway Trust Fund by the time their full impact is felt (estimated to be in 2040).[32] Although the authors do not state the extent to which electric vehicles are included in their calculations, the CBO study underscores the fact that revenue erosion related to increased PEV use is only a piece of a larger problem. The Transportation and Climate Initiative (TCI), of which MDOT is a member, is currently exploring the effect of widespread PEV deployment on state transportation revenues and has commissioned an in-depth Final Report which is intended to provide a user-friendly guidebook to revenue issues and options that can be used as a basis for practical action.

  MDOT should follow up on the Blue Ribbon Commission mandates to further study (1) the development of revenue mechanisms that are directly tied to the use of the transportation system, and that take into account the transition to alternative fuels (e.g. electric vehicles) and enhanced fuel economy (e.g. hybrid vehicles), commonly referred to as mileage-based or vehicle miles traveled (VMT) charges and (2) consideration of energy taxes as an alternative or additional funding approach in conjunction with electric vehicle penetration. (Phase III)

- **Other Research Areas** (Phase III)

  - Impacts of PEV deployment and infrastructure investment on driver behavior, auto level of service variables (PEVs and conventional vehicles), and nested mode choice within travel demand models;
  - Battery technology, swapping, and ownership models;
  - PEVs case study on implementation of Vehicle-Miles Traveled fees;
  - Estimation of PEV life cycle costs/incentives/equity; and
  - Driver behavior and range anxiety by socio-demographic characteristics.

Legislation

1. Extend the Electric Vehicle Infrastructure Council beyond its current sunset date by two years, to June 2015. (Phase I)

2. Extend existing incentives (Phase I)

3. Consolidate and amend Maryland's existing definitions of "qualified plug-in electric drive vehicle" and "plug-in vehicle" and move to an appropriate section of law. Currently these two different definitions are located in sections of the Annotated Code that pertain to incentives, both of which have expiration dates. In addition, the Council's legislation in the 2012 legislative Session, SB 998 / HB 1279 Motor Vehicle Administration -Plug-In Vehicles - Disclosure of Personal Information, as passed by the General Assembly, reference the term "plug-in vehicle" as defined in section 25-108 of the Transportation Article. Section 25-108 currently sunsets on September 30, 2013. Because that section, including the definition of "plug-in vehicle" is subject to abrogation, it is recommended that PEV be separately defined and located in statute. The Council also recommends that the definition be amended to include vehicles that have been converted to plug-in status aftermarket . (Phase I)

4. Restrictive Covenants Ban**:** Legislation, similar to the California and Hawaii legislation, prohibiting HOAs from banning or placing unreasonable restrictions on EV charging station installation and use in common parking areas was discussed by the Council. There is precedent for such legislation in Maryland. Two bills – one prohibiting unreasonable homeowner association restrictions on the installation of solar collection systems (Chapter 138), and the other (Chapter 253) prohibiting unreasonable restrictions on the installation and use of clotheslines – were enacted by the General Assembly and signed into law in 2008 and 2010, respectively. The

[32] Congressional Budget Office, 2012.

Council recommends that no action be taken in this Legislative Session, but that ground-truthing and outreach to affected communities should occur during 2013 in preparation for legislation in 2014. (Phase III)

2012 Legislation Referred to the Council for Summer Study

Two bills affecting PEVs were introduced in the 2012 Legislative Session and subsequently referred to the Council for additional study and comment. These were:

- SB 340 / HB 108 - Vehicle Laws - Stopping, Standing, and Parking - Plug-In Vehicles; and
- HB 683 - Electric Vehicles - Use of High Occupancy Vehicle Lanes - Reciprocity with Virginia.

Based upon extensive review and discussions, the Council recommends that these issues are not yet ripe for legislative action.

SB 340 / HB 108 - Vehicle Laws - Stopping, Standing, and Parking - Plug-In Vehicles: This bill prohibits a person from stopping, standing, or parking a vehicle that is not a plug-in vehicle in a space that is marked for the use of plug-in vehicles and provides access to a plug-in vehicle recharging station. The intent of the bill was to ensure that PEV drivers would not be precluded from needed access to a charging station by a non-PEV driver's use of the charger space.

Pros and cons were raised during committee hearings and ultimately the bill passed through the Senate with two amendments:

- The EV must be plugged-in while in the space and must vacate upon reaching a full charge; and
- All penalties collected from violations of this law shall be distributed to the Transportation Trust Fund (TTF).

These amendments served to increase the complexity of the issue. It is anticipated that many charging stations will be installed by business owners as a courtesy to their customers. While the availability of charging is an important issue, it was felt by some that business owners would be discouraged from installing chargers if they could not manage them in a way they deemed most beneficial to their customers. In some public situations, such as airport parking and park and ride lots for transit or carpooling, long-term parking is the norm and does not lend itself to vacating a charger space upon reaching a full charge.

On the TTF issue, since enforcement of such a parking regulation would fall largely to local governments, it was felt that this placed a burden on those governments while diverting from them a revenue source for that enforcement.
The Council's Workgroup on Urban Charging found that there are other measures that could be implemented to discourage overstaying at charging stations without attempting a blanket regulation that may not be appropriate to all circumstances. Limiting the number of hours a car can occupy the parking space, with associated fines, is one option. Rate structures can also be an effective disincentive. Usage of a pricing mechanism that is based on hourly rates and charges progressively higher rates once the vehicle is fully charged, alone or in combination with the automatic assessment of additional "inconvenience fees," is one option that could encourage drivers to move their vehicles once they are fully charged. In areas where extended or overnight parking is intended and encouraged (i.e., park and ride locations, transit and airport extended parking locations, specifically designated overnight parking spaces for city/urban locations) these restrictions would not be applied.

The Council's recommendation is that action on this issue be deferred until local governments and/or market forces have had more opportunity to address it in ways appropriate to different situations. (Phase III)

HB 683 - Electric Vehicles - Use of High Occupancy Vehicle Lanes - Reciprocity with Virginia This bill would have required that electric vehicles registered in Virginia that qualify for the use of high occupancy vehicle (HOV) lanes in Virginia be allowed to use HOV lanes in Maryland; and making the Act subject to a specified contingency related to enactment of a similar Act in Virginia providing for reciprocity for electric vehicles registered in Maryland.

It is agreed that HOV reciprocity is desirable, but this issue is also more complex than it appears on the surface. Virginia's HOV laws are complicated and rely on vehicle eligibility that changes according to vehicle model year and the HOV facility in question. These eligibility requirements are not compatible with Maryland's existing PEV definition in law, nor would the Council recommend that Maryland alter its PEV definition to match Virginia's. Additional questions were raised as to whether Pennsylvania should also be included in any such attempt at reciprocity.

Several regional groups including the Metropolitan Washington Council of Governments (MWCOG) and TCI, which encompasses twelve states, are already in the process of examining this issue.

The Council's recommendation is that action on this issue be deferred until these regional organizations have had the opportunity to propose a multi-state solution. (Phase III)

Appendixes:

- A - Recommendation Matrix
- B - Statewide Infrastructure Plan
- C- TCI Guidance Documents
- D- Permit Streamlining Outreach Process
- E- Electrical Inspector Survey Results
- F- Council Membership

Appendix A

Recommendations

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Recommendation Phase I Phase II Phase III	Phase	Legislation Required
Coordinated Action		
1. A coordinated effort to promote PEV adoption will require continued oversight and management. It is recommended that the EVIC be continued beyond its current sunset date of 6/13.	I	Yes
2. Creation of an Urban/ Workplace Charging Task Force to specifically study the issues and opportunities presented by workplace and urban charging and develop solutions and best practices.	I	
3. Creation of a State Agency Task Force to develop policies for PEV charging at State facilities by State employees, including the use of existing electrical outlets where feasible.	I	
4. Dedicated staff should be identified to implement the recommendations of EVIC.	II	
Policy Changes		
5. The State should place increased emphasis on the electrification of transportation, and its accompanying potential for energy storage and peak load management, as a specific component of the State's overall energy goals. Several aspects of current state policy are technically in conflict with the goal of expanded PEV adoption. The mandates of State programs and funding sources directed toward petroleum use reduction, GHG emissions reduction, and/or support for renewable energy, including the programs of instrumentalities such as the Maryland Clean Energy Center, should be realigned where necessary to ensure support for the advancement of Electric Vehicles.	I	
6. Institute goal for state agencies that the state vehicle fleet increase the number of its zero-emission vehicles through the normal course of fleet replacement so that at least 10 percent of fleet purchases of light-duty vehicles be zero-emission by 2020 and at least 25 percent of fleet purchases of light-duty vehicles be zero-emission by 2025. This directive shall not apply to vehicles that have special performance requirements necessary for the protection of the public safety and welfare. DBM should be directed to investigate: • Potential for leasing PEVs • Bulk purchase agreements, with local government • Bulk purchase or lease agreements with the NE corridor states.	I	
7. Integration of EVs into State and regional plans and policies: State government should promote EVs through engaging all levels of government in a collaborative approach to EV-friendly plans and policy development consistent with State and Local Smart Growth goals. Policy should include integration of EVs and infrastructure planning into existing regional and local planning processes, such as regional transportation plans, regional (nonattainment area) action plans, local comprehensive plans, zoning, building and other related ordinances and regulations.	I	

Recommendation Phase I Phase II Phase III	Phase	Legislation Required
Incentives		
8. PEV Excise Tax Credit The PEV Excise Tax Credit expires July 1, 2013. EVIC recommends the legislature extend the statute expiration date to July 1, 2016	I	Yes
8. b Remove the 10 vehicle limit placed on businesses	II	Yes
8. c Consider turning the credit into a point of purchase rebate to reduce the consumer's cash outlay	II	Yes
8. d Consider expanding beyond the 8500 pound weight limit	II	Yes
9. PEV Charging Station Income Tax Credit EVIC recommends the Legislature extend the program for an additional 3 years.	I	Yes
9. b Remove the 30 tax credit limit imposed in the statute	II	Yes
10. Support extension of the Federal Section 30C tax credit for alternative fuel infrastructure The IRS Code Sec 30C alternative fuel vehicle refueling property credit (commonly referred to as the infrastructure or 30C credit) originally provided 30 percent of the cost of any property for storing (at the point of dispensing) or dispensing alternative fuel placed in service after 2005 and before the end of 2009. These credits were extended through 2011.	I	
11. Extend the HOV lane Use Permits to 2020, continuing the caveat to consult with SHA on potential congestion management	I	Yes
12. Multi-dwelling Unit Charging Grant Program: Establish a grant program to assist in the funding of EVSE equipment, installation & initial procurement of transaction management software for Multi-Unit Dwellings	II	Yes

Recommendation Phase I Phase II Phase III	Phase	Legislation Required
Outreach and Education		
13. Adopt a specific symbol or logo to identify State funded or supported EV equipment, technology or materials, i.e., a State EV website, posters, newsletters, materials etc. This logo would be prominently displayed on State Fleet Vehicles that are EV, as well as on any EV License Plate or decal that may be developed for any state use.	I	
14. Website: A state website should be developed for Maryland specific EV info on any incentives, regulations, programs, plus links to other EV sites. Website can be used to promote any related state priority, such as choosing renewable energy for consumers' electricity generation.	I	
15. Workshops: It is recommended that educational workshops or webinars be conducted for developers, property managers and homeowner associations about the benefits of providing charging. These should provide information about best practices and implementation of charging programs, cover applicable regulations, incentives, real world costs of installation, most cost-effective options, possibilities for using renewable energy in support of charging, and the types of chargers and management services available. Workshops should provide models for dealing with allocation of electricity and maintenance costs, reservation of parking spaces, installation issues, and policies for visitor use. Workshops should also provide a showcase for charging and management service businesses active in Maryland. Workshops/webinars could be provided through partnership with EV non-profits.	II	
16. *Guidance Documents:* is recommended that a series of guidance documents be developed to provide guidance on charger installation, management and regulation. The Transportation and Climate Initiative (TCI) and others have produced guidance documents that could be the basis of MD documents, along with the findings of the EVIC. • EV Infrastructure Planning Guide for Local Governments **:** to include model documents for permitting, siting and design, building codes, and zoning, including historic district overlays, and parking ordinances. • Guidance Document for Local Governments on the issues and complexities of providing urban charging and potential solutions. • Document on Charging in the Urban & Multi-unit Setting**:** To include best practices in the implementation of charging programs. Cover applicable regulations and incentives, real world costs, most cost-effective options, possibilities for using renewable energy in support of charging, charger types and management services available. Provide models for allocation of electricity and maintenance costs, reservation of parking spaces, and policies for visitor use. Should include templates or "sample policy" documents that homeowner and condo associations, apartment complexes, etc. can use in adopting their own policies.	I	
17. Outreach Materials: Should be developed, i.e. brochures, presentations, e-newsletter, webinars on sub-topics.	II	

Recommendation Phase I Phase II Phase III	Phase	Legislation Required
Promotion of Infrastructure: State Charging Stations		
18. The State should promote, through new and existing programs, and incentives, and in conformance with the State's goals for Smart Growth, the establishment of adequate EV charging infrastructure to support a goal of 60,000 EVs on the road by 2020.	I	
19. There are currently seventy-three charging stations accessible by the public installed at State facilities. The Council recommends that the State monitor the installation of private sector charging facilities across the State and continue to add charging infrastructure at State facilities in areas that are underserved.	I	
20. The Council recommends that the State retain the data collection software and continue to allow public to these charging stations, free of charge until June 30, 2014. In the interim, host agencies shall collect data on the usage of the stations and the amount of electricity used in order to facilitate planning for future installations, electrical infrastructure and cost recovery. Utilization data will be available to the public.	I	
Promotion of Infrastructure: Urban Charging Infrastructure		
21. Urban Charging: State and local officials, along with utilities, business organizations and property managers should discuss options for wiring existing garages for charging in urban areas. Garage managers could then incorporate that service into long-term parking agreements with urban area employers.	I	
22. Urban Demonstration Projects: • Work with a local county or municipality to install and make available charging stations in government parking garages for urban resident charging. • Work with county or municipality to identify off-street outdoor parking locations where local resident PEV charging can be provided (Level 1 and Level 2). • Work with a business or institution to make Level 1 and/or Level 2 PEV charging available to nearby residents. • Work with a multi-unit dwelling owner or property manager to make Level 1 and Level 2 charging available for one or more spaces in a shared parking facility and arrange for tracking and billing for electricity usage by residents.	II	
Charging Solutions		
23. Revision of Zoning and Planning Codes: Municipal zoning and planning codes should be amended to permit and regulate on-street PEV charging, require PEV parking spaces in new developments and re-development initiatives and include siting and design guidelines for PEV charging stations, Level 1 outlets and parking spaces.		

Recommendation Phase I Phase II Phase III	Phase	Legislation Required
24. Historic District Restrictions: State and local zoning and historic district codes should be reviewed for the existence of provisions that could effectively prohibit the installation of PEV charging stations and outlets in historic districts or in close proximity to historic properties. The adoption of code amendments that prohibit unreasonable restrictions on the installation of charging equipment in historic districts while conforming to the federal requirements may be necessary to ensure the location of an adequate number of charging stations and outlets in these communities. Reasonable alternatives, such as siting charging in adjacent public and/or business parking areas should be considered and encouraged.		
25. On-Street Parking: Building on the municipal parking permit model for residential on-street parking, local government-owned and maintained PEV charging stations (Level 2 charging) and 120V outlets (Level 1 charging) can be installed and made available in designated on-street spaces for use by residents who purchase a PEV upgrade to their on-street parking permit.		
26.Measures to Discourage Overstaying: There are a number of possible measures that, if adopted, can discourage overstaying. Limiting the number of hours a car can occupy the parking space, with associated fines, is one option. Rate structures can also be an effective disincentive. Usage of a pricing mechanism that is based on hourly rates and charges progressively higher rates once the vehicle is fully charged, alone or in combination with the automatic assessment of additional "inconvenience fees," is another option that could encourage drivers to move their vehicles once they are fully charged.		
27. Charging and Metering Configurations: To address challenging parking and metering configurations at multi-dwelling unit properties property owners and managers should consider the addition of Level 2 chargers at unassigned shared parking spaces in configurations that maximize the number of spaces that the charging cord can reach.		
28. Clustering Level 1 Charging: Assigned parking spaces can be reassigned to locate parking for PEV drivers in clusters close to 120V outlets.		

Recommendation Phase I Phase II Phase III	Phase	Legislation Required
29. Allocation of Costs and Responsibility for Installation and Maintenance of Charging Stations: Installing necessary panel and wiring upgrades and maintaining the PEV equipment in good repair, and tracking and paying for the electricity usage is a threshold issue for all multi-dwelling unit residents and property owners. The following strategies should be considered: • Use of a business model in which a charging station provider, at its own expense, installs, maintains and owns the charging station and rebates the cost of electricity usage back to the property owner. The PEV owner pays for access to charging in the network through a monthly membership fee. (www.PEVgonetwork.com) • Installation of charging stations by the property owner who recovers the cost of the station and electricity usage through add-ons to leases or, in condominiums or cooperatives, through a special assessment for PEV drivers. • Future State and/or local government programs to support the installation of PEV charging in these more challenging environments and reduce the cost to the property manager/owner.	I	
Permit Streamlining -Based on the Council's review and outreach to the community they found no significant existing barriers to the permitting of EVCS, and therefore make no recommendation for action at this time.		
Pricing Displays The Council recommends that no action be taken to fix a pricing display model for Maryland until after the national standard has been developed and adopted by the National Institute of Standards and Technology (NIST), as those standards are anticipated in July 2013.	III	

Recommendation Phase I Phase II Phase III	Phase	Legislation Required
Changing Technology		
30. **Technical Workshops:** Recommend that the PSC hold Technical Workshops to gather information on innovations in the interface between PEVs and the electrical grid, including both technical feasibility and cost/benefit. Workshop topics should include: • Vehicle –to-Grid (V2G) • Vehicle to Home • Potential for use of down-cycled batteries for power storage.	I	
31. Investment: Foster emerging PEV technologies and their potential for a role in electrical grid management through existing financing vehicles, such as InvestMaryland.	I	
32. Financing : The State should explore opportunities to reduce the upfront costs of PEVs and charging infrastructure installation through public/private financing to allow for the provision and underwriting of low-interest, low-risk loans to energy projects that further the State's energy goals, and to link EV charging to renewable energy and grid management.	II	

Appendix B

Statewide Infrastructure Plan Analysis

Electric Vehicle Infrastructure Plan

November 2012

Prepared for:

Maryland Electric Vehicle Infrastructure Council

Prepared by:

PARSONS BRINCKERHOFF

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Introduction

Nationally and internationally there is interest in promoting electric vehicles (EV) as a method to reduce reliance on foreign oil sources, capitalize on increasing clean energy programs, promote cleaner vehicle technologies, and provide an alternative to the internal combustion engine. Auto makers worldwide have recognized this focus and have committed resources to the development of a series of vehicles which can be plugged in to use electric grid energy and rely on hybrid (fuel and electricity) or solely electric power for propulsion.

The state of Maryland, which has long been a leader in promoting policies that advance environmental responsibility, has embraced this focus on electric vehicles. The Governor and General Assembly have combined in making Maryland a national leader in advancing opportunities for electric vehicle owners by developing supporting legislation which calls for action in addressing the potential for EVs in Maryland.

In the 2011 Maryland General Assembly Session Senate Bill 400 was passed and created The Electric Vehicle Infrastructure Council (EVIC). The EVIC was charged with accomplishing the following:

1. Develop an action plan to facilitate the successful integration of electric vehicles into the State's transportation network.
2. Assist in developing and coordinating statewide standards for streamlined permitting and installation of residential and commercial EV charging stations and supply equipment.
3. Develop a recommendation for a statewide charging infrastructure plan, including placement opportunities for public charging stations.
4. Increase consumer awareness and demand for electric vehicles through public outreach.
5. Make recommendations regarding monetary and nonmonetary incentives to support electric vehicle ownership and maximize private sector investment in electric vehicles.
6. Develop targeted policies to support fleet purchases of electric vehicles.
7. Develop charging solutions for existing and future multi-dwelling units.

> The Maryland Electric Vehicle Infrastructure Council (EVIC) was established during the 2011 Legislative Session by House Bill 167/Senate Bill 176 and signed by Governor O'Malley on May 19, 2011. The EVIC has been tasked with recommending policies to assimilate Electric Vehicles into Maryland's transportation network.
>
> Chaired by Maryland Department of Transportation (MDOT) Deputy Secretary Darrell Mobley, the EVIC is comprised of business, academic and industry leaders hailing from diverse backgrounds: electricians, automobile dealers and manufacturers, electric vehicle charging manufacturers, utility company representatives, experts in the energy, transportation and environmental fields; as well as members of the State legislature, State Cabinet level officials and their representatives, and County and Municipal officials. The EVIC is researching best practices, analyzing available data and applying their individual perspective and expertise to develop a series of recommendations to promote EV ownership and use in Maryland.

8. Encourage local and regional efforts to promote the use of electric vehicles and attract federal funding for State and local EV programs.
9. Recommend policies that support EV charging from clean energy sources.
10. Recommend a method of displaying pricing information at public charging stations.
11. Establish performance measures for meeting EV–related employment, infrastructure, and regulatory goals.
12. Pursue other goals and objectives that promote the utilization of electric vehicles in the State.

The EVIC has a number of initiatives underway to address each of the items specified in that legislation. This plan addresses items 1 and 3 of the legislation and is focused on identifying the infrastructure requirements for ensuring that Maryland residents and the traveling public are afforded a system of charging options that address basic travel needs. The challenge in addressing these issues is not minimal, however, in that the existing transportation systems in Maryland have developed over a century for automobiles which rely on carried fuel storage which enables travel in the hundreds of miles before refueling.

Other initiatives underway by the EVIC consider items specific to addressing barriers to the provision of charging options, including development of supporting ordinances, assessing charging opportunities at multi-family dwellings and improved outreach. This document is specific to the needs for infrastructure at the specific level of understanding a few basic questions:

- How many chargers are required to address needs in Maryland?
- What type of charger is needed?
- Where should they be located to meet the needs of Maryland drivers?

This plan is organized to provide some background information on electric vehicle drivers and their charging options and then identifies charger needs for a number of different market penetration scenarios. This information is provided to offer context to the infrastructure needs of charging options moving forward so is more informational/report format in delivery than a typical plan which presents only actions. As the technology is new, it was felt that providing context for decisions was an important consideration.

Why Focus on Electric Vehicles?

Electric vehicles have the potential to maintain Marylander's freedom of travel while addressing the increasing cost, price volatility, and supply security concerns of petroleum; the need for climate change management; and the state's air quality goals. There are two primary types of electric vehicles of interest for this plan. They included Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV) which both incorporate off-board electricity to power travel. BEVs rely entirely on electric power whereas PHEVs also provide a gasoline powered generator to supplement the electric motor. Collectively BEVs and PHEVs are called plug-in electric vehicles (PEVs).

BEVs operate solely on electric charge obtained from plugging into an electrical power source. They differ from internal combustion engines by being powered by electricity from the grid and not having gasoline on board. PHEVs are powered by grid electricity and by fossil fuel used by a conventional internal combustion engine. The actual source of energy used to drive the electric vehicles is based on the grid mix in Maryland, and includes coal, nuclear, natural gas, wind, and solar.

Currently, the BEVs available in the US include the Nissan Leaf and the Mitsubishi i with the Honda Fit EV, Toyota rav4, Ford Focus EV, Tesla Model S, and Coda debuting in California and Oregon in 2012. Battery Electric Vehicles have greater full-battery range than their main PHEV competitors; however their range is limited. For example, the Leaf obtains an EPA estimated 73 miles on a full battery charge, the Honda Fit EV about 70 miles, and the Mitsubishi I 62 miles.

Plug-in Hybrid Electric Vehicles (PHEVs) combine an electric motor and internal combustion engine as a source of power, with various approaches to how these power sources interact. One vehicle - the Chevy Volt, with a 35 mile battery range, initially operates on the battery but also has a gasoline powered generator to recharge the battery once the battery charge is depleted. The driving range of PHEV's such as the Chevy Volt is 35 miles from the battery, and about 300 miles powered by the gasoline-fueled generator.

The use of electricity for propulsion eliminates tailpipe emissions typical of an auto powered by an internal combustion engine which reduces the amount of fine particulate matter released on the roads throughout the region and can help address these issues in our most congested urban areas and on heavily traveled roads in the Baltimore and Washington regions, areas of the State with some of the poorest air quality. And, powered from the existing grid mix, including coal-fired power plants, electric vehicles charged in Maryland have greenhouse gas emissions less then the best gasoline powered hybrids available today.

EV use coupled with progressive energy policies like the Maryland Offshore Wind Energy Act of 2011, with the goal of implementing 80 – 200 wind turbines 10 nautical miles off the coast of Maryland, and the Renewable Portfolio Standard (RPS) requiring 2% of Maryland's power to be generated by solar energy by 2022 could help reduce tailpipe emissions and greenhouse gases (GHG) in Maryland. The combined effort of the Maryland RPS, the Maryland Offshore Energy Act of 2011, and the implementation of an aggressive EV program contribute substantially to achieving Maryland's Energy Goals.

EV Travel Opportunities

As noted, BEVs and PHEVs use electric charging infrastructure to refuel. In the case of all-electric vehicles, BEVs, drivers of these cars need to think about their trips, to ensure they can make their round trip on the charge they receive at home or at a workplace or public charger while away from home. The graphic below depicts some specifics of various EV models (PHEVs and BEVs) including the typical range, final purchase cost, and the amount of units sold in the US (as of June 2012).

Figure 1 - Example PHEV and BEV Electric Vehicle Options[1]

	Vehicle Type	Price	Unit sold in the US
	Toyota Plug-in Prius Plug-in Hybrid vehicle 10 miles of electric driving	MSRP $32,000 Rebate $2,500 State: Final Cost $29,950	4,333 2012 – June 2012
	Chevrolet Volt Plug-in Hybrid (range extender) 37 miles of electric range	MSRP $39,995 Rebate $7,500 State: Final Cost $32,495	16,814 2010 - June 2012
	Nissan LEAF Battery electric vehicle Range of 73 – 100 miles	MSRP $36,500 Rebate $7,500 State: Final Cost $29,000	12,841 2010 – June 2012

It should be noted that the full range of PHEV vehicles (like the Prius) is into the hundreds of miles when electric and internal combustion engine operation are taken into account. The Prius Plug-in has an internal combustion engine (ICE) and electric motor and the ability to plug into an electric power source to recharge its battery. The battery in the Prius Plug-in is quite small and has a limited range of approximately 11 miles. Because of the small battery and electric motor size the ICE frequently turns on to assist with acceleration even when sufficient charge exists to operate solely on electric power. The Plan will need to include consideration of the differences and similarities between these BEVs and PHEVs and their charging requirements.

Existing EV Ownership and EV Infrastructure in Maryland

The number of electric vehicles in the state is expanding as interest in the vehicles increases. Currently, 439[2] PEVs are registered in Maryland with the highest number of vehicles concentrated in Montgomery (155), Anne Arundel (62), Baltimore (46), and Howard (30) counties. Baltimore City, Frederick, and Prince Georges counties have 29 EVs registered in each of their jurisdictions. This EV registration distribution follows the education, income, and commute demographics of typical EV owners – bachelors degree or higher, $100K salary or greater, a round trip commute of 40 miles or less.

[1] University of California at Davis
[2] As of August, 2012

In Maryland 76 Level 1 chargers[3] and 218 Level 2 chargers[4] are available for public use – with the majority of the chargers clustered in the areas with the highest number of EV owners. Charles County is the exception to this pattern with 17 EV chargers – 6 Level 1 and 11 Level 2, with only 2 EVs registered in the county.

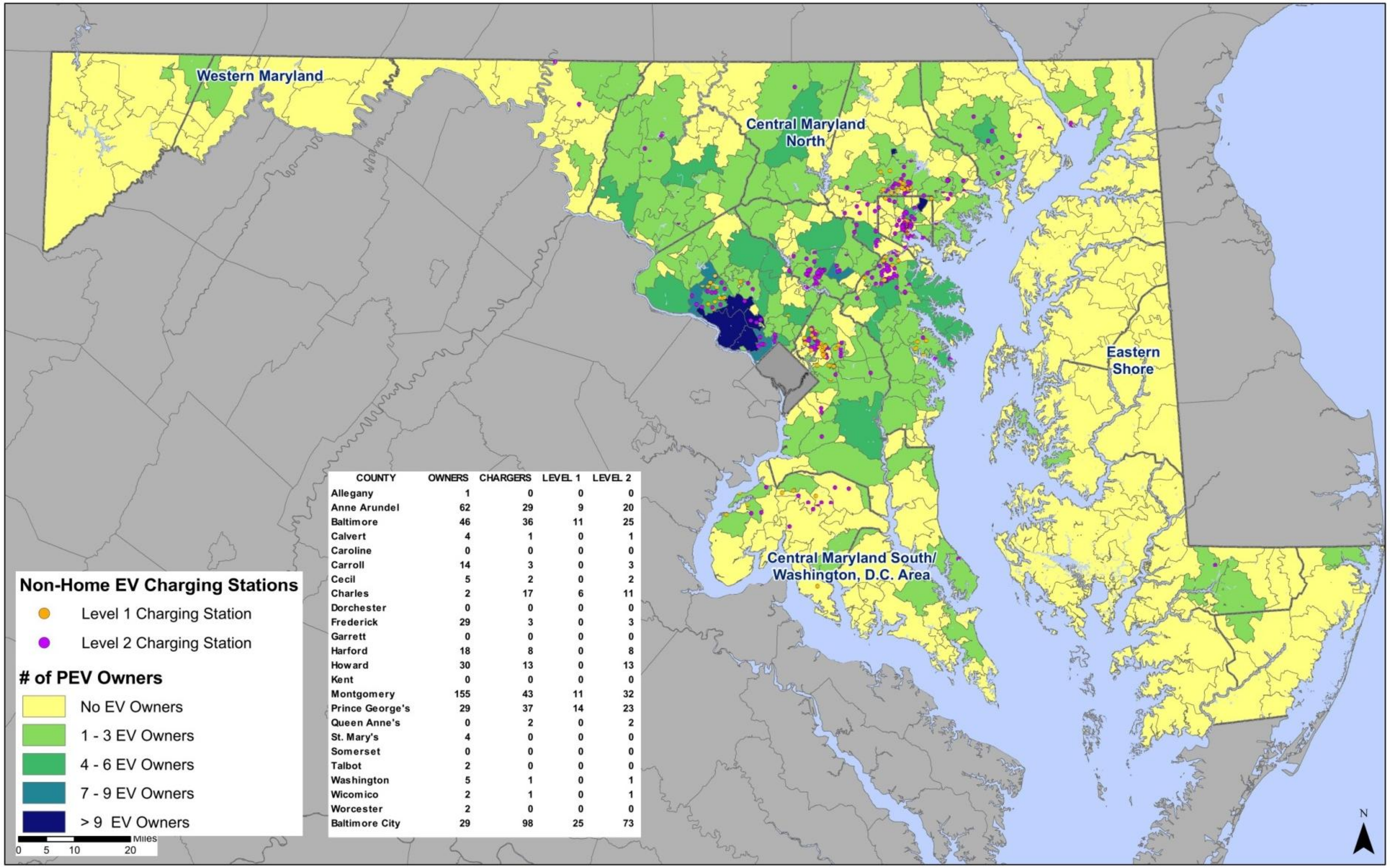
Some corporate interests have embraced electric vehicle charging stations with Walgreen's Drug stores providing the most public charging in Maryland with Level 2 charging stations at thirty-one of its locations. The University of Maryland provides a total of 41 charging stations at four of its campuses with primary installation at its College Park and Baltimore campuses.

The map below depicts the existing conditions in Maryland showing the existing network of EV charging stations and the number of EV drivers for counties around the state.

[3] Information on charger type (standard or J1772) was not available

[4] See the following section, "Charging Options for the EV Driver", for a description of Level 1 and Level 2 chargers.

Figure 2 - Existing Conditions for Electric Vehicles in Maryland - Current Owners (By Zip Code) and Locations of Chargers

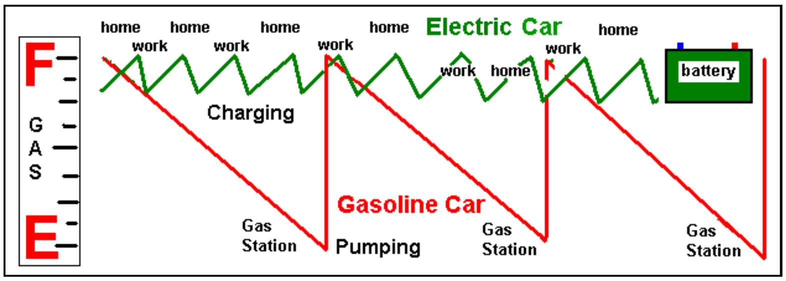


COUNTY	OWNERS	CHARGERS	LEVEL 1	LEVEL 2
Allegany	1	0	0	0
Anne Arundel	62	29	9	20
Baltimore	46	36	11	25
Calvert	4	1	0	1
Caroline	0	0	0	0
Carroll	14	3	0	3
Cecil	5	2	0	2
Charles	2	17	6	11
Dorchester	0	0	0	0
Frederick	29	3	0	3
Garrett	0	0	0	0
Harford	18	8	0	8
Howard	30	13	0	13
Kent	0	0	0	0
Montgomery	155	43	11	32
Prince George's	29	37	14	23
Queen Anne's	0	2	0	2
St. Mary's	4	0	0	0
Somerset	0	0	0	0
Talbot	2	0	0	0
Washington	5	1	0	1
Wicomico	2	1	0	1
Worcester	2	0	0	0
Baltimore City	29	98	25	73

Charging Options for the EV Driver

Electric vehicle owners make decisions on the use of their vehicles for travel and accept somewhat limited overall range (when compared to an internal-combustion engine). Most home to work trips, nearby errands, and other trips that are typical of household travel can be accomplished within the range of most electric vehicles. The EV driver also has the ability to charge their vehicle – if an electrical outlet is available - during long periods when the car is parked, both at home and at their employment site when the car sits parked for long periods and can be recharged for upcoming travel needs. The graphic below depicts the typical pattern of charging for a BEV owner as compared to that of a vehicle powered by gasoline.

Figure 3 - BEV Charging vs Gasoline Refueling Patterns[5]



Charging needs (current and future) are typically heavily influenced by the reality that vehicle charging at home or work are preferred options given the travel and parking patterns of the typical driver. A goal of this plan should be to facilitate charging at both the home and workplace to ensure that EV drivers are afforded the opportunity to recharge while the vehicle is parked. Where parking time is insufficient to recharge conventionally, DC fast charging can help expand the range of a BEV.

There are several items that need to be considered in order to facilitate the level of EV usage envisioned by this plan. These include:

- Workers in urban centers often park in publicly available parking lots or garages
- A good portion of commuters in Maryland travel longer than the total range of a typical mid-level BEV vehicle (73 miles) on their trip to and from work when combined with other trip types (personal, shopping, etc.) included in their daily tour
- Commute patterns surrounding major urban areas may include driving to a transit stop and continuing to work via transit
- Convenient trips to or through Maryland from outside of the state are not possible without highway based Level 3 charging due to the distances involved

The overarching goal of this plan is to create a network of charging opportunities that enables a PEV owner to maximize the amount of household travel possible powered by electricity. Therefore the focus of this plan is on the provision of three different charger types for use by

[5] EV Association of Greater Washington DC (evadc.org)

PHEV or BEV users. The specifics of each charger and its typical use are provided below as background to later recommendations.

- Level 1 Electric Vehicle Supply Equipment (EVSE) charging requires 120 volt AC of electricity, the voltage of a typical US electric outlet. Most plug-in electric vehicles come with the EVSE cord needed to charge their vehicles in a 120 volt outlet, but this power level can be chosen for permanently installed public chargers as well. Level 1 charging provides on average between 4-5 miles of EV driving range per hour of charging.
- Level 2 charging requires 240 volt AC electricity, the voltage utilized by a large appliance such as a range or clothes dryer. The majority of BEV owners install Level 2 charging at home which requires the purchase and installation of a special charging unit on a dedicated circuit. Level 2 charging provides on average between 10 -20 miles of EV driving range per hour of charging. Future versions of Level 2 charging may increase capacity depending on the auto manufacturer's specifications for their vehicles.
- Direct current (DC) fast charging - provides 60 – 80 miles of EV driving range in a charge period of approximately 20 – 30 minutes. DC fast chargers are often prohibitively expensive for an individual home user, need special electrical connections, and are typically installed at commercial centers where high capacity electrical infrastructure is available for use.

Level 1 and 2 chargers are widely used and available and use the same connector on the vehicle side called J1772[6]. DC Fast/Quick chargers are emerging in the market as various manufacturers work through the technical issues of creating charging infrastructure that is compatible with various charger connections and batteries. There are two standards for DC fast charging: CHAdeMO and Combo. CHAdeMO is a Japanese standard and is available on the Nissan Leaf and the Mitsubishi i. Combo is supported by American and European automakers. Although competing standards seem like a barrier, the most significant barrier to DC Fast charging is the cost of installation which is greater than the cost of the actual charging unit. If one standard takes over, then the transformer can be adapted for either or both standards. Further, designs are in progress to have two plug types on one unified charging unit. In California, the decision has been made to not exclude either type in order to encourage the development of high capacity electrical infrastructure regardless of which standard is used.

A primary difference between each of the charger levels (other than the expense of the unit and its installation) is charging time required for a vehicle. The table below provides some basic information on charging time required for the three charging types using the Nissan Leaf (73-100 miles on a full charge) as an example for charging.

[6] Society of Automotive Engineers - http://standards.sae.org/j1772_201001/

Table 1 - EV Charger Information by Charger Type

EV Charger Performance by Type (for a Nissan Leaf)		
Type	Cost(charger installation)	Speed
Level 1	$-$$	20 Hours for a Full Charge
Level 2	$$	3-8 Hours for a Full Charge
DC Fast or Quick Charger	$$$$	30 minutes for an 80% Charge

Level 1 chargers can either be a portable version plugged into a simple 120V outlet or a permanently installed unit, both with a J1772 connector. Many drivers have opted for slow charging at home using typical household plugs. Portable Level 1 chargers requiring 120V outlets can be used in public as well, but there are a few cautions, summarized below:

- A typical 120V outlet exposed to the elements can cause some issues and there have been some plug failures when using this type of plug for public charging, especially with substandard installation.
- There is the potential for a free rider effect. There is currently no way to monitor outlets for energy usage so there is potential for PEV drivers to maximize free energy at work and reduce or eliminate their home charging. If typical 120V outlets are used at public locations, there should be a monitoring system to make electricity cost on par with the price of home electricity.
- It is not uncommon for existing parking garages to have 120V outlets linked to the same 20A circuit. EV vehicles, on average, draw approximately 12A so the capacity for more than one vehicle per circuit is severely limited. Constructing garages so that each outlet has its own circuit is a method to address this issue.

Level 1 charging is most appropriate for home, commuter parking, and workplace use where long parking times allow for sufficient vehicle charges. Level 2 chargers offer a faster charge and can be used to obtain additional charge to allow for greater range throughout the day or to fully charge at night. These charging options are appropriate at home and workplace and also could be used at retail locations, libraries, or similar locations where short to midrange parking times allow for charging of the batteries.

DC Fast or Quick Chargers can be used in many locations but typically will not be found at home. These chargers are a reasonable type of charger for use on longer distance trips where a 15-30 minute recharge period can provide a significant recharge to vehicle batteries.

Given the typical travel pattern for a Maryland resident the home and work charging option will be the most important consideration for chargers. Careful consideration of the best locations for publicly available Level 2 and DC Fast type charging options will be critical to creating a network of chargers that allows for a broader range of trips and flexibility of use that will help increase the viability of electric vehicles as a consideration for Maryland residents.

Some issues currently identified with Fast Chargers, notably reduced vehicle battery life, have been forwarded as an issue for consideration in this plan. The impact on batteries is thermal in nature in that the charging process can result in increased temperatures in the batteries, which can impact their longevity. This issue is not expected to be a factor in future car models as cooling mechanisms are refined through engineering. The Chevy Volt currently has liquid cooling for its batteries as a way to extend battery life. Other manufacturers like Nissan are advising no more than one fast charge per day unless a cooling period of 20 minutes is allowed after the second charge. Engineering strategies are expected to overcome many of the current limitations for various charging options and therefore this issue was not considered in developing recommendations.

Addressing Demand for Electric Vehicle Charging Needs

Demand for electric vehicles is and will be dependent on a number of factors influencing purchasing decisions. Currently electric vehicles are at a higher purchase price when compared to similar vehicles with internal combustion engines, however tax breaks and documented benefits on total cost of ownership are helping make investment decisions somewhat more comparable to the existing automobile fleet.

There are a number of factors that may positively impact the number of EV users in the market. They include:

- Federal and state incentives
- Non monetary incentives (HOV lanes, Parking)
- Higher gas price (or tax)
- Emission regulations
- International market forces impacting cost per vehicle

There are also a number of factors that may act as barriers to EV market penetration. They include:

- Price and cost of ownership
    - EV Battery cost substantially increasing the vehicle purchase price
- Charging infrastructure
    - Multi-dwelling units and lack of infrastructure
    - Old homes
- Range needs
- Industry slow change (EV supply)

As with any product, expectations are that rising demand for vehicles will reduce costs as manufacturing efficiencies and technological advances make electric vehicles a more desirable choice to a broader section of potential drivers. Also, the market for used electric vehicles is expected to increase, meaning that many of the existing EVs will remain on the road contributing to the demand for charging infrastructure.

As the main purpose of this plan is to look at short, medium, and long term demand for electric vehicle charging options it is important to consider what the future demand for chargers may be and how that information can be used to plan for additional chargers at various locations. The number of charging options that will be needed to support all types of travel is dependent on the number of EV owners, the extent of their trips, and the opportunities for recharging vehicle batteries across all charger types. The answer to this question is not fully defined, as the expectations for the future market are dynamic. Table 2 below depicts projected market penetration rates identified by a few different market research firms looking at expected future growth in electric vehicle purchases.

Table 2 - Predicted Electric Vehicle Penetration Rates - Various Sources

Forecast Source	Geography	Forecast Year	Market share			Unit sales (millions)		
			PHEV	BEV	Combined	PHEV	BEV	Combined
Pike Research	United States	2015				0.2	0.06	0.26
Deloitte Consulting	United States	2015 2020			2015: 0.3-0.5% 2020: 1.9-5.3%			2015: 0.05-0.08 2020: 0.3-0.8
BCG	North America	2020	0-5%	0-5%	0-10%	0-1.35	0-1.35	0-2.7
JD Power and Associates	Worldwide and United States	2020		World: 1.8% US: <1%			World: 1.3 US: 0.1	
Bain & Company	Worldwide	2020	2-20%	5-30%	7-50%			
McKinsey & Company	Worldwide	2020 2030	2020: 0-6% 2030: 0-24%	2020: 0-2% 2030: 0-8%	2020: 0-8% 2030: 0-32%	2020: 0-4.5 2030: 0-22	2020: 0-1.5 2030: 0-7	2020: 0-6 2030: 0-29

Source: *Realizing the Potential of the Los Angeles Electric Vehicle Market Authors: Jeffrey Dubin, Ross Barney, Annamaria Csontos, Jonathan Um, and Nini Wu. Luskin Center UCLA 2012*

The market data then points to a potential market in the United States in the year 2020 as somewhere between 250,000 and 2,700,000 vehicles sold annually depending on the source referenced for the data. The implications in Maryland vary widely with the overall market dependent in some part on local initiatives to increase usage.

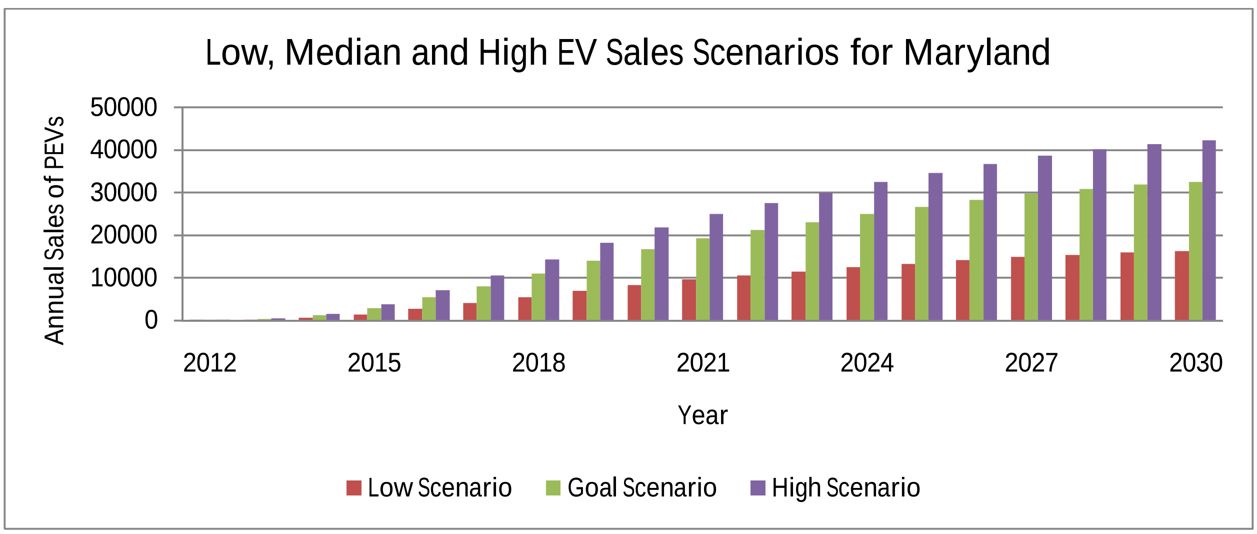
For this effort three possible scenarios were developed for Maryland based on literature for possible growth of EV sales in the state. The three scenarios include:

- Low Scenario – relying only on market forces, what would be a reasonably assumed market penetration rate
- Medium/Goal Scenario – a reasonable, achievable, and aspirational goal of 60,000 PEVs in Maryland by 2020 and 300,000 PEVs by 2030.
- High Scenario – a scenario assuming gas prices go high, increasing the viability of EV vehicles for all owners

The medium scenario identified above was set for the purposes of providing a target for charging infrastructure that is potentially beyond the needs of a typical market scenario but is within reason for what could be expected. It was chosen as a means of creating a network that provides ample charging opportunities as the number of EV vehicles on Maryland's roads increase.

The graphic below depicts the total number of annual sales of PEV's anticipated under each of these scenarios in Maryland, showing varying annual sales totals to the year 2030.

Figure 4 - Market Penetration Scenarios for Maryland



As sales increase in Maryland the total number of electric vehicles on the roads and requiring plug in locations for recharging will increase significantly. The table below converts annual PEV sales to total number of electric vehicles in the market to 2030.

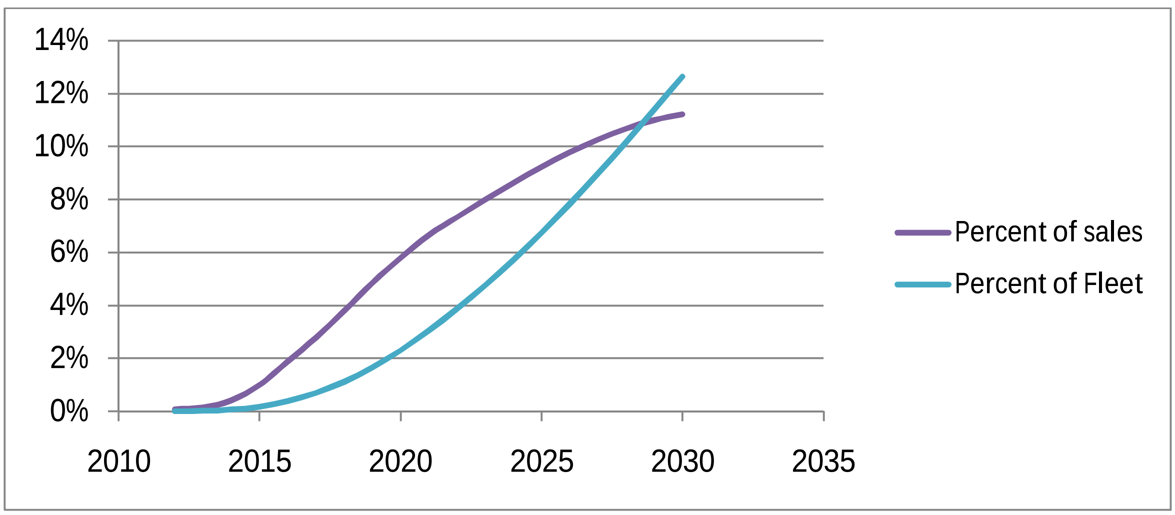
Table 3 - Total Plug In Electric Vehicles by Year

Year	Low Scenario	Goal Scenario	High Scenario
2012*	500	500	500
2015	2,450	4,700	6,050
2020	30,200	60,000	78,200
2030	164,550	328,800	427,510

* Estimate of annual sales for the year based on sales through August.

To accomplish this market potential a shift in EV purchasing will be required and is possible with incentives. To achieve a statewide goal of 60,000 EV vehicles on the road by 2020 a market penetration rate increase would have to be achieved. The figure below identifies the percentage of overall vehicle sales needed in order to be able to achieve the target goal for this plan.

Figure 5 - Sales and Percentage of Fleet - Goal Scenario



This assessment[7] shows that:

- 60,000 vehicles by 2020 would be 2.3% of the state passenger vehicle fleet
- Sales would grow up to 6% of the new vehicles by 2020
- To Reach 300,000 by 2030 PEV sales capture 10% of the market.

The challenge to achieve this level of market penetration will require a coordinated effort to advocate for an expanded market for electric vehicles through a series of incentive/promotional programs.

[7] Nicholas/Tai

Future EV Charger Demand in Maryland

The demand for electric vehicle chargers in Maryland was determined in two primary ways:

- For daily trips for a typical Maryland travel day (including commutes) a series of data resources were assessed to determine demand throughout the state
- For through/visitor trips a geographic exercise was conducted on data obtained to determine locations where trips may require charging infrastructure.

The medium/goal scenario was used to generate demand for charging options statewide in order to provide charging infrastructure in advance of expected market share but not in excess of what could reasonably be expected given market forces. This option was identified as providing enough infrastructure to assure drivers while not requiring investment in a level that would not be reasonable.

Daily Trips

Forecasts of daily electrical vehicle travel demand were generated for this plan based on technical analysis pioneered by researchers at the University of California at Davis (UCD) who were members of the plan development team for this effort. Forecasted demand in Maryland for EV chargers is based on a set of socio-economic factors for potential purchasers of vehicles combined with a detailed analysis of travel survey information. Data from the US Census, Maryland Department of Planning, PEPCO, Maryland Energy Administration, and Maryland Motor Vehicle Administration were analyzed for indicators of potential demand. Generally, EV purchasers can be considered to have higher income and education levels. Early adopters are also more likely to live in single-family homes (often with garages), tend to be interested in solar panels, and/or are current hybrid users.[8]

Also, travel survey data compiled by the Baltimore Metropolitan Council and the Metro Washington Council of Governments provided insight into the daily travel habits of Marylanders in the central urbanized part of the state - their commutes to work, the stops they made along the way, the times of day they traveled as well as the times of day their vehicles were parked. Generalized travel patterns and land use data from regional and statewide models[9] were also used to determine charger demand by geographic area. The process of estimating demand is similar to that of a demand forecasting model used in transportation planning. Further detailed information on demand estimating methodology for daily trips in Maryland can be found in other project documents.

Some assumption on the type of PEV vehicles expected in the future was needed to help quantify the number of chargers that could potentially be needed. This is an important consideration when determining whether vehicles will be BEVs and wholly dependent on

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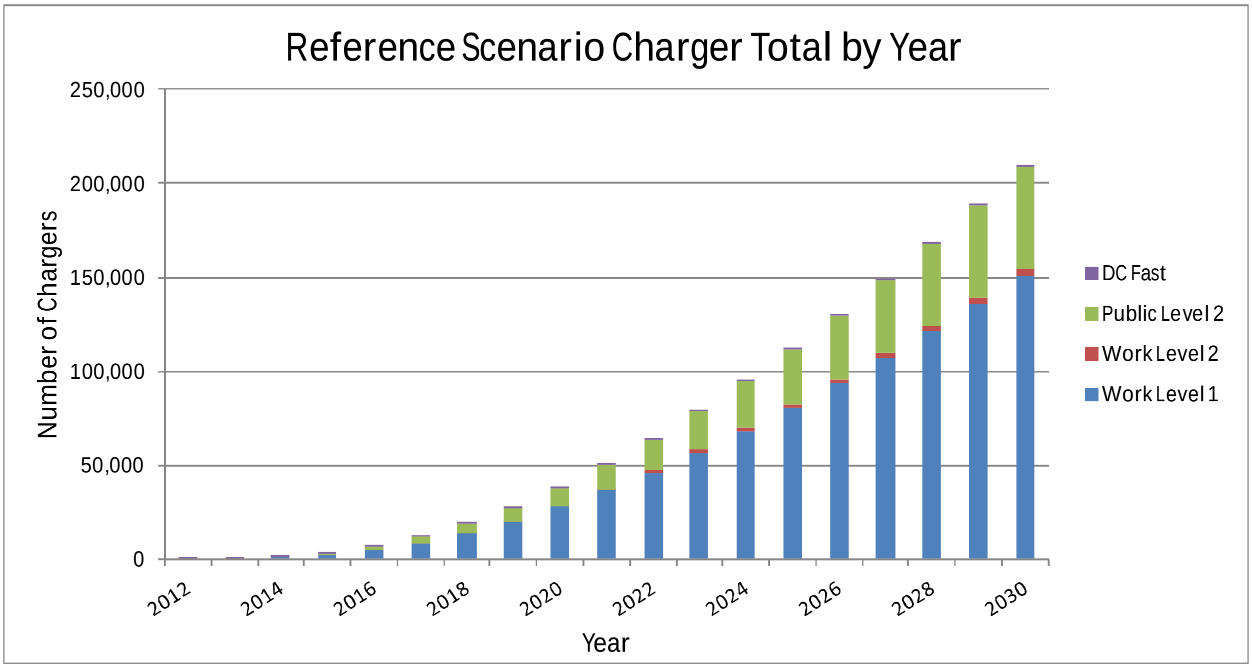
[8] Tal, Gil; Michael Nicholas; Who Wants and Who Can Buy a Plug-in Vehicle: Modeling the Spatial Demand for Plug-ins Vehicles among Different Areas in the San-Diego Region Charging behavior. Presented at the EVS 26 Electric Vehicle Symposium(May 6-9 2012) Los-Angeles California

[9] Regional models supplied by the Baltimore Metropolitan Council and Metropolitan Washington Council of Governments were used for this analysis. The statewide model developed by MDSHA for use in multimodal planning used the two regional models as input.

electrical charging for travel or PHEVs and contribute to demand but not being completely dependent on charging for their travel. Input provided by UCD researchers on existing market forces indicated that a reasonable assumption of future vehicle type was 30% BEVs, 30% PHEV40, and 40% PHEV10. PHEV40 vehicles travel 40 miles on electrical charge, an example being the Chevy Volt. PHEV10 vehicles travel 10 miles on an electrical charge – a Toyota Prius being an example. This assumption was used to generate charger needs.

The focus of this document is to identify public charger needs. It has been assumed, for purposes of this analysis that for the immediate future most EV purchasers will have the ability to charge their EVs at home. As more urban dwellers, without the ability to charge their vehicle at home, acquire EVs the public charging needs will increase. As has been identified in the previous sections, home and work will be the primary charging locations for vehicles due to the long parking times for each location. The chart below projects total statewide charger needs to 2030 breaking down the projections by charger type.

Figure 6 - Projected Non-Home Charger Demand by Type to 2030



EV charger demand has been estimated using the UCD model by minor civil division geography statewide in Maryland. This census-derived data set has been used as a method to provide sub-county level charger need estimates while recognizing the variability in the data and the need to summarize at a larger geography than the neighborhood to be statistically sound. MCD's are administrative subdivisions of counties with comparably sized populations used for presenting statistical/geographical data in the US Census. For this analysis the year 2000 MCDs were used, which roughly correspond to election districts, and assessment districts. Future work determining the exact locations for chargers will have to follow this effort to provide a network map.

It should be noted that this demand estimate has been generated by assuming that some level of cost will be associated with charging at work. Experience in California has noted that electric vehicle owners with unlimited and free access to charging at the work location will tend to heavily prefer to charge at work and will no longer charge at home. Should that same condition occur in Maryland the number of chargers shown as needed at work would substantially increase.

Also there have been many discussions about battery life, vehicle technology and other factors that may impact demand for charging options in Maryland. For the purposes of this report, and due to the many unknowns on the timing of implementation of many of the EV innovations discussed, current technology was used in generating demand. Future demand for charging options may decrease if larger capacity batteries become more prevalent and may increase if EV vehicles become more common as a vehicle type. Predicting what the future holds was not an exercise completed in preparing this plan.

The results of this demand analysis are presented on the following pages statewide for Maryland showing summary results for 2020 for the medium scenario and the demand for chargers by minor civil division. A table summarizing the needs and map displaying results are in the following pages.

Table 4 - Electric Vehicle Charger Need by Type for Minor Civil Divisions in Maryland

County	Minor Civil Division By County	Public L2	Work L1	Work L2	Daily Travel L3
Allegany County	District 1, Orleans	2	14	0	
	District 2, Oldtown	2	13	0	
	District 3, Flintstone	7	13	0	
	District 4, Cumberland	15	13	0	
	District 5, Wills Creek	4	7	0	
	District 6, Cumberland	14	15	0	
	District 7, Cresaptown/Bel Air	9	28	0	
	District 8, Westernport/Luke	2	20	1	
	District 9, Barton	2	14	0	
	District 10, Lonaconing	6	28	1	
	District 11, West Frostburg	2	14	0	
	District 12, East Frostburg	2	14	0	
	District 13, Mount Savage	6	22	1	
	District 14, Cumberland	5	7	0	
	District 16, North Branch	8	16	0	
	District 18, Midland/Shaft	2	40	1	
	District 20, Corriganville/Ellerslie	4	19	0	
	District 21, Gross	2	22	0	
	District 22, Cumberland	4	17	0	
	District 23, Decatur	2	10	0	
	District 24, Eckhart	13	33	1	
	District 26, Frostburg	9	25	1	
	District 29, La Vale	10	46	1	
	District 31, McCoole	7	28	1	
	District 34, Bedford Road	5	16	0	
	Totals:	143	493	11	2
Anne Arundel	District 1	45	185	5	
	District 2	172	448	11	
	District 3	277	685	16	
	District 4	147	448	11	
	District 5	116	305	6	
	District 6	127	166	4	
	District 7	20	56	2	
	District 8	17	132	4	
	Totals:	921	2,425	59	16
Baltimore County	District 1	170	370	8	
	District 2	67	367	9	
	District 3	69	349	7	
	District 4	87	352	9	
	District 5	7	105	3	
	District 6	9	93	3	
	District 7	15	143	4	
	District 8	150	361	8	
	District 9	286	471	8	
	District 10	20	163	4	
	District 11	121	424	10	
	District 12	40	155	3	
	District 13	29	184	4	
	District 14	107	249	5	
	District 15	112	373	9	
	Totals:	1,288	4,160	96	16
	Baltimore City	972	1,287	24	
	Totals:	972	1,287	24	7
Calvert County	District 1, Solomons Island	64	100	3	
	District 2, Prince Frederick	52	142	4	
	District 3, Sunderland	40	99	3	
	Totals:	155	341	9	4
Caroline County	District 1, Henderson	6	32	1	
	District 2, Greensboro	10	51	1	
	District 3, Denton	10	37	1	
	District 4, Preston	7	84	2	
	District 5, Federalsburg	8	47	1	
	District 6, Hillsboro	10	72	2	
	District 7, Ridgely	2	38	1	
	District 8, American Corner	4	53	1	
	Totals:	57	414	11	0

County	Minor Civil Division By County	Public L2	Work L1	Work L2	Daily Travel L3
Carroll County	District 1, Taneytown	15	70	2	
	District 2, Uniontown	8	107	3	
	District 3, Myers	10	93	2	
	District 4, Woolerys	31	169	4	
	District 5, Freedom	74	149	4	
	District 6, Manchester	22	135	4	
	District 7, Westminster	63	249	6	
	District 8, Hampstead	26	102	3	
	District 9, Franklin	14	110	3	
	District 10, Middleburg	3	65	2	
	District 11, New Windsor	7	83	2	
	District 12, Union Bridge	3	47	1	
	District 13, Mount Airy	14	93	3	
	District 14, Berrett	22	143	4	
	Totals:	310	1,614	44	7
Cecil County	District 1, Cecilton	8	43	1	
	District 2, Chesapeake City	11	36	1	
	District 3, Elkton	46	81	2	
	District 4, Fair Hill	15	30	1	
	District 5, North East	38	87	2	
	District 6, Rising Sun	18	47	1	
	District 7, Port Deposit	20	90	2	
	District 8, Oakwood	7	58	2	
	District 9, Calvert	9	35	1	
	Totals:	171	507	12	5
Charles County	District 1, La Plata	19	64	1	
	District 2, Hill Top	5	34	1	
	District 3, Nanjemoy	7	18	1	
	District 4, Allens Fresh	19	51	2	
	District 5, Thompkinsville	8	28	1	
	District 6, Waldorf	136	149	4	
	District 7, Pomonkey	22	52	1	
	District 8, Bryantown	20	100	3	
	District 9, Hughesville	14	57	2	
	District 10, Marbury	10	35	1	
	Totals:	259	589	16	0
Dorchester County	District 1, Fork	5	37	1	
	District 2, East New Market	2	48	1	
	District 3, Vienna	2	33	1	
	District 4, Taylors Island	4	12	0	
	District 5, Lakes	3	12	0	
	District 6, Hoopers Island	2	12	0	
	District 7, Cambridge	25	60	1	
	District 8, Neck	2	31	1	
	District 9, Church Creek	2	23	1	
	District 10, Straits	4	11	0	
	District 11, Drawbridge	2	36	1	
	District 12, Williamsburg	2	42	1	
	District 13, Bucktown	2	38	1	
	District 14, Linkwood	7	58	1	
	District 15, Hurlock	9	59	1	
	District 16, Madison	2	18	0	
	District 17, Salem	2	27	1	
	District 18, Elliott	2	6	0	
	Totals:	78	562	14	1

Note: Level 3 chargers are shown only at the county level and represent the number of chargers estimated to meet daily traveler demand.

Minor Civil Divisions are administrative divisions of counties with comparably sized populations used for presenting statistical/geographical data in the US Census. For the 2000 Census the 290 Maryland MCDs roughly correspond to election districts and assessment districts.

County	Minor Civil Division By County	Public L2	Work L1	Work L2	Daily Travel L3
Frederick County	District 1, Buckeystown	14	69	2	
	District 2, Frederick	128	226	5	
	District 3, Middletown	16	106	3	
	District 4, Creagerstown	2	43	1	
	District 5, Emmitsburg	14	38	1	
	District 6, Catoctin	11	63	2	
	District 7, Urbana	6	92	3	
	District 8, Liberty	18	51	1	
	District 9, New Market	62	112	3	
	District 10, Hauvers	2	32	1	
	District 11, Woodsboro	6	50	1	
	District 12, Petersville	13	50	1	
	District 13, Mount Pleasant	2	95	2	
	District 14, Jefferson	15	39	1	
	District 15, Thurmont	20	56	2	
	District 16, Jackson	7	59	1	
	District 17, Johnsville	5	48	1	
	District 18, Woodville	14	77	2	
	District 19, Linganore	2	62	2	
	District 20, Lewistown	10	65	2	
	District 21, Tuscarora	20	65	1	
	District 22, Burkittsville	2	47	1	
	District 23, Ballenger	2	82	2	
	District 24, Braddock	2	61	1	
	District 25, Brunswick	2	14	0	
	District 26, Walkersville	16	74	2	
	Totals:	409	1,779	45	10
Garrett County	District 1, Swanton	2	13	0	
	District 2, Friendsville	2	7	0	
	District 3, Grantsville	12	16	1	
	District 4, Bloomington	2	17	0	
	District 5, Accident	7	18	1	
	District 6, Sang Run	7	31	1	
	District 7, East Oakland	2	35	1	
	District 8, Red House	10	28	1	
	District 9, Finzel	2	16	1	
	District 10, Deer Park	2	35	1	
	District 11, The Elbow	2	20	1	
	District 12, Bittinger	2	22	1	
	District 13, Kitzmiller	6	5	0	
	District 14, West Oakland	11	30	1	
	District 15, Avilton	2	5	0	
	District 16, Mountain Lake Park	2	28	1	
	Totals:	72	326	8	2
Harford Co	District 1, Abingdon	103	277	7	
	District 2, Halls Cross Roads	71	135	3	
	District 3, Bel Air	243	393	10	
	District 4, Marshall	36	201	6	
	District 5, Dublin	22	125	3	
	District 6, Havre de Grace	24	70	2	
	Totals:	499	1,202	32	1
Howard Co	District 1, Elkridge	58	187	4	
	District 2, Ellicott City	116	305	8	
	District 3, West Friendship	23	204	6	
	District 4, Lisbon	24	133	4	
	District 5, Clarksville	228	368	9	
	District 6, Savage	197	365	9	
	Totals:	645	1,562	39	8
Kent County	District 1, Massey	6	33	1	
	District 2, Kennedyville	9	35	1	
	District 3, Worton (Betterton)	2	23	0	
	District 4, Chestertown	10	33	1	
	District 5, Edesville	5	11	0	
	District 6, Fairlee	6	28	1	
	District 7, Pomona	2	40	1	
	Totals:	40	203	4	0

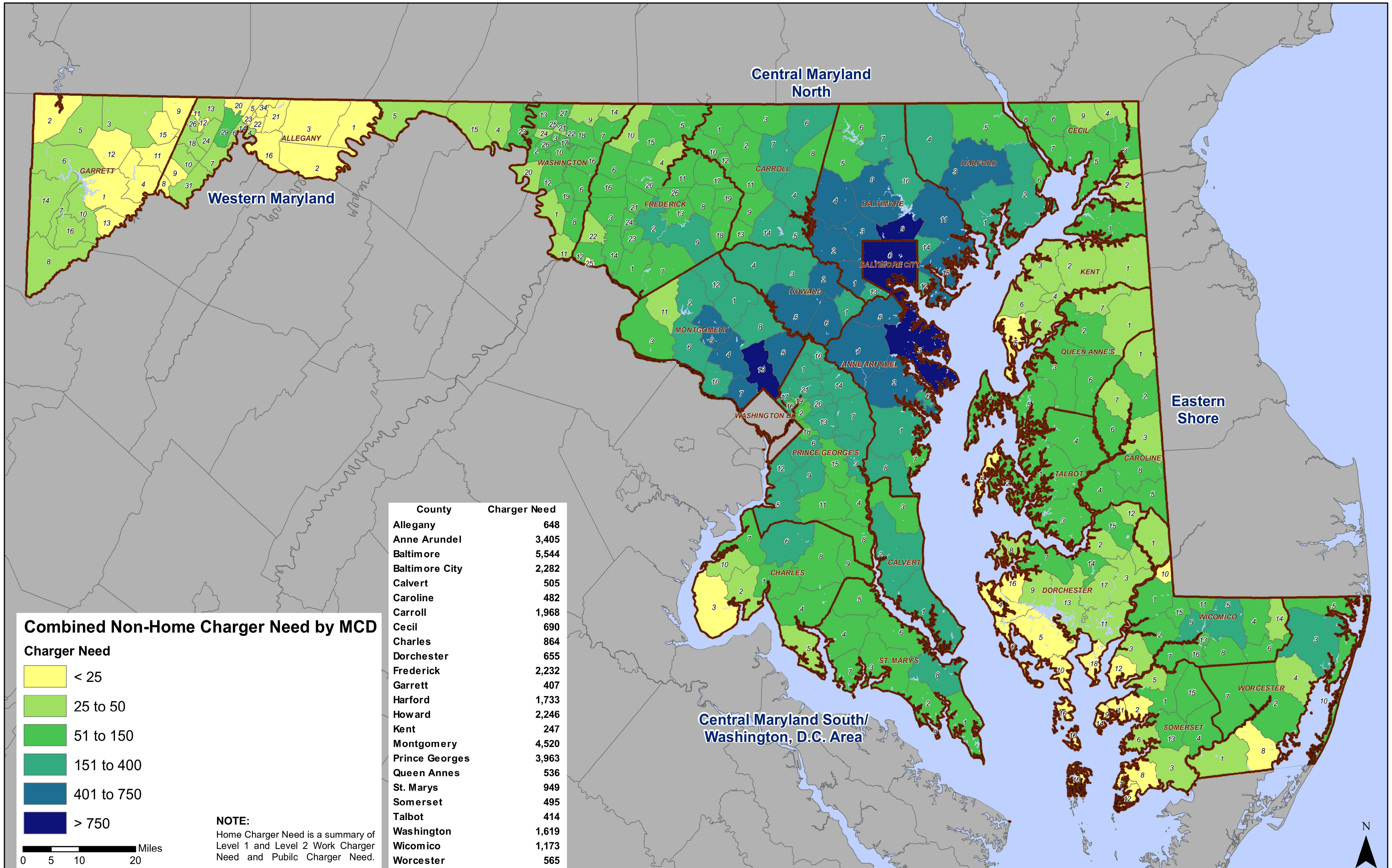
County	Minor Civil Division By County	Public L2	Work L1	Work L2	Daily Travel L3
Montgomery County	District 1	22	197	5	
	District 2	63	160	4	
	District 3	13	52	1	
	District 4	313	322	5	
	District 5	94	308	8	
	District 6	56	200	4	
	District 7	310	159	3	
	District 8	74	273	6	
	District 9	188	384	7	
	District 10	49	109	2	
	District 11	4	40	1	
	District 12	37	136	4	
	District 13	424	474	9	
	Totals:	1,646	2,815	59	16
Prince George's County	District 1, Vansville	65	129	3	
	District 2, Bladensburg	54	87	2	
	District 3, Marlboro	25	131	4	
	District 4, Nottingham	6	58	2	
	District 5, Piscataway	47	126	3	
	District 6, Spauldings	136	146	4	
	District 7, Queen Anne	78	232	6	
	District 8, Aquasco	3	78	2	
	District 9, Surratts	87	115	3	
	District 10, Laurel	96	185	5	
	District 11, Brandywine	22	88	2	
	District 12, Oxon Hill	87	106	3	
	District 13, Kent	136	173	4	
	District 14, Bowie	69	144	4	
	District 15, Mellwood	32	95	2	
	District 16, Hyattsville	26	49	1	
	District 17, Chillum	54	136	3	
	District 18, Seat Pleasant	45	81	2	
	District 19, Riverdale	32	70	2	
	District 20, Lanham	65	119	3	
	District 21, Berwyn	226	160	4	
	Totals:	1,389	2,510	64	18
Queen Anne's County	District 1, Dixon	5	43	1	
	District 2, Church Hill	7	57	1	
	District 3, Centreville	9	67	2	
	District 4, Kent Island	33	58	2	
	District 5, Queenstown	16	98	3	
	District 6, Ruthsburg	6	78	2	
	District 7, Crumpton	5	44	1	
	Totals:	80	444	12	2
Somerset County	District 1, St. Inigoes	10	50	1	
	District 2, Valley Lee	14	82	2	
	District 3, Leonardtown	21	92	2	
	District 4, Chaptico	19	96	3	
	District 5, Mechanicsville	19	116	3	
	District 6, Patuxent	24	114	3	
	District 7, Milestown	6	46	1	
	District 8, Bay	52	151	3	
	District 9, St. George Island	2	18	0	
	Totals:	166	765	18	0
St Marys County	District 1, West Princess Anne	2	64	1	
	District 2, St. Peters	2	22	1	
	District 3, Brinkleys	8	30	1	
	District 4, Dublin	2	49	1	
	District 5, Mount Vernon	6	32	1	
	District 6, Fairmount	2	25	1	
	District 7, Crisfield	5	19	0	
	District 8, Lawsons	2	19	0	
	District 9, Tangier	2	5	0	
	District 10, Smith Island	4	16	0	
	District 11, Dames Quarter	3	5	0	
	District 12, Asbury	2	19	0	
	District 13, Westover	10	47	1	
	District 14, Deal Island	2	5	0	
	District 15, East Princess Anne	10	64	1	
	Totals:	62	424	10	1

County	Minor Civil Division By County	Public L2	Work L1	Work L2	Daily Travel L3
Talbot County	District 1, Easton	33	113	2	
	District 2, St. Michaels	10	42	1	
	District 3, Trappe	8	95	2	
	District 4, Chapel	8	83	2	
	District 5, Bay Hundred	3	11	0	
	Totals:	62	344	8	0
Washington County	District 1, Sharpsburg	5	39	1	
	District 2, Williamsport	11	49	1	
	District 3, Hagerstown	6	48	1	
	District 4, Clear Spring	2	28	1	
	District 5, Hancock	6	27	1	
	District 6, Boonsboro	9	89	2	
	District 7, Smithsburg	8	62	1	
	District 8, Rohrersville	12	47	1	
	District 9, Leitersburg	8	35	1	
	District 10, Funkstown	10	103	2	
	District 11, Sandy Hook	2	27	1	
	District 12, Fairplay	12	52	1	
	District 13, Maugansville	16	51	1	
	District 14, Ringgold	2	29	1	
	District 15, Indian Spring	9	21	1	
	District 16, Beaver Creek	6	67	1	
	District 17, Hagerstown	11	63	1	
	District 18, Chewsville	20	111	2	
	District 19, Keedysville	2	52	1	
	District 20, Downsville	12	24	0	
	District 21, Hagerstown	13	58	1	
	District 22, Hagerstown	13	27	0	
	District 23, Wilsons	10	52	1	
	District 24, Cedar Lawn	2	39	1	
	District 25, Hagerstown	9	31	0	
	District 26, Halfway	23	71	1	
	District 27, Fountain Head	11	43	1	
	Totals:	248	1,346	25	2
Wicomico County	District 1, Barren Creek	6	52	1	
	District 2, Quantico	2	62	1	
	District 3, Tyaskin	10	33	1	
	District 4, Pittsburg	9	44	1	
	District 5, Parsons	51	116	2	
	District 6, Dennis	2	61	1	
	District 7, Trappe	2	58	1	
	District 8, Nutters	14	63	1	
	District 9, Salisbury	29	124	2	
	District 10, Sharptown	2	13	0	
	District 11, Delmar	2	56	1	
	District 12, Nanticoke	2	17	0	
	District 13, Camden	15	81	1	
	District 14, Willards	2	41	1	
	District 15, Hebron	13	66	1	
	District 16, Fruitland	10	99	2	
	Totals:	170	986	17	1
Worcester County	District 1, Pocomoke	9	39	1	
	District 2, Snow Hill	10	40	1	
	District 3, Berlin	45	113	3	
	District 4, Newark	2	27	1	
	District 5, St. Martin	2	52	1	
	District 7, Atkinsons	5	75	2	
	District 8, Stockton	2	19	0	
	District 10, Ocean City	25	91	2	
	Totals:	99	456	11	1

Total Statewide Charger Need by Type

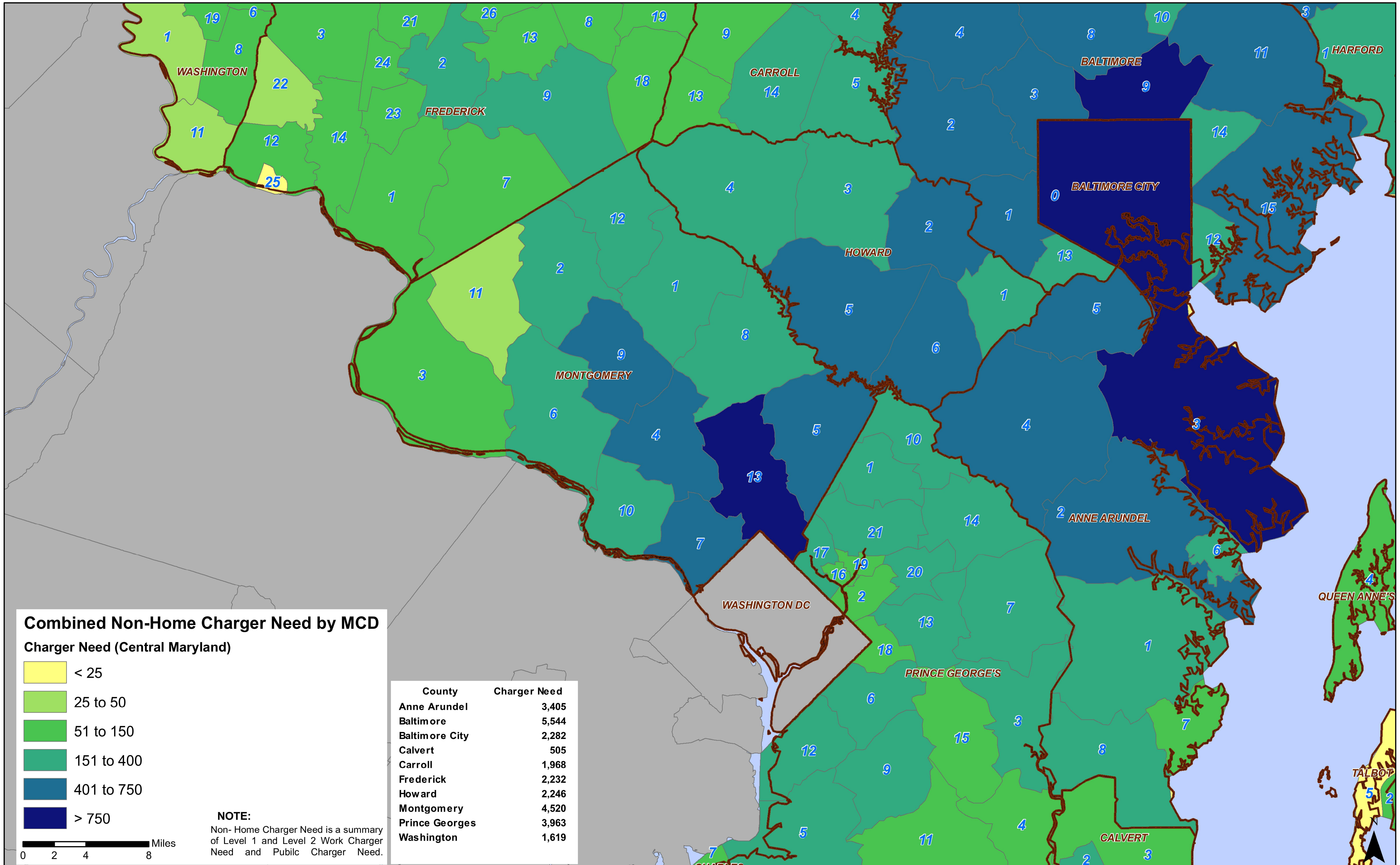
Public Level 2	9,940
Work Level 1	24,481
Work Level 2	649
Daily Travel - Level 3	120

Figure 7 - Non-Home EV Charging Needs by Minor Civil Division and County based on 60,000 EVs in Maryland by 2020



County	Charger Need
Allegany	648
Anne Arundel	3,405
Baltimore	5,544
Baltimore City	2,282
Calvert	505
Caroline	482
Carroll	1,968
Cecil	690
Charles	864
Dorchester	655
Frederick	2,232
Garrett	407
Harford	1,733
Howard	2,246
Kent	247
Montgomery	4,520
Prince Georges	3,963
Queen Annes	536
St. Marys	949
Somerset	495
Talbot	414
Washington	1,619
Wicomico	1,173
Worcester	565

Figure 8 - Non-Home Charger Demand – Central Maryland Focus



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Carroll	1,968
Frederick	2,232
Howard	2,246
Montgomery	4,520
Prince Georges	3,963
Washington	1,619

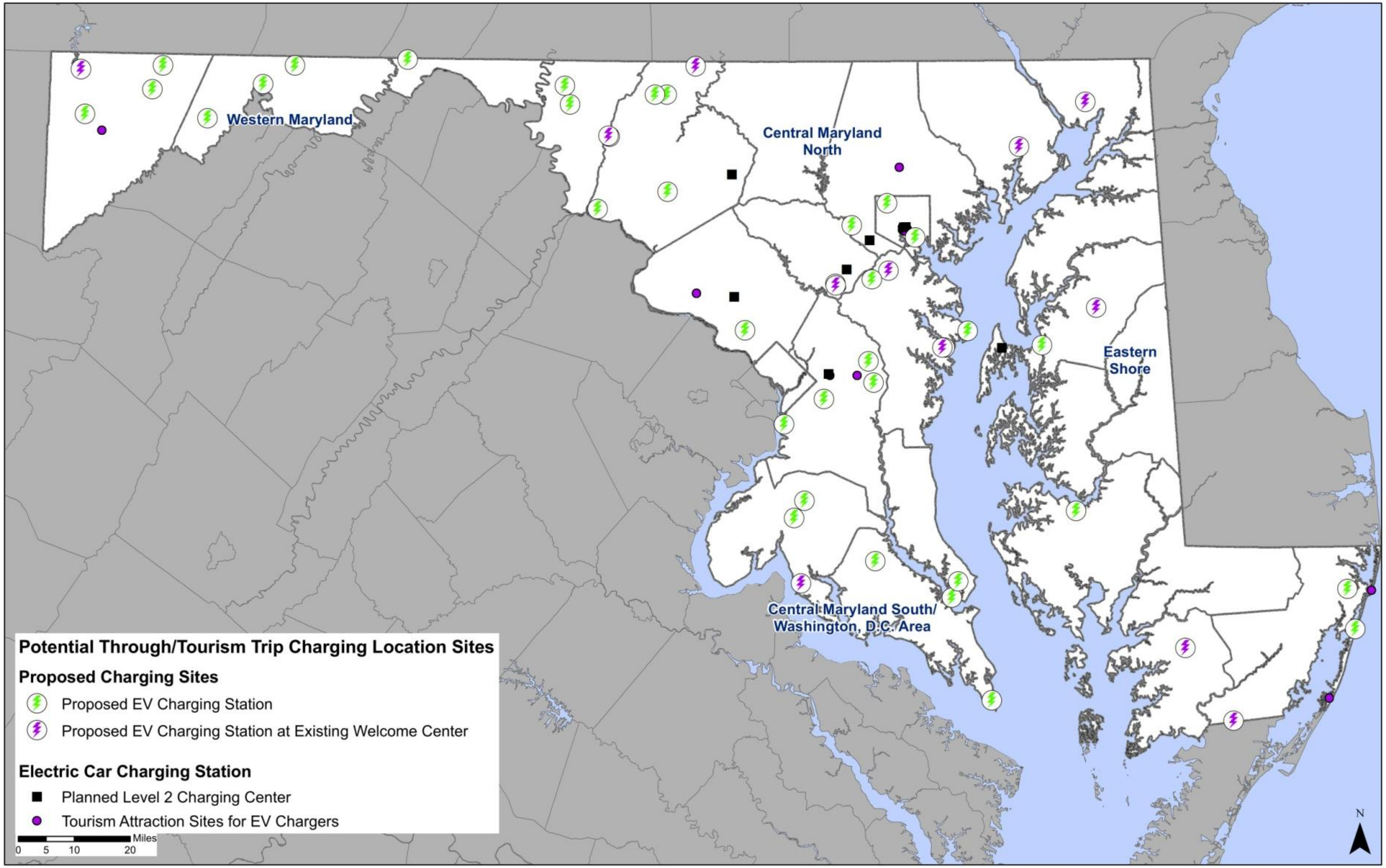
Needs for Through/Visitor Trips

An assessment of long distance / through trips was also conducted to help determine requirements for visitors to and through the state of Maryland from surrounding areas for the purpose of identifying potential charging needs for these trip types. An assessment of destinations in Maryland, with its significant historic areas, extensive park system, tourism sites, travel plazas / rest areas, airports, and major commercial areas was performed to identify those locations where chargers could be located.

Proposed charger locations were determined based on the demand for the facility (in terms of visitors per year) for appropriate sites and were linked, where possible, by distances of less than 40 miles in the central part of the state, between 40 and 60 miles on the eastern shore and west of Frederick and 30 miles apart in Western Maryland (due to decreased battery performance in mountainous areas). As many of the through and visitor trips will require quick charging times to be viable for these trip types, Level 3 chargers would be recommended in these locations.

A listing of charging sites and a map depicting the potential through/visitor network of chargers has been included below.

Figure 9 - Potential Through/Tourism Trip Charging Location Sites



Considerations for Commercial Electric Vehicle Fleets

Commercial activity in Maryland helps contribute to its strength as a business destination and desirable home location for Maryland residents. There have been some successes nationally at implementing an EV commercial vehicle fleet. Some notable national examples of EV commercial vehicles include:

- Frito-Lay has added 176 all-electric trucks on daily routes in New York City; Columbus, Ohio; and Fort Worth, Texas. To date, these trucks have eliminated the need for approximately 200,000 gallons of diesel fuel. The trucks, designed by Smith Electric Vehicles, generate zero tailpipe emissions and operate for up to 100 miles on a single charge.
- FedEx Corp. expanded its alternative-energy fleet with four all-electric, purpose-built, delivery trucks in the Los Angeles area in June 2010, joining more than 1,800 alternative-energy vehicles already in service for FedEx around the world, according to the company. These electric vehicles are designed with a range that allows many FedEx Express couriers to make a full eight-hour shift of deliveries before their vehicles need recharging.

An assessment of the travel patterns of commercial vehicles within the state of Maryland was not possible given the scope of this effort. Commercial PEVs have a typical range of between 40 and 100 miles depending on the manufacturer. Some coordination with businesses employing or planning to employ electric vehicles as part of their fleet will need to take place to determine whether charging stations may be required and, if so, the type of charger and location that would be best for ensuring vehicles are able to complete their trip tour before returning to the distribution center for recharging.

Taxi companies and car sharing programs have also begun utilizing electric vehicles as part of their fleets. Arlington County, Virginia is currently assessing a proposal to license an all-EV vehicle taxi company. San Francisco and San Jose in California have also recently approved a switchable battery EV vehicle taxi service in those cities. BMW has initiate a program for car sharing also in the San Francisco area which utilizes a series of stations throughout the city where residents can pick up and drop off one of the vehicles from a fully-electric fleet. The implications of the expansion of these programs in Maryland will have to be assessed as they are implemented.

Appendix C

Transportation and Climate Initiative

Guidance Documents

SITING AND DESIGN GUIDELINES FOR ELECTRIC VEHICLE SUPPLY EQUIPMENT

Prepared for:
New York State Energy Research and Development Authority
and
Transportation and Climate Initiative

Prepared by:
WXY Architecture + Urban Design

With support from:
Energetics Incorporated

November 2012

TABLE OF CONTENTS

NOTICE

This material is based upon work supported by the U.S. Department of Energy under Award Number #DE-EE0005586.

TCI is a collaboration of the transportation, energy and environment agencies from the 11 Northeast and Mid-Atlantic states and Washington, DC, focused on reducing greenhouse gas emissions from the transportation sector. Jurisdictions participating in this TCI project are Connecticut, Delaware, DC, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont. Clean Cities Coalitions from the Northeast and Mid-Atlantic regions are working with the TCI states on this project through the Northeast Electric Vehicle Network.

This document was commissioned by TCI, and was developed as part of the Electric Vehicle Supply Equipment (EVSE) Support project awarded under NYSERDA Program Opportunity Notice (PON) 2392 to Energetics Incorporated. The research, interviews and analysis in this report were performed by WXY Architecture + Urban Design (Project team Adam Lubinsky, Jennifer Gardner and Paul Salama), with support from Energetics Incorporated.

INTRODUCTION

Overview
Charging Basics
Levels of Charge

OVERVIEW

Charging stations are the point of connection to the electrical grid for electric vehicles (EVs), and the point of power for EV drivers. With the anticipated growth of EVs as a widespread transportation choice, the incorporation of electric vehicle supply equipment (EVSE) will become a critical element of city and town planning and designing from a master plan for site-specific installation.

EVSE is a new infrastructure typology. Unlike traditional fueling stations for gas engine vehicles, EVSE lets drivers charge up at home, at work and countless places in between. In fact, this is one of the central value propositions behind EVs—the ability to charge from the grid anytime, anywhere. Many estimates agree that approximately 80%-90% of charging will happen at home. These design guidelines discuss the other 10%-20% as the extension of EV charging to complex residential applications, such as multi-unit dwellings, and to publicly-accessible locations, such as workplaces, downtowns and highway corridors, will be critical to establishing a full network of charging options. Expanding the infrastructure network will help make EVs a viable option for all drivers, even those without garages. The benefits come from extended infrastructure networks that are consistent, accessible and easy to use from place to place. EVSE deployment depends on cooperation, a process in which municipalities, the development community and the EV industry will all play leading roles.

The purpose of these design guidelines is to identify and diagram key siting and design issues that are relevant to local governments as well as developers, homeowners, businesses, utility providers and other organizations interested in best practices for EVSE implementation.

The guidelines are organized into two main sections.

ELEMENTS OF SITE DESIGN

Site-level planning creates the user and public interface for EV charging. Critical factors in early EVSE deployment and include the following:

- Accessibility and ease of use
- Visibility
- Safety for installers, users and the public

The guidelines explore communication networks, connection to the grid and user interface, as well as considerations that range from the parking spot up to the urban scale. Every site is unique. These guidelines set out a framework for analyzing site conditions, typical issues and for locating additional resources.

INSTALLATION SCENARIOS

These guidelines present analysis and site design solutions that approach these considerations from the perspective of installation scenarios. Surface lots, on-street parking, parking decks or garages, in-transit and trucking applications comprise the primary installation scenarios that, collectively, cover a majority of potential EVSE applications.

Siting and installation of EVSE will depend on a number of considerations, including: proximity to power supply, parking space size and orientation, pedestrian traffic; and lighting and visibility. Many of these considerations are not yet standardized in terms of functionality, and others fall outside the realm of the standards and codes system, such as aesthetics. Each EVSE installation will be different, so this guide takes the important step of establishing baseline considerations that are predicated on a typology of sites.

CHARGING BASICS

EVSE COMPONENTS
EVSE delivers electrical energy from the power source to the EV, and ensures that an appropriate and safe flow of electricity is supplied to the vehicle. EVSE is the main interface between user, vehicle and utility.

BATTERIES
Most EVs use lithium-ion batteries for their relatively good power performance, energy storage density, rapid charge capability and long life span. The size and energy density of batteries will greatly impact the future of EV range, functionality and consumer cost. As storage capacity increases—and as battery size and weight decrease—charging times and driving distance will change according to new technology.

The majority of the charging operation actually occurs inside the vehicle's on-board charger, where the conversion from alternating current (AC) to direct current (DC) takes place at charging levels 1 and 2, and the battery charge is regulated.

CHARGING STATION
There are currently three categories of charging station, which correspond to the three levels of charge detailed in the diagram on the following page. The charging station acts as the point of transfer from vehicle to grid, and for level 2 and up contains network communications, utility communications and monitoring, payment interface and, oftentimes, user information opportunities, such as advertising screens.

CONNECTORS AND CORD SETS
Most EVs and EVSE use a standard Society of Automotive Engineers (SAE) J1772 connector and receptacle that is compatible with both level 1 and 2 charging equipment. Level 1 charging is done through simple portable cord sets that can plug into a typical wall outlet.

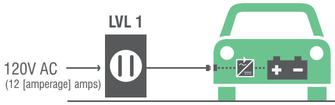
Standardization in this area is an ongoing issue for DC fast charging. The CHAdeMO DC fast charging connector, developed in Japan and used on Japanese EVs like the Nissan LEAF and Mitsubishi iMiEV, allows vehicles to connect to DC fast chargers. The SAE is currently developing an alternate "hybrid" connector that is expected to be used by American auto manufacturers, and will be compatible with all charging levels.

The National Electrical Code (NEC) requires that cords be no longer than 25 feet, unless the charging station is equipped with a retraction or other cord control device. However, experienced installers recommend site design that will require no more than 3-5 feet of cord distance from vehicle to charging station or outlet to minimize tripping hazards.

IMAGE 1. FROM LEFT TO RIGHT: J1772 CONNECTOR AND J1772 DC FAST CHARGER (DCFC) COMBO CONNECTOR

LEVELS OF CHARGE: DIAGRAMS AND ATTRIBUTES

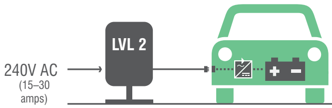
LEVEL 1



ATTRIBUTES:

- A standard outlet can potentially fully recharge an EV battery in 8–12 hours, though larger batteries, such as on the Tesla Model S, would require between 1 and 2 days
- This level is often sufficient for overnight, home charging
- Standard outlets can also provide an option for “peace of mind” charging using on-board equipment on the go
- Uses standard J1772 coupler
- In-vehicle power conversion

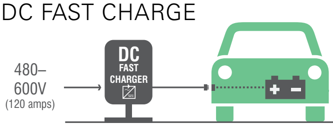
LEVEL 2

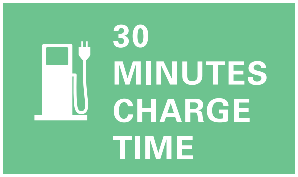


ATTRIBUTES:

- Free-standing or hanging charging station units mediate the connection between power outlets and vehicles
- Requires installation of charging equipment and often a dedicated 20–80 amp circuit, and may require utility upgrades
- Well-suited for inside and outside locations, where cars park for only several hours at a time, or when homeowners seek added flexibility of use and a faster recharge
- The public charging network will comprise primarily Level 2 charging stations
- Public context requires additional design features, such as payment and provider network interfaces or reservation systems
- Uses standard J1772 coupler
- In-vehicle power conversion, charging speed limited by the onboard charger

DC FAST CHARGE





ATTRIBUTES

- Free-standing units, often higher profile
- Enable rapid charging of EV battery to 80% capacity in as little as 30 minutes
- Electrical conversion occurs in EVSE unit itself
- Relatively high cost compared to level 2 chargers, but new units on the market are more competitively priced
- Draws large amounts of electrical current, requires utility upgrades and dedicated circuits
- Beneficial in heavy-use transit corridors or public fueling stations
- Standard J1772 coupler approved October 2012

SITE SELECTION AND DESIGN

SITE SELECTION

Selecting a site for EVSE installation will likely require consideration of a combination of factors. While every site is unique and every EVSE host has priorities for installation, common physical elements characterize every EVSE site design.

CONNECTION TO POWER

When installing EVSE or EVSE-ready wiring, a dedicated circuit may be required or optimal. This can be added to an existing panel, or planned for in new construction. Dedicated circuits may require a new conduit, in addition to the conduit running from the panel to the EVSE's location. Costs rise as cable length increases due to the installation costs of construction and trenching. Experienced installers recommend not exceeding 25 feet of conduit from panel to EVSE site, but this will vary widely.

Most facilities have accessible 120V circuits sufficient to power level 1 EVSE. Level 2 charging requires 208-240 volts and at least 15-30 amps. Many jurisdictions require or recommend a dedicated branch circuit for level 2 charging. The existing electrical panel in most installations, and especially older structures constructed prior to 1960 will not have the system capacity to handle large and continuous loads. While level 2 EVSE is similar to other household appliances like clothes dryers, the continuous nature of the load may be a burden on the system. Installation of dedicated branch circuits/new panels may reduce safety risk and assist with peak load management in scenarios with multiple charging vehicles.

NETWORKS AND COMMUNICATIONS

Most public EVSE will contain an advanced metering system and link to a network that tracks usage, bills customers and manages electrical loads. Some EVSE will connect to telecommunications networks using wi-fi, Ethernet or cellular connections. This type of communication is especially important for managing user messaging and other technology advances that regulate information about available charging stations and when a driver's charge is complete. Complications for network connections arise in garages, where repeaters may need to be installed in order to guarantee network signals. Potential installation sites should be assessed for their network connection ability.

EXISTING INFRASTRUCTURE

Construction costs are the number one driver of added expense for EVSE, and the cost differential depends on the work required. Existing elements such as landscaping, walkways, curb cuts and other structural elements should be considered in an EVSE site plan. These elements add costs for removal or relocation, in addition to acting as barriers to accessible charging. Trenching, curb cuts and drilling through hardscaping or structural elements to add new conduits to connect EVSE to power sources can also be cost prohibitive. When possible, consider trenching through landscaping, although the EVSE should always be mounted on a concrete or other hard surface pad and protected from traffic.

EVSE INTERFACES

Each of the broad-based considerations discussed above impacts planning at multiple scales. Interfaces—points of interaction—set up actors, relationships and decision making, determining specifics of EVSE site design and implementation strategies. The following sections diagram site design components and relationships governing installation, use and maintenance from different points of reference, including:

1) Network Interface (page 6)
2) Urban Interface (page 8)
3) Power Interface (page 9)
4) Parking Interface (page10)
5) EVSE Interface (page12)

SITE DESIGN ELEMENTS

INSTALLATION

These site design elements are considerations for initial site planning and design. They contribute to costs and determine what type of EVSE to install.

- CHARGE LEVEL
- PROXIMITY TO POWER
- MOUNTING APPROACH
- NUMBER OF CORD SETS
- PARKING SPACE DIMENSIONS
- ENVIRONMENTAL CONDITIONS
- TECHNOLOGY
- HAZARDS

ACCESS

Accessibility has many aspects and includes wireless connections to communications networks, as well as access to buildings. These site design elements relate to the user experience.

- NETWORK CONNECTION
- ACCESSIBILITY
- PROXIMITY TO TRAFFIC
- PROXIMITY TO BUILDING ENTRANCE
- PROXIMITY TO ELEVATOR
- LIGHTING
- SIGNAGE AND WAYFINDING
- PEDESTRIAN TRAFFIC

OPERATION

These elements of site design relate to day-to-day use of the EVSE as well as long-term goals of hosts and operators.

- HOST-OPERATOR AGREEMENTS
- VISIBILITY
- LOCATION IN LOT
- METERING
- LENGTH OF STAY
- FUTURE-PROOFING

1) NETWORK INTERFACE

NETWORKED INFRASTRUCTURE
Many EVSE and EV manufacturers include on-board or on-unit technology enabling network communications and metering. Networks help maximize utility and investment by providing a mechanism through which drivers can most efficiently locate and cycle through EVSE parking spaces.

Car to parking spot communication occurs through cellular network communication, alerting drivers to charging space locations in public areas through on-vehicle systems or smart phone apps. Developments on the horizon include built-in sensors that help determine if spaces are free.

Consumer to charging network communication enables payment for publicly-accessible EVSE. Public EVSE will need to track usage and potentially bill consumers by charging network, typically connecting to back-office billing software. Such communications will involve an ongoing evolution of business models; currently, most networks require members to swipe an access card that links charging to an account. Not all networks are yet compatible across charging platforms, but innovation in the area of communications will ultimately improve overall efficiency and ease of use.

EVSE to utility communication can enable better service, even adapting the rate of flow of electrical current to the unit, such as at times when grid loads are high—and when rates peak.

In each of these communications areas, data collection will improve systems and let us learn more about EV charging demand.

PHYSICAL NETWORKS
EVSE is connected via physical road and highway networks, and electrified corridors extend the effective battery range of an EV.

ENFORCEMENT MECHANISMS
Networks can help mitigate emerging issues in the EV driver community. Systems like alerts and other communication-based approaches can help ensure more efficient access to and use of publicly-accessible EVSE charging spaces.

Network-based communication and community enforcement may help to avoid regulatory enforcement—a more costly approach for local jurisdictions responsible for ticketing and towing. As an alternative to enforcing parking ordinances, networks can disincentivize prolonged parking by charging for time, not for the electricity.

NETWORKED COMMUNICATIONS
1) EV to parking space sensor
2) EV to EVSE
3) EVSE to grid
4) Consumer to payment network
5) Consumer to vehicle
6) EVSE to host/operator

FIGURE 1.
EXAMPLE CELLULAR APPLICATION INTERFACE

TECHNOLOGY

Charging networks are currently experimenting with options. It is widely agreed that a common platform for communication will be via smart phones, in addition to built-in vehicle technology.

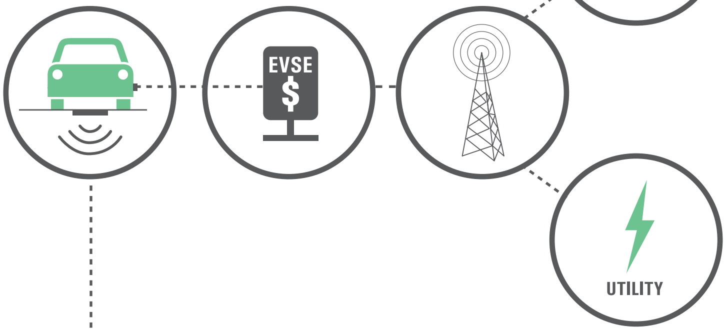
This type of technology depends on network access in all locations. Hardwiring and wireless network connections may require special equipment to bring these networks to remote or indoor scenarios.

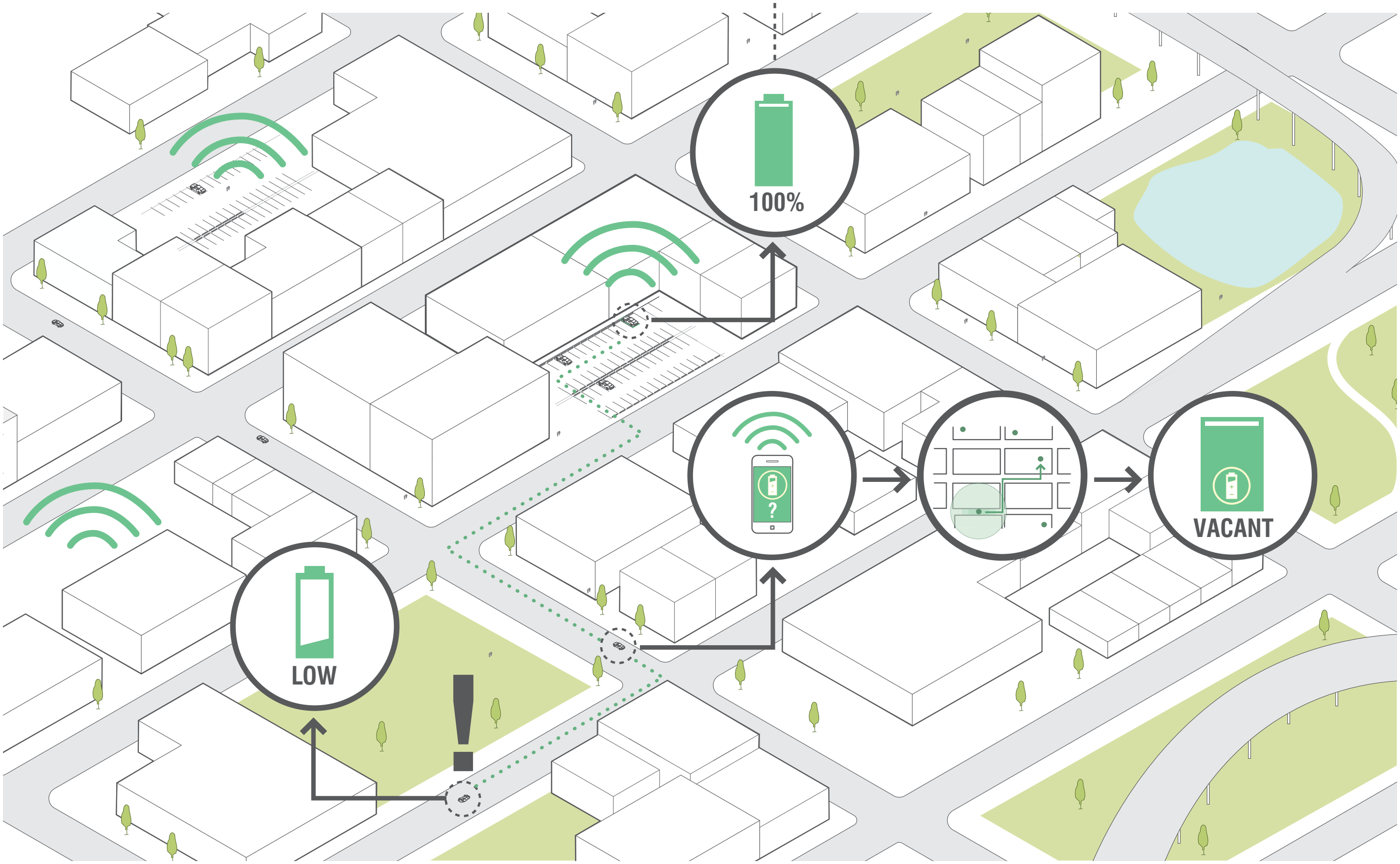
METERING

Most EVSE have integrated payment technologies. Metering in residential applications, or for free charging in public locations, will need to connect the owner/ operator of the EVSE to the utility grid.

FIGURE 2. NETWORKED PATHWAY TO A FULL CHARGE

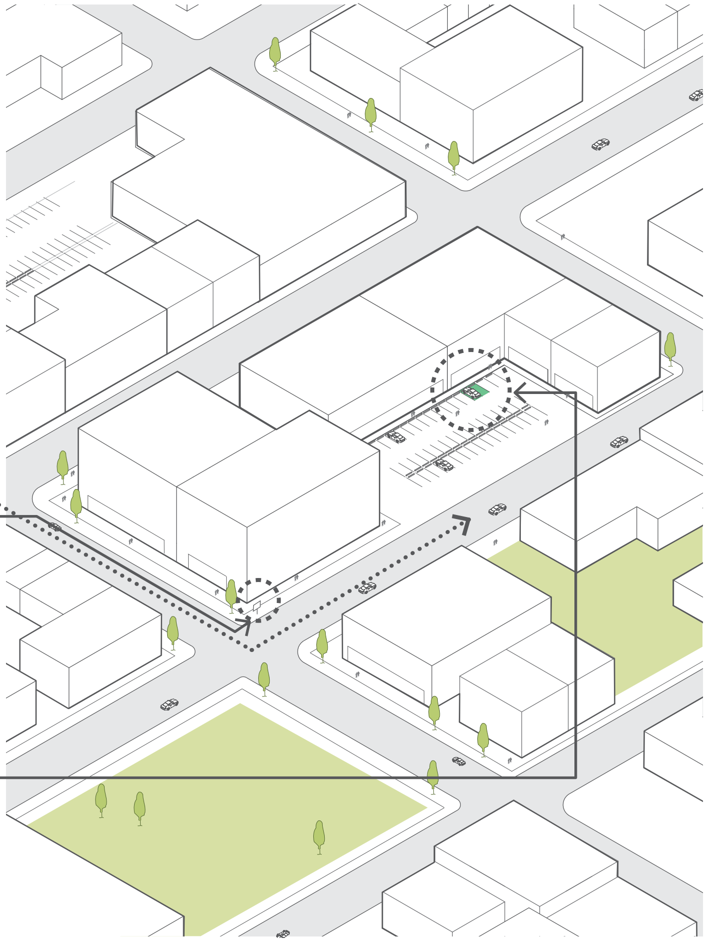
THIS DIAGRAM FOLLOWS THE PATH OF ONE VEHICLE FROM A LOW BATTERY ALERT TO THE LOCATION OF A CHARGING STATION. ALSO SHOWN IS THE PARKED CAR CONNECTING TO THE CHARGING NETWORK AND THE UTILITY COMPANY THROUGH WIRELESS COMMUNICATION NETWORKS.





2) URBAN INTERFACE

The urban interface of the EVSE includes the larger-scale systems and patterns that relate to traffic, frequency of EVSE use and accessibility, as well as the fine-grained details of how the EVSE and EV driver interacts with the streetscape. Placement of EVSE with respect to building frontage demonstrates host priorities. From an owner or host perspective, the urban scale includes location choice and the management of the EVSE and parking space. The urban interface considers functional and aesthetic aspects of site design.



PROXIMITY TO TRAFFIC
Physical proximity to heavy traffic use may be positive (high traffic volume) or negative (difficult to install on-street EVSE). Large-scale traffic patterns and counts determine viability of locations for most commercial operations, and such analytics may be used for EVSE location choice.

SIGNAGE AND WAYFINDING
User visibility begins with wayfinding systems that provide consistent and clear signage to direct EV drivers to parking spaces. Signage should have a hierarchy, helping to direct drivers and organize the EVSE infrastructure network at the urban scale. Consistency and visibility of signage throughout a city, state or region can help drivers locate EVSE regardless of network access.

PROXIMITY TO BUILDING ENTRANCE
Placement of the EVSE determines its visibility and accessibility, typically with respect to priority parking spaces—those that are located a short distance from building entrances. EVSE hosts that choose to highlight the EVSE through prominent placement may incur higher installation costs, due to increased distance from panels.

PEDESTRIAN TRAFFIC
High traffic areas offer visibility and challenges. EVSE and cord sets should not interfere with pedestrian routes; charging stations should not be placed in a location that would cause a cord to be a tripping hazard. Pedestrian paths relate to site planning and design of parking lots, garages and other places. EVSE site choices should consider building entry ways, pathways, street crossings and meeting points so as not to impede pedestrians.

MANAGEMENT OF SPACE
At the urban scale, EVSE hosts or owners (e.g., garage managers, retail chain stores, transportation authorities) are responsible for managing the use and maintenance of the EVSE and parking space. On-site relationships are very important to user experience (accessibility or charge network access, for example). EVSE locations and amenities depends on the motivation of EVSE hosts: green branding or points for the U.S. Green Building Council's LEED certification, providing customer amenities and a company's sustainability mission are all examples of factors that determine whether a parking operator chooses to host EVSE and where within the lot these are located.

3) POWER INTERFACE

The ability to connect to a power source is the top priority for EVSE site design—without power, there is no charge. The EVSE's connection to both vehicle and power source occurs across boundaries of ownership and management and includes both the public and private sectors. There is a potentially complex set of relationships and costs, with different aspects of the power connection occurring in one or both of two areas: the public realm, including the public right-of-way, and the private space. These relationships have physical and business implications.

ELECTRICAL CAPACITY

Connecting EVSE to a power source will require evaluation of existing electrical capacity. This has two parts: the electrical system at the location of the EVSE installation, and the capacity of neighborhood systems to support many EVs charging at once. Electrical cabinets, panels and circuitry will need to accommodate the anticipated additional load. Utilities will be at the center of discussion of capacity. In addition to ensuring safety where EVSE is installed, utilities are concerned with overloading local transformers. Some jurisdictions, such as Vancouver, Canada, have used their building codes to require that new construction allow sufficient space within electrical rooms for panels and other equipment required to increase capacity in the future. Other jurisdictions, such as Maryland, have passed legislation that allows for the disclosure of EV owner data to utilities, enabling them to plan for neighborhood power needs.

CONSTRUCTION COST

The cost differential for EVSE installation is represented by the power interface. Considering a site's power sources and capacity will help plan for lower-cost installations that require less physical construction.

PROXIMITY TO POWER SOURCE

Installing the EVSE close to the required power source reduces the need for cutting, trenching and drilling to add new conduits to reach the EVSE. Additionally, the cost of installation can be reduced if the existing conduit has adequate capacity for EVSE.

METERING

Metering is a concern or necessity when more than one vehicle requires use of the EVSE. Dedicated meters isolate energy utilized for EV charging from the rest of the building. Split meters attribute energy use to the correct party. Smart meters help users and utilities to balance electrical use across peak load times. Meters not only measure energy consumed in billable units but also transmit information to the utility.

HOST-OPERATOR AGREEMENTS

Different ownership and management structures will determine the degree of difficulty associated with accessing power supply, running conduit and maintaining EVSE. The relationship of owners and operators is critical, as different business models will place different requirements on navigating these relationships. The utility will work with the host or operator to bring the power connection to the site.

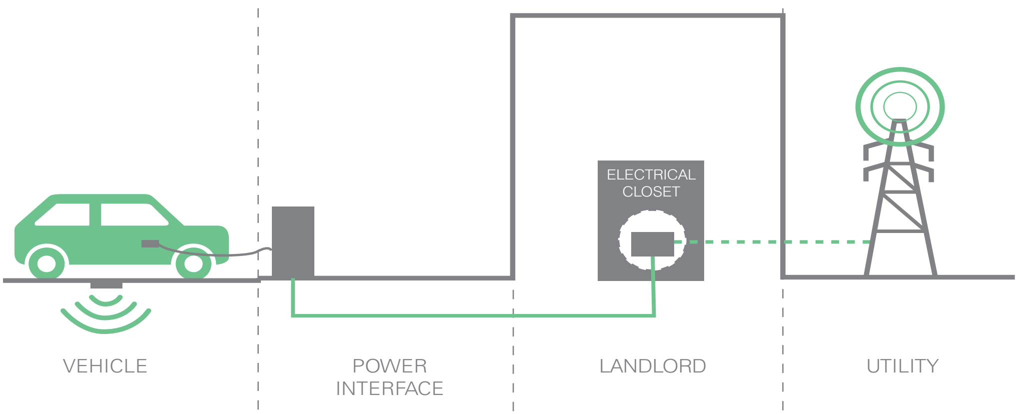


FIGURE 3.
ZONES OF OWNERSHIP AND MANAGEMENT IN THE EVSE INFRASTRUCTURE DOMAIN
THE EVSE INFRASTRUCTURE DOMAIN INCLUDES ALL CHARGING-RELATED EQUIPMENT FROM THE COUPLER THAT CONNECTS THE CHARGER TO THE VEHICLE TO THE ELECTRICAL PANEL AND CONDUIT THAT CONNECTS THE CHARGING STATION TO THE UTILITY GRID. THE OWNERSHIP AND MANAGEMENT OF EACH AREA THAT THE EVSE PASSES THROUGH WILL REQUIRE CONSULTATION AND POSSIBLE PARTNERSHIP TO INSTALL CHARGING EQUIPMENT.

4) PARKING INTERFACE

At the level of the parking space itself, EVs will require certain considerations above and beyond typical design approaches to parking lots and garages. At this scale, the physical aspects take precedence but still impact the user's experience. Cost-adding concerns are largely addressed in the previous section; however, design choices such as canopies, alternative power sources and other extras will add expense. Adding EVSE into the typically tight mix of parking lot and garage planning may cost planners and developers some valuable floor area; several extra square feet will be required to install and access the EVSE.

For safety, extra care in general should be given to placement of electrical equipment in areas that will experience extreme weather or pooling.

SIGNAGE AND WAYFINDING

Guiding a car to the space is one function of signage, but the parking interface requires clear markings that designate the space for EVSE charging only. Signage appearing on the ground similar to striped spaces reserved for handicapped parking) as well as on vertical surfaces should both be used.

PARKING SPACE SIZE

Ample space should be provided for loading and unloading as well as operation of the charging equipment. However, the designated space should not impact adjacent traffic.

MOUNTING APPROACH

Site design will specify a mounting approach. Choice of EVSE unit design will allow site planners to save space by choosing a configuration that maximizes square footage: wall- or ceiling-mounted products will be appropriate where floor area is at a premium, while charging stations with multiple cord sets will enable one unit to serve multiple spaces.

LIGHTING

Visibility is critical for EV driver safety and helps to deter vandalism of equipment. Most parking facilities are designed with lighting that is suitable for EVSE installations. Dim lights or cables can create tripping hazards. Lighting upgrades (such as to more sustainable fluorescent lamps) may also present an opportunity to extend wiring for EVSE installation.

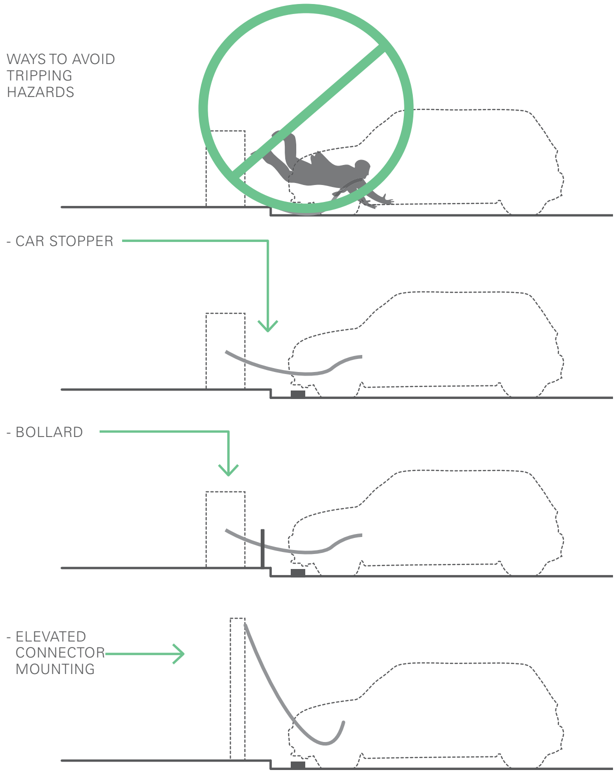


FIGURE 4.
EVSE PROTECTION
WHEEL STOPS AND BOLLARDS OFFER PROTECTION OF THE EVSE FROM TRAFFIC INCIDENT, AND CAN ALSO SERVE TO BLOCK PEDESTRIAN ACCESS FROM TRIPPING HAZARDS. COST AND SPACE WILL DETERMINE WHAT TYPE, IF ANY EVSE PROTECTION IS SUITABLE. WALL-MOUNTED BARRIERS AND SETBACKS ARE OTHER PROTECTION OPTIONS.

ACCESSIBILITY

It is necessary to create spaces and routes that are safe and accessible to drivers of all physical abilities. In general, EV drivers spend more time than usual maneuvering around a parking space in order to connect and disconnect from the EVSE. Accessibility strategies should seek to limit tripping hazards and minimize liability concerns. Accessibility is also about Americans With Disabilities Act (ADA)-compatible designs and space designation. Wheelchair accessible EV charging needs a free path from the space to the building entrance. Standards are being considered to determine how many, if any, EVSE spaces in a lot should be ADA-accessible.

FIGURE 5.
STANDARD PARKING SPACE CONSIDERATIONS
MORE THAN TYPICAL SPACE IS REQUIRED IN ORDER TO ENSURE SAFE AND EASY MOVEMENT AROUND THE CHARGING STATION.

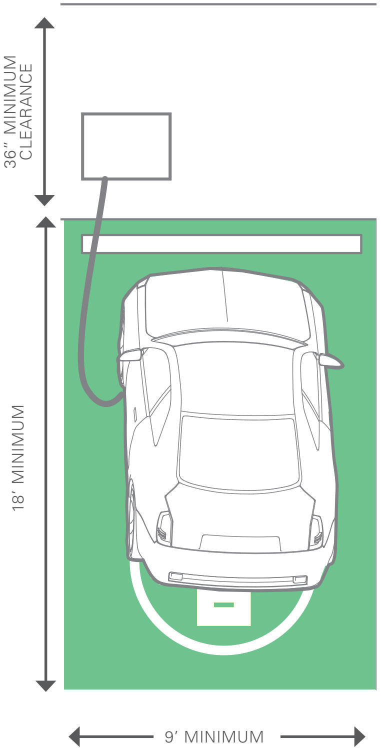


FIGURE 6.
PARKING SPACE CONSIDERATIONS FOR WHEELCHAIR ACCESSIBILITY
THE GROUND SURFACE SHOULD BE FIRM, LEVEL, AND HAVE A SLOPE NO MORE THAN 2% IN ANY DIRECTION

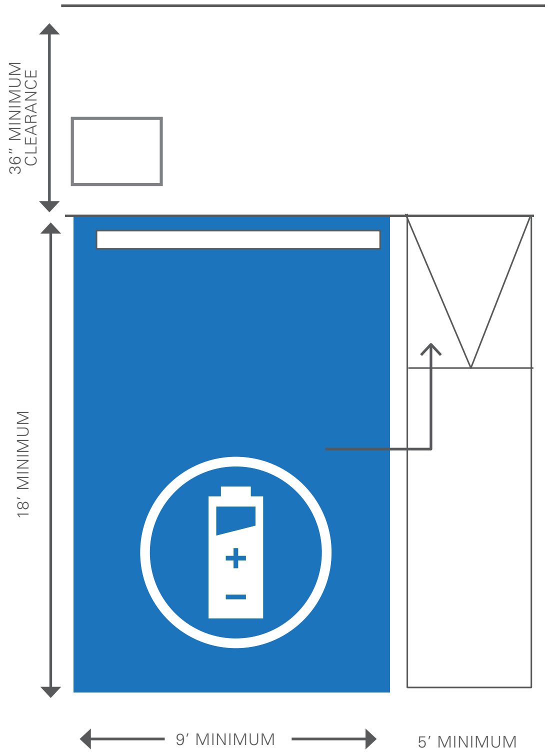
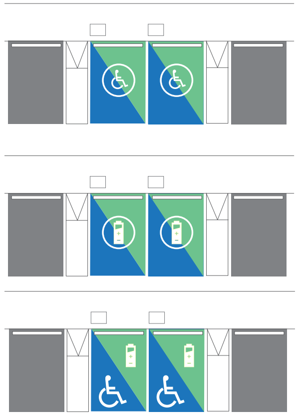


FIGURE 7.
POSSIBLE VARIATIONS FOR WHEELCHAIR ACCESSIBLE EVSE CHARGING SPACES



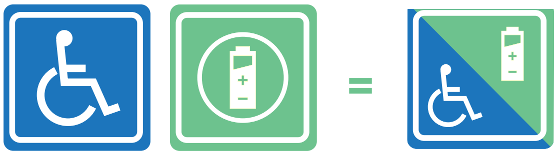
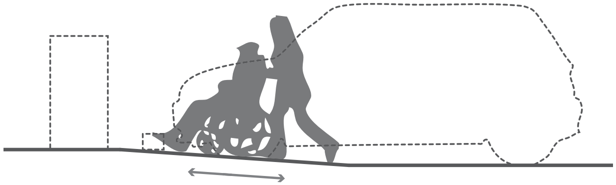


FIGURE 8.
MULTI-DIMENSIONS OF ACCESSIBILITY
VERTICAL SIGNAGE (SEE SECTION ON SIGNAGE AND WAYFINDING FOR MORE DETAIL) SHOULD DESIGNATE WHETHER EVSE IS WHEELCHAIR-ACCESSIBLE. THE GROUND SURFACE SHOULD BE FIRM, LEVEL, AND HAVE A SLOPE NO MORE THAN 2% IN ANY DIRECTION



5) EVSE INTERFACE

THE CHARGING EXPERIENCE

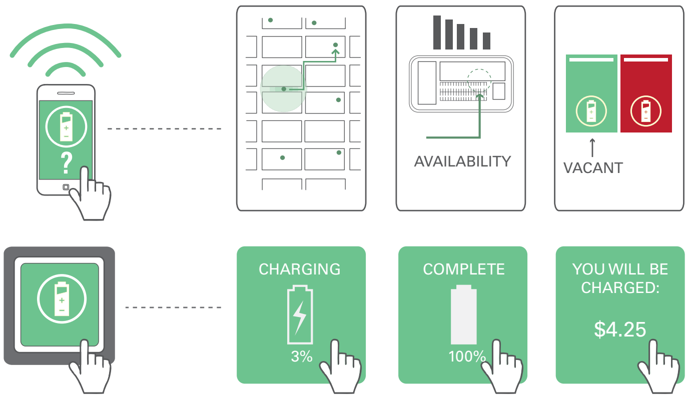
Most EVSE is equipped with touch screens and video capability, providing a forum for user information, ranging from communicating EV driver account details to local news content. Branding also plays a role in bringing information to drivers. The user experience at the EVSE site presents branding opportunities for the EVSE host's or partners' purposes.

At the scale of the vehicle, the interface connecting the EV and the EV driver to the charging station highlights the final group of site design considerations.

The EVSE interface presents design challenges for several key exchanges:

1) Physical interface of the technical components
2) Human and technology interface

FIGURE 9.
EXAMPLES OF USER INTERFACE



MOUNTING APPROACH

Site design will specify a mounting approach. Multiple EVSE unit designs will allow site planners to save space by choosing a configuration that maximizes square footage: wall- or ceiling-mounted products will be appropriate where floor area is at a premium, while charging stations with multiple cord sets will enable one unit to serve multiple spaces.

NUMBER OF CONNECTORS

The method of coupling the EV to the charger impacts placement at the site and ease-of-use for EV drivers.

EVSE PROTECTION

Wheel stops and bollards offer protection for the EVSE from traffic incidents, and can also serve to block pedestrian access from tripping hazards. Cost and space will determine what type, if any EVSE protection is suitable. Wall-mounted barriers and setbacks are other protection options.

ACCESSIBILITY

At the EVSE scale, accessibility refers to the ability of the EV driver to comfortably and safely plug in and access any on-screen or other controls on the EVSE unit. The location of the on-vehicle inlet to connect to the EVSE coupler presents an accessibility issue for EV drivers at this scale. As a rule of thumb, EVSE should be located in the first 1/3 of a parking space, preferably directly ahead, to allow drivers to plug in with minimal draping of the cord.

TECHNOLOGY

Communications systems linking the EV to the EVSE via sensors (such as those that detect the presence of the vehicle and can indicate that the space is occupied).

SIGNAGE AND WAYFINDING

Signage indicating parking information and directions on how to operate the EVSE completes the signage hierarchy.

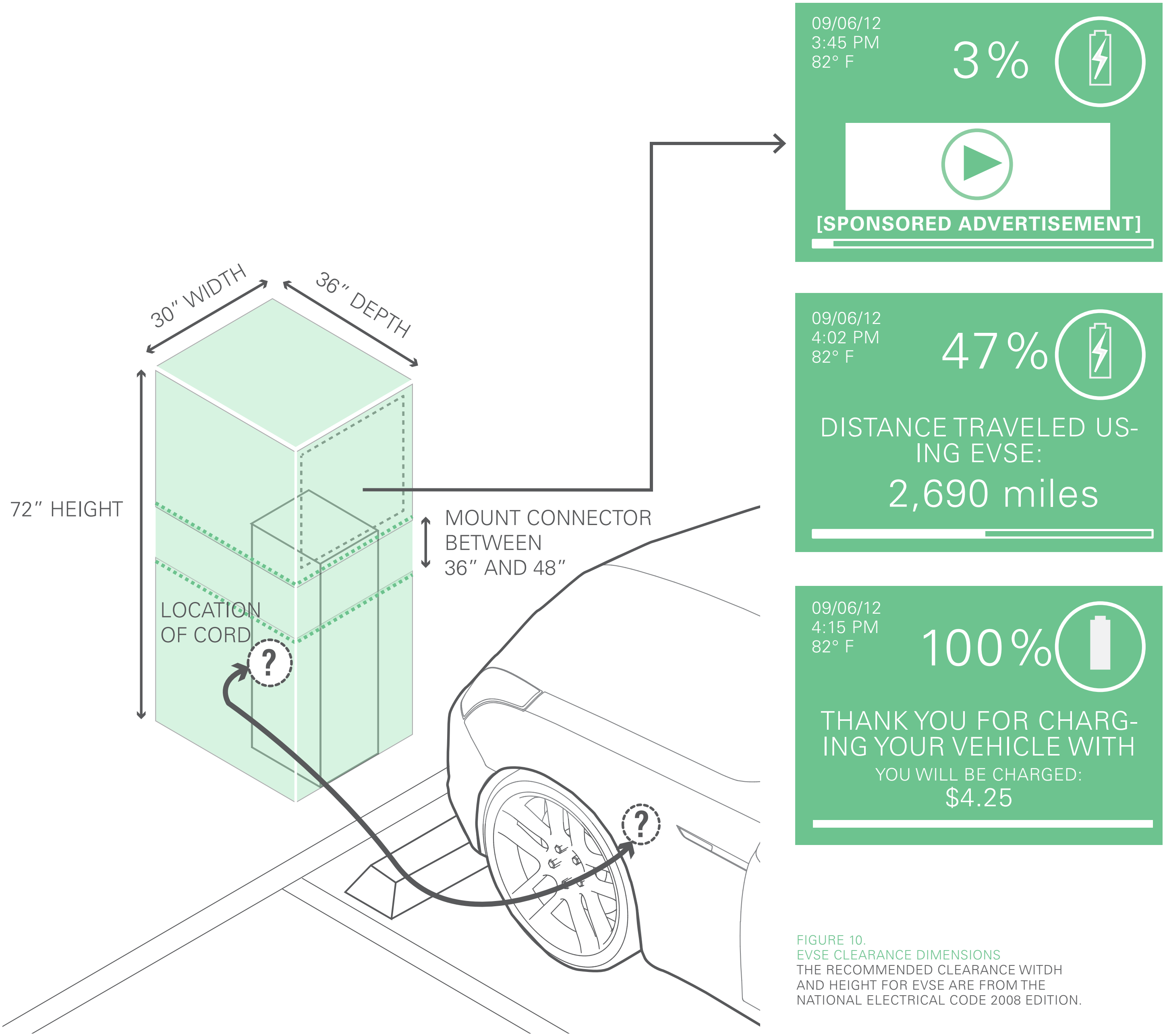


FIGURE 10.
EVSE CLEARANCE DIMENSIONS
THE RECOMMENDED CLEARANCE WITDH AND HEIGHT FOR EVSE ARE FROM THE NATIONAL ELECTRICAL CODE 2008 EDITION.

SIGNAGE AND WAYFINDING

Regulatory
Wayfinding

Signage designates EV parking spaces and helps EV drivers locate charging stations. Regulatory signage designates a space and restrictions regarding its use, while wayfinding signage directs drivers to charging stations; both should be provided in a consistent and accessible style.

The United States Department of Transportation Federal Highway Administration publishes a guide, *Manual of Uniform Traffic Control Devices* (MUTCD) that sets signage standards used by road managers nationwide on all public and private roads. Local regulations also come into play. Local jurisdictions, property owners and parking managers will have preferences for look and function of signs. For EVSE, the goal should be clarity and consistency, particularly in the early stages of the sector's development. A common visual identity will reduce confusion and increase public awareness of EVSE.

It is important for local jurisdictions and designers to note that any deviance from MUTCD regulations requires approval under the "experimentations" waiver. Overall regulations applicable to EV charging designation signage include color and placement hierarchy. The examples of signage offered in these guidelines are intended to be illustrative. Jurisdictions and designers will need to ensure their signs and systems comply with any applicable regulations.

REGULATORY

Regulatory signs indicate who may park in a designated location. Common examples of regulatory include handicapped parking designations, curb striping, no parking or permit-only signs. Regulations can be communicated through wording or design, such as through the color. A report on EVSE signage written by ECOtality for the EV Project recommends a combination of visual and written cues. These would include both an EV symbol and regulatory instructions. A symbol and wording, such as "Electric Vehicle Charging Only," can be used in combination.

Vertical or pole-mounted signage is the most standard (please reference the following page for examples). Pavement markings, similar to those used at handicapped-accessible parking spots, can also be used for clear designation of EV parking spaces. For handicapped-accessible EV parking spots, additional pavement markings can indicate ADA routes that must be kept clear. See page 11 for several possibilities for designating handicap-accessible EV charging spaces.

Other regulations, such as the length of parking if the electricity is provided with the cost of parking, can be indicated. Signs associated with DC fast chargers should indicate a time limit of up to one hour, for example. This is one example of how signage

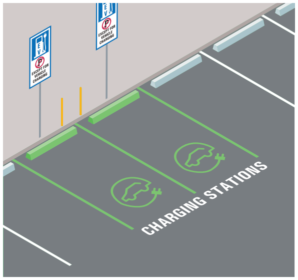


FIGURE 11.
PAVEMENT MARKINGS ARE EFFECTIVE WAYS OF CLEARLY DESIGNATING SPACES FOR ELECTRIC VEHICLE CHARGING.

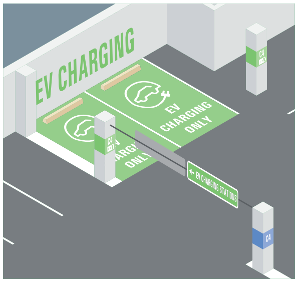


FIGURE 12.
PARKING GARAGES OFFER MANY SURFACES FOR SIGNAGE TO BE ATTACHED OR PAINTED.

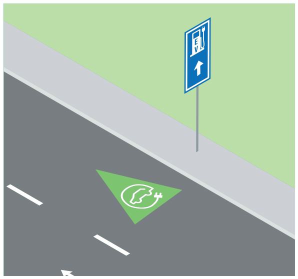


FIGURE 13.
WAYFINDING SIGNAGE DIRECTS DRIVERS TO EV CHARGING STATIONS AND CAN INDICATE WHAT TYPE OF EVSE IS AVAILABLE.

can work with local parking management strategies to establish clear expectations for EV and non-EV drivers. Time limits will also include the participation of local authorities or parking managers to enforce the regulations established on the sign.

Information on the charging station should also indicate voltage and amp levels and any fees or safety information. Electrical codes will ask hosts to indicate the date of installation, equipment type and model and owner contact information on the EVSE.

WAYFINDING

Wayfinding describes a system of signs that do just that—help people find their way. In the case of EVSE, wayfinding systems will direct drivers to EVSE locations. These signs can be located on adjacent streets, access points to parking areas and highways. Pavement markings can also offer additional guidance and point drivers to the exact spaces. It may also be beneficial to drivers if signs indicate the level of charging available.

The MUTCD provides guidelines for developing wayfinding signage systems. Community wayfinding signs have a lower placement priority than other guide signs. MUTCD also suggests that color coding can be an effective way to differentiate between different types of destinations.

Where wayfinding signs can be installed will be an area of potential contention for EVSE. At present, community wayfinding signs cannot be installed on freeway or expressway main lines or ramps. Nor can they be used to designate primary destinations. Recognizing the need to connect a decentralized infrastructure system, moving forward, it will be necessary for communities and for the Federal Highway Administration to consider what type of destination an EV charging station is, and whether EV charging station locations can be indicated to drivers en route along major highways.

COLOR AND SYMBOLS

Currently, a variety of symbols, colors and wording are used for EVSE and the associated regulations. As such, signs can be extremely confusing and may result in non-EV drivers unintentionally using these spaces. Color choice also poses a communication problem. Blue is often mistaken for accessibility, green is mistaken for short term parking and red is associated with prohibited action.

LANGUAGE

There is a need for clear language on all regulatory and wayfinding signs. "No Parking Except for Electric Vehicle Charging" has been recommended to be used on regulatory signs. Signs should use the term "charging" to eliminate confusion for drivers of hybrid electric vehicles, or EVs that do not need to charge. This language also encourages drivers to move their EV once charging is complete. It is important to indicate the active use of the charging station for EVSE designated parking stalls.

INFORMATION AND ADVERTISING

The many surfaces of the EVSE can be used to display information, such as how to use the machine or level of power. Display screens also may provide status information for the user and other communications, including advertising and branding for the EVSE host or partners.

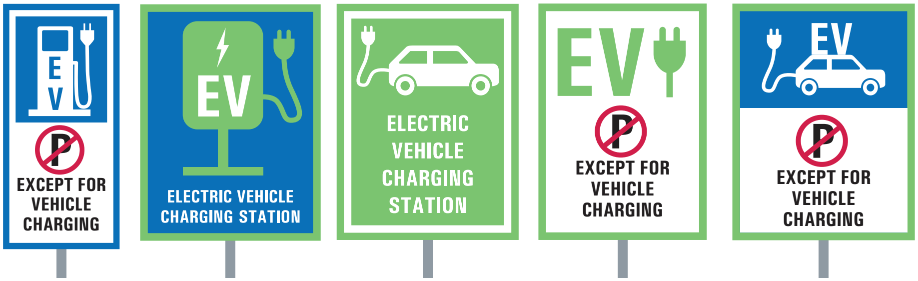


FIGURE 14.

A COMBINATION OF SYMBOL AND TEXT IS RECOMMENDED. THE TERM "CHARGING" SHOULD BE USED TO ENSURE HYBRID VEHICLES DO NOT USE THE SPACES FOR PARKING. THE SELECTED ELECTRIC VEHICLE SYMBOL SHOULD BE LARGER AND MORE PRONOUNCED THAN THE NO-PARKING SYMBOL TO AVOID CONFUSING MESSAGES.

INSTALLATION CONTEXTS

Implementation Considerations

Factors Affecting EVSE Installation

Installation Contexts

This section is intended to illustrate basic site design concerns and wider implementation considerations, such as the motivations of the EVSE installer, costs and operational issues that are relevant to shaping EVSE deployment on a site-by-site basis. The installation contexts described in the following pages of this guide will place design issues in context. It is acknowledged that each context shown here would include a wide degree of site-specific variation.

IMPLEMENTATION CONSIDERATIONS

MARKETS AND MOTIVATION

Placement of the EVSE will depend on host motivation. For example, green branding opportunities require prominent placement and the provision of EV charging for employees might mean settling for more economically efficient locations. The host's understanding of the EVSE users at their site and the benefits that the EVSE will provide them with will inform decisions about their site locations and expenditures.

INFRASTRUCTURE COSTS

The capital outlay associated with EVSE includes the purchase of the unit and the construction costs associated with trenching, structural, utility or electrical work. Soft costs are incurred through the permitting, maintenance and network servicing of EVSE.

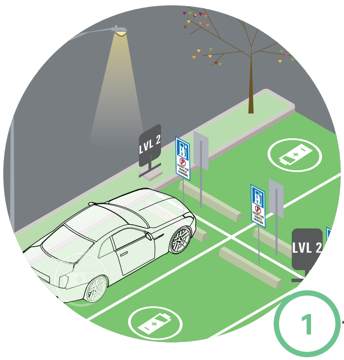
In some cases, EVSE manufacturing groups will provide the EVSE unit for free if they are in position to collect data or fees associated with the EVSE usage. As a result, the business models of the EVSE manufacturing groups may have an influence on emerging EV locations based on their ability to collect fees in certain kinds of locations.

REGULATIONS

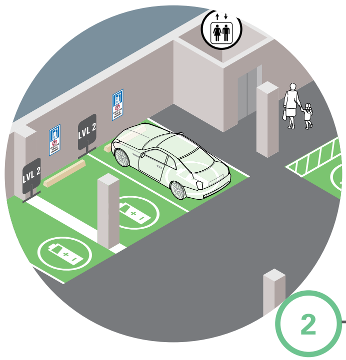
Ordinances serve planning and permitting purposes at the city-wide scale and are another layer of agreement for developers and EVSE hosts. Liability issues associated with hazards and accessibility are another regulatory concern.

HOST AGREEMENTS

Tenants, such as retail operators, contract with landowners; both of these parties may assume responsibility for EVSE-related costs, but landlords will likely assume liability for the EVSE. Owners, tenants, developers, parking lot operators and EVSE networks may be operators of the EVSE.



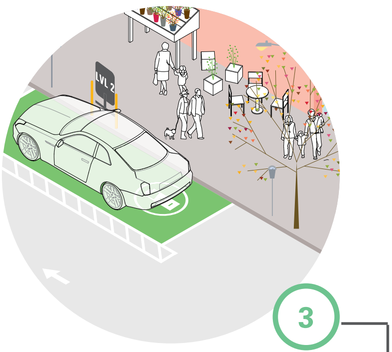
COMMERCIAL LOT



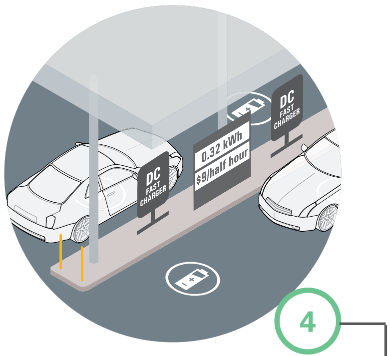
MULTI-UNIT RESIDENTIAL

FACTORS AFFECTING EVSE INSTALLATION

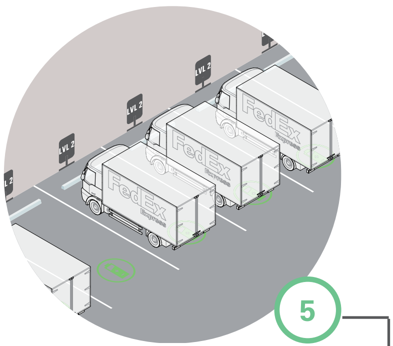
MARKET ANALYSIS	TARGET MARKETS	What are the host's motivations and goals for EVSE installation?
	DEMAND	How does anticipated use determine scope of work for charging stations and EVSE-ready sites?
	HOST LOCATION	Does the retail, commercial or residential location affect rate of use?
ECONOMIC FEASIBILITY	EVSE COST	Will grant or program funding be available? What is the marginal cost of additional EVSE?
	CONSTRUCTION	Is trenching or other heavy work required?
	SERVICE UPGRADE	What is the cost of a service upgrade? How does this impact location?
	MAINTENANCE	What will annual upkeep cost?
	REVENUE	What business model is most appropriate for recuperating the host's or network's capital outlay?
	FISCAL IMPACTS	What costs and benefits are associated with public or government-installed EVSE?
LEGAL	REGULATIONS	What codes and ordinances apply to the site, construction and electrical installation?
	LAND USE	Are there any local barriers to where EVSE can be installed?
	LIABILITY	What entity takes responsibility for any necessary insurance or other liability measures?
	TERMS	What agreements and contracts are necessary or advisable to install and operate EVSE?
OPERATIONS	MANAGEMENT	What entity (host/site owner/network/municipality) will operate and maintain the EVSE?
	UTILITY	What upgrades to service, conduit installation, metering are needed?
	EQUIPMENT	Will EVSE require equipment or technology upgrades beyond the charging station itself?
	SCENARIOS	What alternative installation scenarios could reduce costs or increase revenue?



ON-STREET PARKING



SERVICE STATION



FLEET

1) COMMERCIAL

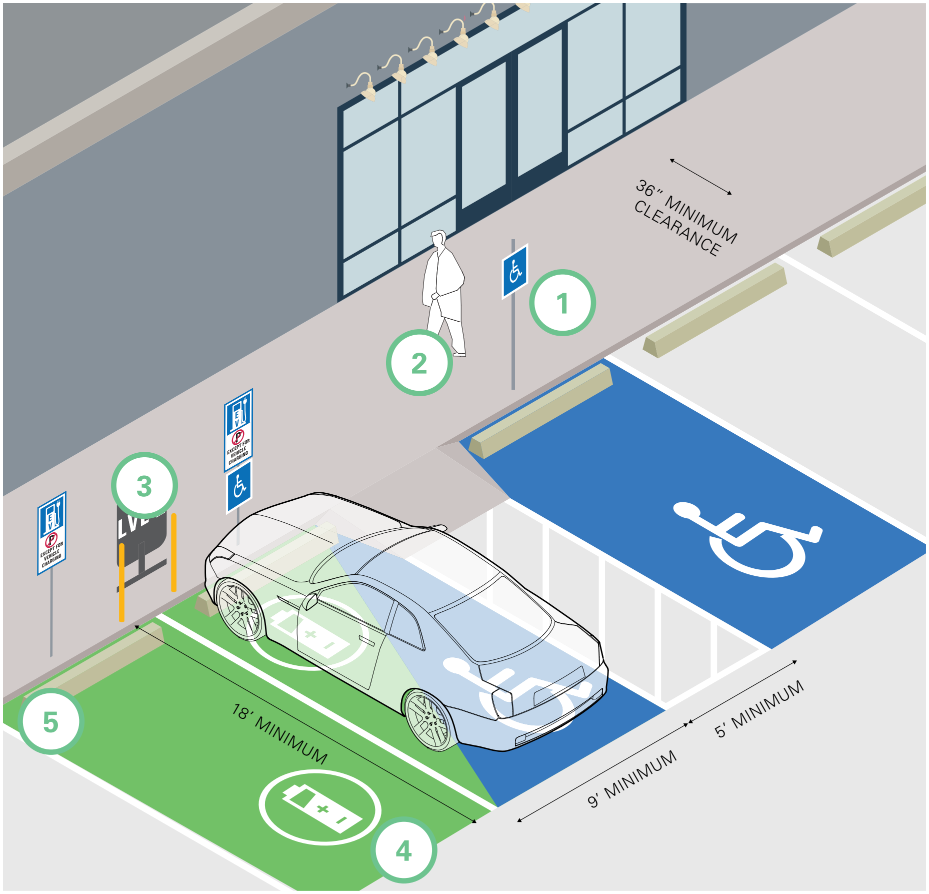


FIGURE 15. SITING AND DESIGN GUIDELINES FOR A COMMERCIAL LOT

IMAGE 2. MILILANI, HI THE EVSE IS MOUNTED ON AN EXISTING POST AS TO NOT SHORTEN THE PARKING SPACE OR INTERFERE WITH PEDESTRIAN ROUTES.

IMAGE 3. BURBANK, CA THE EVSE IS PLACED ON A CONCRETE PAD IN EXISTING LANDSCAPING, TAKING ADVANTAGE OF EXISTING OPEN SPACE IN FRONT OF THE PARKING SPOT WITHOUT REDUCING SIZE.

Retailers and other commercial operators will be among the early adopters of EVSE. For retail and commercial parking, priority considerations may include satisfying customers, branding the retail outlet or serving employees. The outcomes for the decisions about site location and design will vary depending on the key host motivations. The chart on page 19 associates the EVSE decision-making process for commercial parking lots with iconography describing the relevant site design elements.

1) Signage is critical for finding designated spaces within a busy lot. For large and heavily trafficked lots, vertical signage indicating EVSE charging is key. This type of signage should not be used for commercial purposes, such as branding.

2) Pedestrian safety in commercial areas is critical. ADA requires a minimum of 36″ clearance between building wall and street furniture or signage, so care should be taken not to obstruct pathways for safety and egress.

3) Commercial operators seeking to highlight "green" branding will choose to install EVSE in prime parking spaces. Priority locations communicate to customers the value that the EVSE host places on sustainable business, while incentivizing EV drivers to patronize their store. In some locations, however, such as hospitality businesses with long or overnight stays or those with valet parking it may be more advantageous to position EVSE further out in the lot, leaving prime spaces free for all customers.

4) Installing EVSE in prime parking spaces will likely add additional expenses, as these spaces are often far from the electrical panel, which are commonly located at the back of a building. Trenching, running additional conduit and replacing paving are the types of construction activities that account for the primary expenditures associated with EVSE.

5) Placing EVSE close to the door is an incentive and an out-front location may act as an additional deterrent to vandalism or other damage. Care should be taken to allow sufficient room for user access, including curb cuts, as well as a method to prevent tripping over cords.

1A) MID-LOT

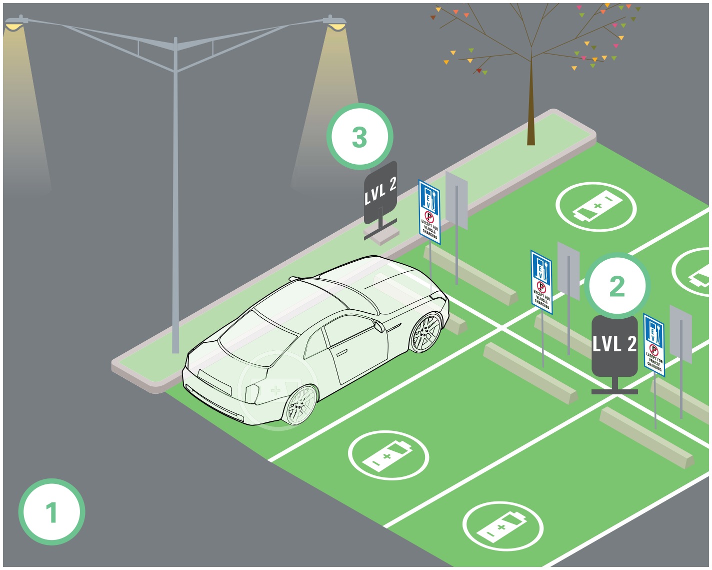


FIGURE 16. SITING AND DESIGN GUIDELINES FOR A MID-LOT

1B) CARPORTS

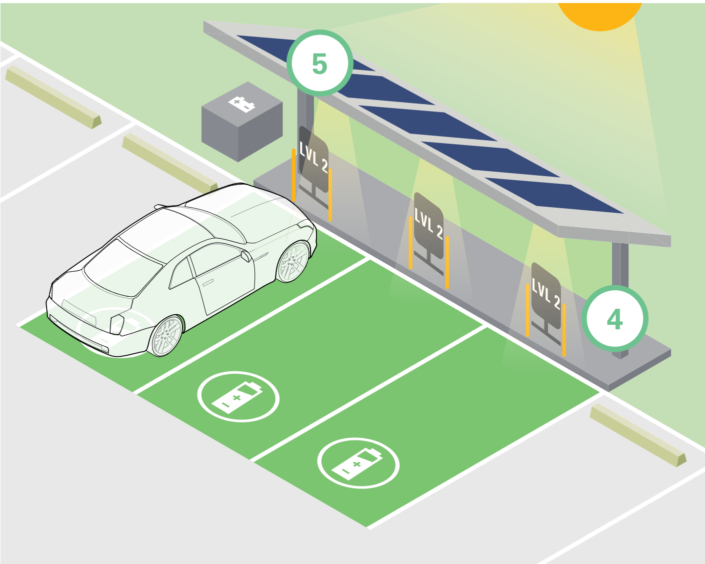


FIGURE 17. SITING AND DESIGN GUIDELINES FOR CARPORTS

PRIORITIES FOR RETAIL AND COMMERCIAL PARKING

MARKET ANALYSIS	TARGET MARKETS HOST LOCATION	
ECONOMIC FEASIBILITY	CONSTRUCTION REVENUE	
LEGAL	LAND USE LIABILITY TERMS	
OPERATIONS	EQUIPMENT	LVL 1 LVL 2 DC

1) Mid-lot parking represents a range of opportunities. In some cases, such as big-box stores or most shopping center locations with no building-adjacent parking, mid-lot spaces will be prime locations for EVSE. The same installation can take place further from the building entrance as well.

2) EVSE can maximize small spaces by being installed in locations accessible to multiple parked vehicles. Wheel stops protect the EVSE but may present a tripping hazard.

3) Landscaped areas can accommodate EVSE as well, but concrete pads are necessary to anchor the device.

4) Canopies and carports add visibility, shelter and opportunities for signage. Price Chopper supermarkets, for example, are installing canopies to designate EVSE parking spaces, which will feature a sustainability branding campaign.

5) Solar energy is a natural solution for canopy designs. Incorporating photovoltaic panels to capture energy (which needs to be stored in a battery on-site) could, in a closed-loop application, eliminate the need to run conduit from an existing panel.

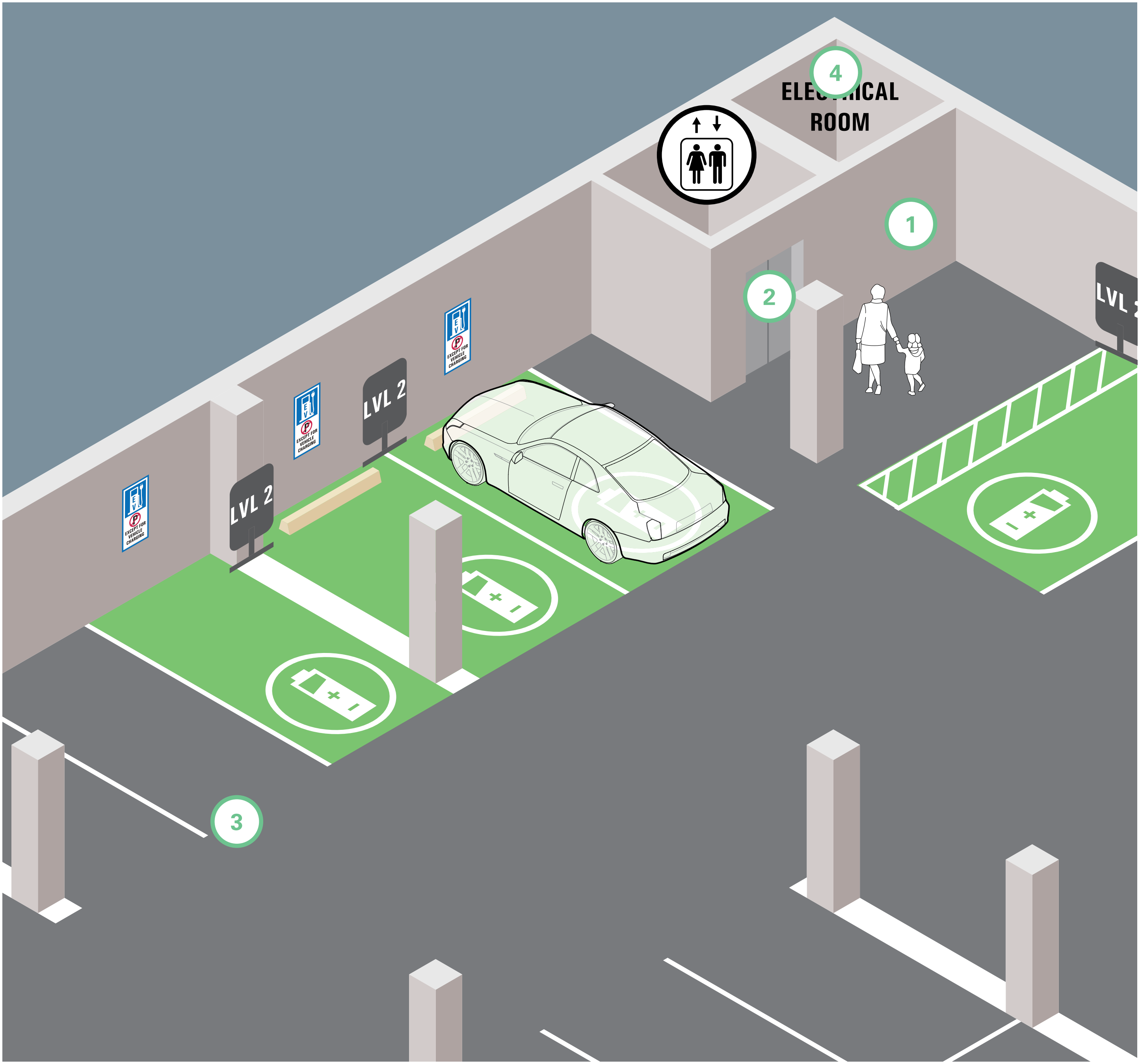


FIGURE 18. SITING AND DESIGN GUIDELINES FOR MULTI-USE RESIDENTIAL PARKING

2) MULTI-UNIT RESIDENTIAL

PRIORITIES FOR MULTI-UNIT RESIDENTIAL

MARKET ANALYSIS	TARGET MARKETS DEMAND
ECONOMIC FEASIBILITY	EVSE COST CONSTRUCTION SERVICE UPGRADE
LEGAL	REGULATIONS LAND USE TERMS
OPERATIONS	MANAGEMENT UTILITY EQUIPMENT

IMAGE 4. PARAMUS, NJ BY MOUNTING THE EVSE ON AN EXISTING POST BETWEEN SPACES, PARKING SPACE SIZES ARE MAINTAINED AND WHEEL STOPS OR BOLLARDS DO NOT NEED TO BE INSTALLED

Multi-unit residential applications are among the most complex. While estimates presume that up to 90% of EV charging will occur at home, issues arise for drivers without private, off-street parking. While residential parking arrangements range widely and include both surface and structured garage parking, the scenario presented here looks at an indoor garage. Management considerations include differences in owner vs. renter-occupied buildings and designation of parking spaces. Developers of new construction housing with parking garages should consider the opportunity to add EVSE-ready wiring at construction, which is much less costly than retrofitting in the future when demand arises. In general, the decision to include EVSE in a residential application will hinge on a developer/owner's choice to provide EVSE as an amenity to residents.

1) How EVSE electricity consumption is metered and billed is a central multi-unit residential question. Typically, tenants or owners will be billed for the electricity used in their unit; installing split metering for parking lot electricity use and assigning usage to the unit is a challenge.

2) The location of EVSE within a residential garage will involve costs associated with extending conduits from the available panel or electrical room as the primary consideration. However, buildings that provide EVSE space in only the most accessible locations may feel push back from residents who are not EV drivers, particularly in the early stages of EV adoption.

3) Garages have limited available space, and are constructed in modules, meaning that adding one or two additional spaces for EVSE to a plan may not be possible. Finding space within an existing layout that is suitable for EVSE involves some creativity. Smaller spaces like Image 5 can often accommodate charging with the right mounting approach. Underutilized space near ramps or entrances can also often accommodate temporary EV charging.

4) EVSE-ready installations should ensure sufficient space in the electrical room or closet for the future inclusion of capacity, panels and, potentially, charging equipment.

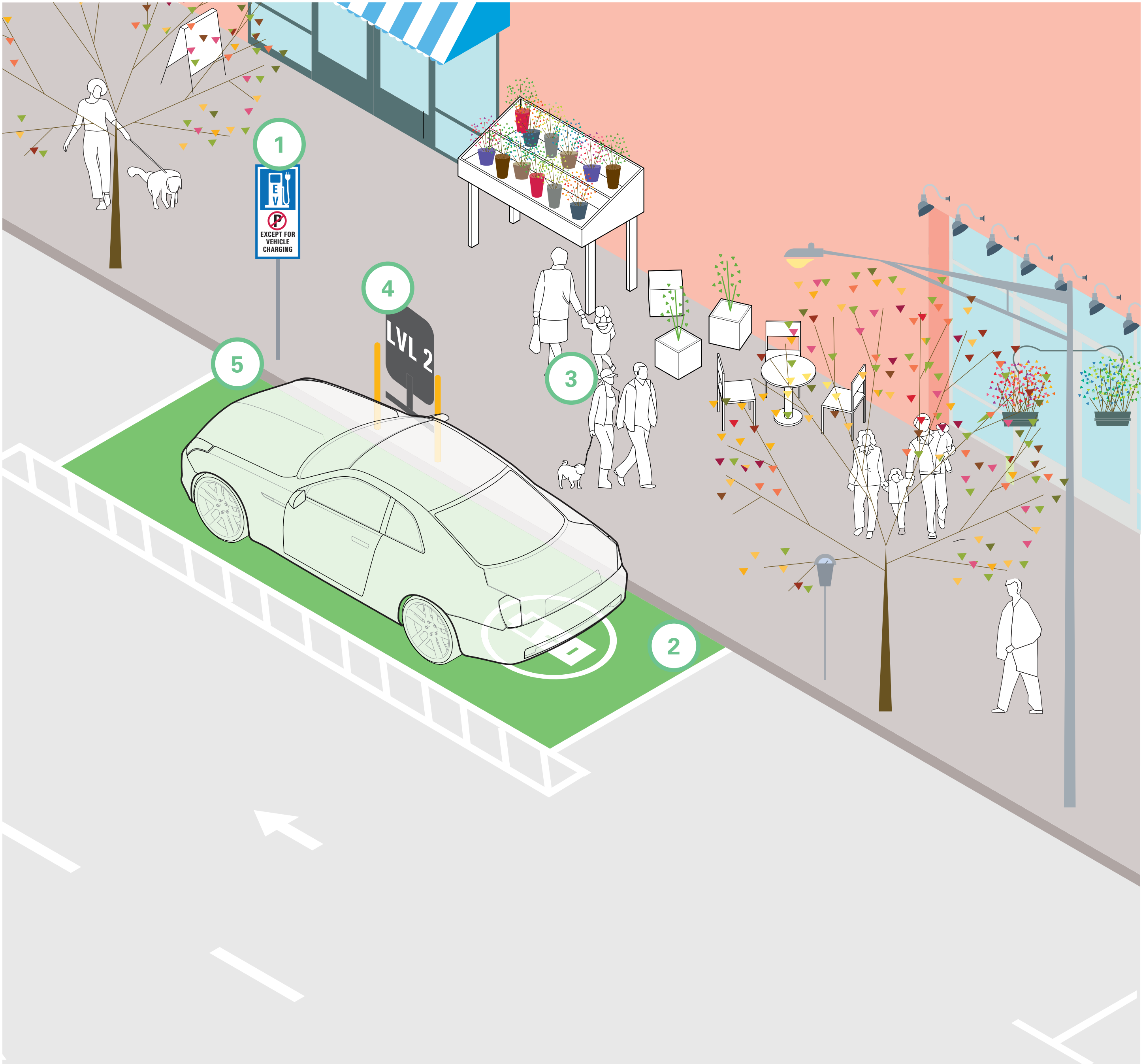


FIGURE 19. SITING AND DESIGN GUIDELINES FOR ON-STREET PARKING

3) ON-STREET

PRIORITIES FOR ON-STREET PARKING

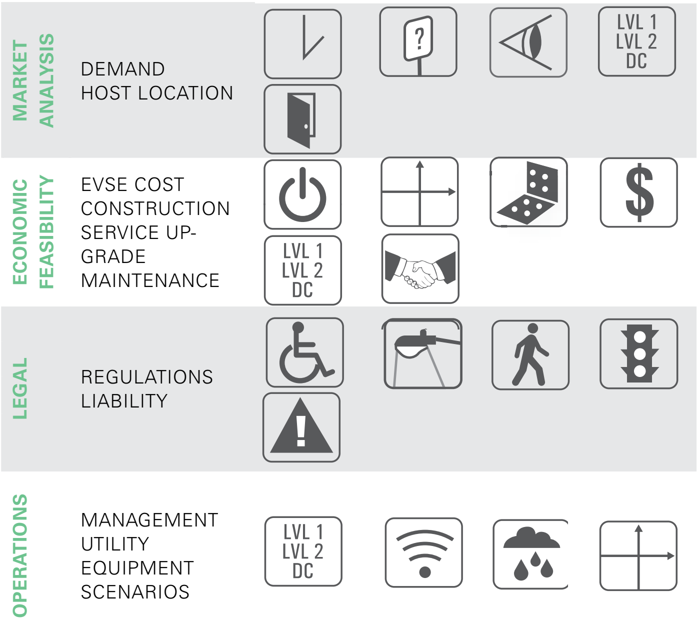


IMAGE 5. LONDON, UK CORD MANAGMENT TECHNOLOGY AND EVSE PLACEMENT IS ESPECIALLY IMPORTANT FOR ON-STREET PARKING SO AS TO NOT CREATE TRIPPING HAZARDS. EVSE SHOULD NOT BE PLACED IN A LOCATION THAT WOULD CROSS SIDEWALKS OR PEDESTRIAN PATHS. RETRACTION DEVICES OR A PLACE TO HANG PERMANENT CORDS AND CONNECTORS SUFFICIENTLY ABOVE THE GROUND SHOULD BE PRESENT ON ALL EVSE.

For urban centers and main streets, on-street parking is one of the primary types of parking available. Providing EVSE in parallel or angled parking spaces in these highly trafficked areas is tricky but not impossible: London, UK has recently installed hundreds of on-street EVSE, and Portland,OR has created "Electric Avenue," an on-street demonstration project. Central issues and priorities outlined here point to challenges and opportunities for this context. For example, municipalities or businesses looking to install on-street EVSE will weigh costs associated with accessibility and liability with the opportunity to provide widely-accessible EVSE in the public realm.
Many municipalities have yet to consider zoning and other design issues for on-street parking. This can be another hurdle for developers, and points to the need for municipalities to address on-street parking locations.

1. Signage and wayfinding is crucial for locating and designating EVSE charging spaces in the public realm. Municipalities or districts seeking a green identity may choose to locate EVSE spaces in prominent locations, and incorporate identity campaigns into accompanying signage. Signage should also designate limits of use. Enforcement should be provided by traffic police who issue tickets for metered parking, and penalties should be enforced in order to maximize use of the EVSE.

2. Street markings can further identify spaces, but striping or painting should be distinct from no parking or bike lane designation.

3. Placement of EVSE in the public right-of-way is a challenge. Charging stations with simple and streamlined designs are desirable, as the EVSE will be a part of an existing streetscape that may already contain numerous obstacles, such as planters, benches, bike racks, signage, vending and merchant furniture or displays.

4. On-street EVSE may be provided in partnership with owners of nearby businesses or buildings, from which power may be drawn. Alternately, electricity may come from existing on-street sources, including city-owned lines, telecommunications companies through phone booths and private sources connecting to street lighting, among others. Ownership of the conduit will determine metering and billing responsibility and options.

5. Access for all drivers will include allowing sufficient space to maneuver to the front and side of the EV in order to attach the coupler to the vehicle. Drivers may be required to enter oncoming traffic in order to reach the EV's port. EVSE placement will also help accessibility; because of the location of EVSE inlets on most EVs is the front grill or over a front wheel, EVSE should be installed at the front third of a parallel space. For angled front-in parking, EVSE can occupy the triangular left over space at the front.

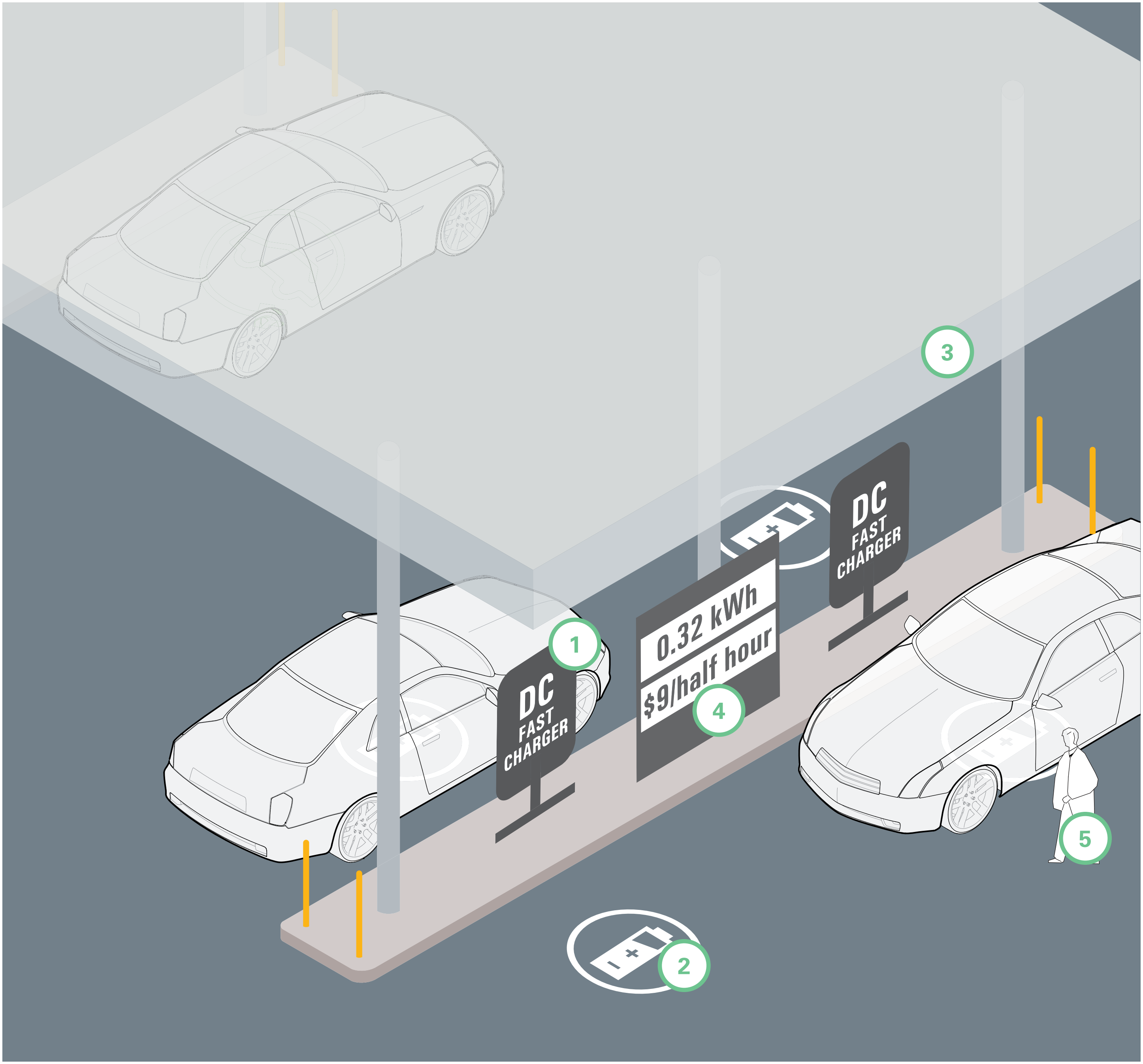


FIGURE 20. SITING AND DESIGN GUIDELINES FOR SERVICE STATION PARKING

4) SERVICE STATION

PRIORITIES FOR SERVICE STATION CHARGING

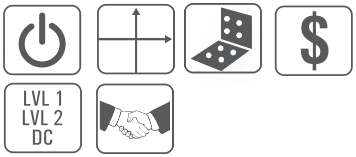
MARKET ANALYSIS	DEMAND HOST LOCATION	
ECONOMIC FEASIBILITY	EVSE COST CONSTRUCTION SERVICE UP-GRADE REVENUE FISCAL IMPACTS	
LEGAL	REGULATIONS LAND USE LIABILITY TERMS	
OPERATIONS	UTILITY EQUIPMENT	

IMAGE 6. BEAVERTON, OR THE EVSE IS INTEGRATED INTO EXISTING INFRASTRUCTURE. IT IS LOCATED BETWEEN OTHER GAS PUMPS AS TO NOT BLOCK TRAFFIC SINCE THE CHARGING VEHICLE MAY BE PARKED FOR UP TO HALF AN HOUR.

Service station charging will most closely approximate the experience of gasoline fill stations, and will likely be accommodated at existing service station locations. This type of charging will prioritize speed and convenience, allowing drivers to pull in off the road and top off a battery in order to continue for longer distances. Service station operators may have to contend with negative customer perception about the proximity of electricity and gasoline, but in fact, this scenario does not present any clear additional user hazard.

1) The type of EVSE most appropriate will likely be DC fast charging. Allowing customers to quickly charge up while in transit is the most important aspect of this location.

2) Clear markings for EVSE charging is essential in order to avoid customer confusion, as many DC fast EVSE models resemble standard gasoline pumps. Location on the service station site must not interfere with vehicles accessing the gasoline pumps.

3) Protecting DC fast chargers from the elements at outdoor locations is both a customer amenity and desirable safety precaution for electrical devices.

4) Service stations will need to partner with EVSE networks or establish their own appropriate charge-for-charge model.

5) Customer amenities are crucial, as drivers will need a safe place to wait for up to a half hour while their vehicle charges. Rest stops already have these options, but standard service stations may need to consider a covered seating area or expanding the convenience retail model to include a café.

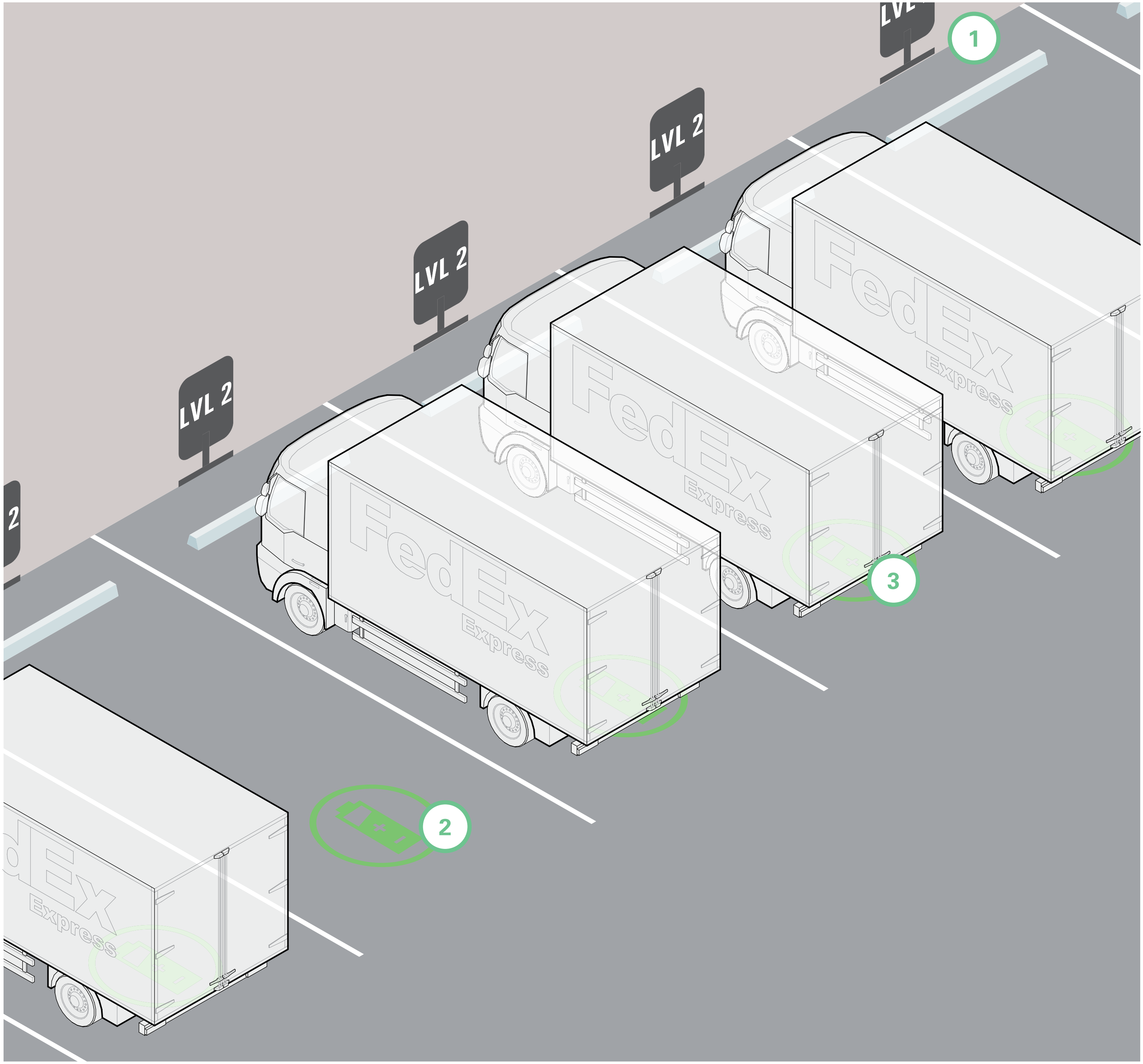


FIGURE 21. SITING AND DESIGN GUIDELINES FOR COMMERCIAL FLEET PARKING

5) FLEET

PRIORITIES FOR COMMERCIAL FLEET CHARGING

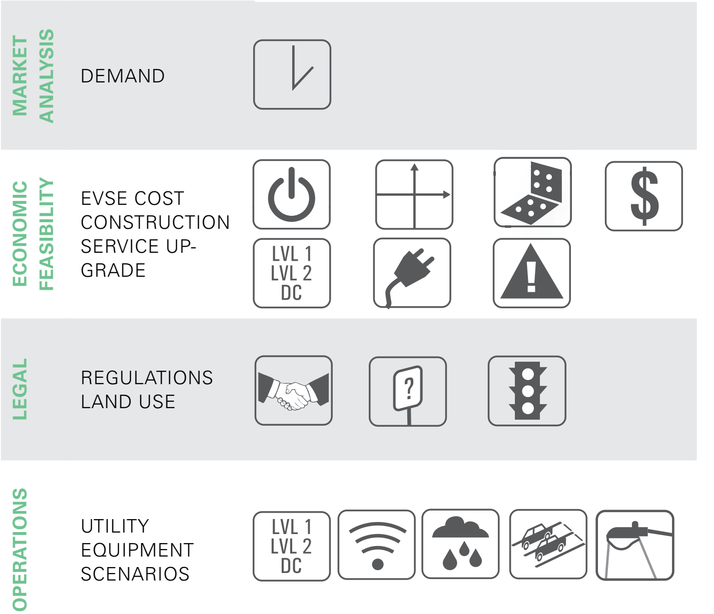


IMAGE 7. FRITO LAY MOST TRUCKS USE THE J1772 STANDARD CONNECTOR TO CONNECT TO EVSE.

Commercial trucking represents a growth area for EV use. Benefits associated with reduced air pollution will make EV fleets an important option for inner city freight hubs. Several large corporations, such as FedEx, Frito Lay and Duane Reade have begun to incorporate EVs into their commercial fleets. Green loading zones will be located at delivery locations and will designate areas near loading docks, or on the street adjacent to building freight entrances, and eliminate the environmental hazards associated with idling diesel engines. However, fleet use is not limited to delivery vehicles. University or medical campuses, governments and car share companies are all incorporating EVs. All fleet vehicles will need a place to charge overnight at their home parking location.

1) Proximity to building entrances is a different consideration for fleet vehicles. For green loading zones, accessibility to freight entrances and elevators is the primary consideration. For other fleet charging, operators may desire a location further from building entrances so as not to impede delivery traffic or other industrial operations.

2) Length of stay for fleet vehicles will help site planners to determine the appropriate level of charge. For green loading zones with a fast turnaround, DC fast charging may become the norm, although level 2 will be more cost effective and standard for the immediate future.

3) Overnight parking is necessary but may place a burden on the existing systems. Most industrial locations will already have access to heavy power in the buildings, but bringing power to the charging location will add to installation costs and the addition of numerous large EV batteries to the circuit will dramatically increase the system's load. Local electrical service transmission capacity is a central concern, and site designers will work with the local utility to ensure that any necessary upgrades are made.

RESOURCES

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Image 2. Ozawa, Ryan. *Electric Vehicle Parking.* Available from: Flickr. JPG Digital Image, http://www.flickr.com/photos/hawaii/6879222319/ (accessed August 11, 2012).

Image 3. *Electric Vehicle Charging stations.* Available from: IKEA. JPG Digital Image, http://www.ikea.com/us/en/store/burbank/activities (accessed August 11, 2012).

Image 4. Yasukawa, Mitsu. C*hris Neff of Mendham charges his car at an electric charging station in parking lot A on the campus of Bergen County Community College.* JPG Digital Image, http://www.northjersey.com/news/environment/Electric_car_tour_stops_in_Paramus_to_charge_up_at_Bergen_Community_College.html?page=all (accessed August 14, 2012).

Image 5. *Plug-in Prius Prototype.* JPG Digital Image, http://www.plugincars.com/exclusive-toyota-explains-its-position-electric-cars.html (accessed August 14, 2012).

Image 6. Tenney, Sam. *A new Chevron station at the corner of Allen and Murray boulevards in Beaverton features an eco-roof, a geothermal system, a solar array, and an electric-vehicle charging station.* Available from: Daily Journal of Commerce Oregon. JPG Digital Image, http://djcoregon.com/news/2011/10/04/beaverton-gas-station-goes-green-with-help-from-eugene-company/ (accessed August 12, 2012).

Image 7. *Frito-Lay Smith EV.* Available from: Fleets and Fuels (Business Intelligence For Clear Transportation Professionals). JPG Digital Image, http://www.fleetsandfuels.com/fuels/cng/2012/05/100-more-smith-evs-for-frito-lay/ (accessed August 16, 2012).

EV-READY CODES

FOR THE BUILT ENVIRONMENT

Electric Vehicle Supply Equipment Support Study

Prepared for:
New York State Energy Research and Development Authority
and
Transportation and Climate Initiative

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November 2012

NOTICE

This material is based upon work supported by the U.S. Department of Energy under Award Number #DE-EE0005586.

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TCI is a collaboration of the transportation, energy and environment agencies from the 11 Northeast and Mid-Atlantic states and Washington, DC, focused on reducing greenhouse gas emissions from the transportation sector. Jurisdictions participating in this TCI project are Connecticut, Delaware, Washington, D.C., Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont. Clean Cities Coalitions from the Northeast and Mid-Atlantic regions are working with the TCI states on this project through the Northeast Electric Vehicle Network.

This document was commissioned by TCI, and was developed as part of the Electric Vehicle Supply Equipment (EVSE) Support project awarded under NYSERDA Program Opportunity Notice (PON) 2392 to Energetics Incorporated. The research, interviews and analysis in this report were performed by WXY Architecture + Urban Design (Project team Adam Lubinsky, Jennifer Gardner and Paul Salama), with support from Energetics Incorporated and Bruce J. Spiewak, AIA, Consulting Architect LLC.

ACKNOWLEDGEMENTS

Thank you to the following individuals for their experience and insight into planning, regulating and deploying electric vehicle charging infrastructure:

Denis Clements, Electrical Program Chief, Oregon Building Codes Division

Richard Cromie, Program Manager, Advanced Technology, Southern California Edison

Mark W. Earley, P.E., Chief Electrical Engineer, National Fire Protection Association

Ken Frank, Sustainability Manager, New Jersey Department of Environmental Protection

Jim Jensen, Senior Bioenergy and Alternative Fuels Specialist, Energy Program, Washington State University

Ari Kahn, Electric Vehicle Policy Analyst, New York City Office of Long-Term Planning and Sustainability

Brian Kiley, Edgewood Electric

James McCabe, Senior Director of Standards Facilitation, American National Standards Institute

Patti Miller-Crowley, Washington State Department of Commerce and member of the State EV Task Force

Beth Neaman, External Engagement, Advance Technology Group, PEV Readiness Program, Southern California Edison

Michael Pfeiffer, Deputy Senior Vice President, Technical Services, International Code Council

Malcolm Shield, Climate Programs Engineer, Sustainability Group, City of Vancouver Sustainability Group

Additional thanks to the Georgetown Climate Center, particularly **Cassandra Powers** of the Transportation and Climate Initiative (TCI), for its guidance and coordinating efforts without which this report and review process would not have been possible, as well as to the **Clean Cities Coordinators** and the **TCI Clean Vehicles and Fuels Workgroup** for their collective review and feedback.

LIST OF ABBREVIATIONS

AC	Alternating Current
ANSI	American National Standards Institute
ANSI EVSP	American National Standards Institute Electric Vehicles Standards Panel
ARRA	American Recovery and Reinvestment Act
BC	British Columbia
BCD	Building Codes Division (Oregon)
CALGreen	California Green Building Code
DC	Direct Current
DOE	U.S. Department of Energy
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gas
IBC	International Building Code
ICC	International Code Council
IgCC	International Green Construction Code
IRC	International Residential Code
MOU	Memorandum of Understanding
NEC	National Electrical Code
NEIS	National Electrical Installation Standards
NFPA	National Fire Protection Association
NTTAA	National Technology Transfer and Advancement Act
NYSERDA	New York State Energy Research and Development Authority
ODOT	Oregon Department of Transportation
PGE	Portland General Electric
SAE	Society of Automotive Engineers
SCE	Southern California Edison
SEC	Seattle Electrical Code
TCI	Transportation and Climate Initiative
UL	Underwriters Laboratory
VAC	Volt Alternating Current

CONTENTS

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EXECUTIVE SUMMARY

Overview: EV-Ready Codes for the Built Environment

Electric vehicles (EVs) are being delivered to the Northeast and Mid-Atlantic markets in increasing numbers, and the battery-charging infrastructure that supports them is being deployed with different location and business models, technology configurations and utility communication networks. Each state, city and town will face a need consider the full scope of regulatory measures available to plan for the anticipated growth in the EV sector in order to facilitate and encourage consistent and accessible infrastructure deployment. The challenges presented by evolving technology and market transitions are significant but not insurmountable; however, they call for comprehensive planning and implementation strategies to account for stakeholder needs and to allow localities to capture the economic and environmental benefits associated with EVs.

The purpose of this report is to build on the discussion and knowledge base required to support electric vehicle supply equipment (EVSE) deployment through the elimination of barriers to widespread deployment by describing the role of building and electrical codes in encouraging or inhibiting the implementation of EVSE and to aid local and state practitioners in assessing local code-specific barriers and identifying the code provisions that would encourage a basic or advanced level of EV readiness in local policies and regulations. EVSE is the infrastructure required to charge an EV—from the cable that connects the vehicle to the charging unit up to the conduit that links the charging location to the utility grid and power supply.[1] The report will also highlight the processes and participants in creating, administering and amending such codes, and will explore the potential for jurisdictions to adopt codes that could encourage EVSE. The subject of analysis is the policy framework and state- and local-level adoption and amendment processes specific to the two key national model codes that impact EVSE installation and inspection: the National Electrical Code (NEC), published by the National Fire Protection Association (NFPA), and the International Building Code (IBC), published by the International Code Council (ICC). While there are other aspects of EVs and EVSE communications networks, as well as electrical utility issues that are standardized by different types of codes, these two relate most specifically to the construction and electrical equipment installation procedures associated with EVSE.

The report finds that the current national codes neither inhibit nor facilitate the implementation of EVSE, and that there are strong examples of jurisdictions where codes are successfully encouraging EV readiness. This report also finds that a proactive, rather than neutral, regulatory framework can assist in the deployment of a connected and strategically located EVSE infrastructure network in the places where drivers are most likely to charge. Structural codes are a part of that framework.

Case studies and expert interviews with codes officials, utility representatives and state and local government agencies were undertaken and describe ways in which codes adopted by states and other jurisdictions having authority can be an instrumental part of an EVSE-ready planning toolkit. A handful of states and jurisdictions across North America have already taken steps to include EV-ready provisions in some part of their structural code, and their experiences demonstrate many of the key reasons and benefits of approaching this type of infrastructure planning from the perspective of building and electrical codes. The lack of such code language at the state level in

[1] Please refer to Appendix A for further description and illustration of EVSE systems and requirements.

the Georgetown Transportation and Climate Initiative (TCI) region is a missed opportunity that the Northeast and Mid-Atlantic region states can work to amend.

Case Studies

Through case studies of model jurisdictions, the report will examine the efforts of and lessons learned by states and local jurisdictions regarding incorporation of EVSE-specific provisions into the building code, and consider lessons learned for model code development. Case studies include: a profile of municipal planning in Vancouver, British Columbia, Canada; initiatives in state-level planning in Oregon; and regional approaches linking city, county and utility planning in Los Angeles, California. The case studies highlight three approaches to metropolitan area and regional cooperation to address the regulatory framework that supports and monitors EV infrastructure deployment. Looking at advanced efforts at state, metropolitan area and municipal levels in forward-thinking jurisdictions, several common factors emerge regarding the successful creation of policy and regulation supportive of EV infrastructure:

- Each jurisdiction took specific and multifaceted steps to encourage use of EVs.
- Each jurisdiction considered opportunities and challenges associated with regulation at multiple levels of government, or with multiple layers of agency, authority or private sector participation, demonstrating the wide range of possibility in working with codes and other components of the regulatory environment.
- Actors in each jurisdiction identified and overcame potential regulatory barriers.

Municipal Planning in Vancouver, BC

In **Vancouver**, a municipality created a collaborative working group to develop EV-readiness strategies with the intent of meeting long-range GHG reduction goals, and it became the first North American municipality to mandate EVSE-ready electrical installation in all new residential and commercial construction.

State-Level Planning in Oregon

Oregon amended the electrical code to reflect a need to address EV-charging infrastructure in an inefficient statewide market with many early adopters concentrated in specific geographic areas and corridors, opting instead to expedite and dramatically reduce costs associated with the permitting process for residential EVSE.

Linking City, County and Utility in Los Angeles, California

In the **Los Angeles** metropolitan area, high statewide standards required by CALGreen, the nation’s first mandatory green building code, and local amendments work in concert with utility-led efforts to plan for EV readiness across complex jurisdictional boundaries.

Summary of Key Findings and Recommendations

Despite the complexities inherent in the state and local decision-making process of evaluating options for EV-ready planning, there are opportunities that can be created for supporting consistent EVSE deployment planning. Structural codes do not operate alone in the local regulatory environment; they are one tool available on the regulatory menu to jurisdictions seeking to govern infrastructure deployment. Despite the environmental benefits and growing EV market in many areas across the United States and throughout the region, each jurisdiction will need to assess the costs and benefits associated with its own goals pursuant to energy efficiency, transportation electrification, green construction, air quality and economic development in order to effectively prioritize EV-readiness steps.

Existing Codes Present No Significant Barriers to EVSE Deployment

While there are no specific barriers to EVSE installation embedded in the existing national model building and electrical codes, there is room within the codes as adopted by the states to more clearly encourage EV readiness. Despite differences between jurisdictions, the structural codes themselves—model and adopted—cover existing safety concerns related to existing automotive and charging technology and permit or facilitate conditions under which EVSE can be installed.

Recommendation to Promote General Code-Related EV Readiness

- Education and training programs for inspectors and installers have become the norm as an early evaluative step in EV-readiness planning. States seeking to evaluate the need of codes and permitting processes should initiate EVSE training for professionals in related fields.

Codes Can Achieve Regional EV Readiness

There are specific reasons to consider changing codes at the state and local levels. Because code amendments are one of several interrelated strategies to encourage EVSE deployment, in considering changes, it is important for jurisdictions to consider what codes can accomplish. Codes are generally revised at the national level every three years and at the local level every six years or more, and they will be updated at the national level to meet new structural or fire safety concerns, such as those related to new and emerging technologies. Local codes will not address this topic. Where codes have more impact is specification of scoping requirements that define numerical goals or limits for certain features in new construction (e.g., percentage of required parking spaces to be built EVSE-ready). Similarly effective, codes can provide for new permitting or inspection protocols and encourage the reduction of associated administrative costs.

Local conditions will factor heavily into the decision to regulate for EVSE based on codes. Variations across the TCI region will mean that states will make different choices. States such as New Jersey, for example, with a relatively evenly distributed, dense population and centrally located transportation corridors, may find scoping requirements in the building code to be a good solution. By contrast, Maine's lack of uniform population density with residential concentration around key urbanized centers may suggest a different approach.

Recommendations for State and Regional Code Policy Cohesion

- Reduce real consumer costs of EV adoption by addressing the extreme variation in permitting fees and lowering fees for residential installations, such as through classifying residential EVSE installations as minor label work.
- Incentivize and encourage incorporation of EVSE by modifying building codes when economically appropriate to require that a percentage of accessory parking associated with new development to be pre-wired for EVSE, providing flexibility for future capacity.
- Enable state and local participation in a forum for interstate cooperation.

EVSE Deployment Contributes to Economic Development

Codes factor into economic development planning. EVs and EVSE deployment influence such disparate areas as maintaining housing affordability; providing equitable access to transportation infrastructure; creating green jobs and marketing metropolitan areas to attract new businesses, residents and institutions.

For the development and construction community, there is a need to keep costs low enough to be easily absorbed into overall project costs. However, inclusion of ESVE readiness in the building phase can be more cost effective than retrofit and increase the value of individual units as well as the community at large.

Another aspect of economic development for EVSE is that jurisdictions encouraging EV readiness will likely gain growth associated with EVs and charging infrastructure. The presence or stimulation of markets for EV and EVSE has primed the pump in early adopting jurisdictions. For example, Vancouver's signing of memoranda of understanding with auto manufacturers highlights an approach to capture a portion of the EV market.

Recommendations for Outreach, Research and Economic Development:

- Incorporate or acknowledge EVSE deployment through TCI-region state-level economic development strategy.
- Fund further research and program assessment specific to the TCI region to enable local jurisdictions to make informed decisions about costs and benefits associated with public expenditures for EVSE, and to guide development of public-private partnerships.
- Fund ongoing demonstration programs, particularly those that focus on innovation and new technology.

High-Level Flexibility Leads to Meaningful Local Options

Standardization is an important goal for EVSE and EV adoption as a means to generate industry consistency, lower costs and avoid excessive fragmentation. At the same time, EVSE policy and planning should not tie hands at the local level. California's CALGreen is an excellent example of the ability of codes to create a high-level planning framework while retaining flexibility at the local level. Significantly, a local jurisdiction's codes must be in compliance with state-level legislation, meaning state laws play a central role in establishing the range and impact of local regulatory requirements. Challenges in this arena include the creation of seamless and simple regulations using consistent language in state and local laws that limit code revision to what is necessary for compliance. State codes can offer an a la carte menu of options, standardized at the state level but adopted through tiered systems and/or on a voluntary basis by the local jurisdiction. Well-written codes may also offer phased provisions or optional parameters, maximizing the adaptability and efficacy of local regulations.

Recommendations for Maximizing Consistency across Local Jurisdictional Boundaries:

- Adopt state code amendments containing voluntary scoping and implementation options, such as tiers of compliance and voluntary appendices.
- Make consistent information and technical support available to officials across state and local agencies through the Clean Cities' Coalitions.
- State agencies having jurisdiction should introduce locally vetted modifications to the discussion of national model codes in the next possible code cycle (2015).

Partnerships Will Guide Infrastructure Deployment

Successful local plans for EVSE rollout have been comprehensive in scope; because codes are one part of the local regulatory environment, they must work in concert with other statutory requirements, economic policies, local planning and regulatory processes. It is necessary for key factors to be in place to successfully advance policy, legislation and ordinances pertaining to EV infrastructure advancement.

Highly significant among these is a forum for cooperation. The reduction of barriers to EVSE deployment will not come from code amendments alone, but rather from the collaborative efforts that can produce such amendments as a part of a comprehensive deployment strategy. Large-scale and multi-agency coalitions and working groups, public-private partnerships and work with academic and research institutions have contributed to a broad-based understanding of intersections among local and regional goals in model jurisdictions.

The role of the private sector can be just as, if not more, important in preparing the region for more comprehensive EVSE deployment. Federal and state funding can be allocated to private infrastructure developers (e.g., ECOtality's EV Project) to gather data, test business models and pilot high-visibility EV charging. Private-sector outcomes will determine many aspects of EVSE.

Recommendations for Legislative Measures to Encourage Public-Private Collaboration:

- Enable the creation of special purpose clean energy districts to connect interests and regulatory processes in the TCI region.
- Enable data exchange and access to EV ownership and EVSE installation to improve utility performance and enhance utility involvement in local and regional planning.
- Create and/or engage EVSE working groups housed within the appropriate agency in each state to leverage TCI regional stakeholder information and influence and to promote high-level cooperation.

1. INTRODUCTION

Plug-in electric vehicles are being delivered to the Northeast and Mid-Atlantic markets in increasing numbers, and the battery-charging infrastructure that supports them is being deployed with different location and business models, technology configurations and utility communication networks. Electric vehicles (EVs) and charging infrastructure are coming to states, cities and towns that have highly individualized regulations—from taxes and EV incentive programs to zoning, permitting and structural codes. Anticipated growth in the EV sector creates a need to plan ahead to facilitate and encourage consistent and accessible infrastructure deployment. The challenges presented by evolving technology and market transitions are significant but not insurmountable; however, they call for comprehensive planning and implementation strategies to account for stakeholder needs and to allow localities to capture the economic and environmental benefits associated with EVs.

This report will build on the discussion and knowledge base required to support electric vehicle supply equipment (EVSE) deployment through the elimination of barriers to widespread deployment by describing the role of building and electrical codes in encouraging or inhibiting the implementation of EVSE. Further, the report will highlight the processes and participants in creating, administering and amending such codes, and will explore the potential for jurisdictions to adopt codes that could encourage EVSE. EVSE is the infrastructure required to charge an EV—from the cable that connects the vehicle to the charging unit up to the conduit that links the charging location to the utility grid and power supply.[2] The EV industry is a developing one, and the entities that create and govern the codes and administrative processes that regulate EVs and charging infrastructure are just beginning to work together to regulate and plan for the charging infrastructure that will anticipate and provide right-sized service for a growing number of EV users.

The regulatory environment that shapes the distribution of infrastructure is itself shaped at the national, state and local levels of government. At each intersection or level of decision making, the private market—including the auto industry, utility, real estate and environmental interests—influences the regulatory choices made by a jurisdiction. For example, a town with no ability to address EVSE through codes or zoning may not be able to assist and benefit from a developer seeking to install EV charging stations in a new apartment complex. Each state or local jurisdiction will need to assess the best implementation strategy for creating an EV-friendly regulatory environment based on unique local criteria. Standards and codes ideally will make it as easy as possible for the public and private realms to interact, resulting in widespread infrastructure distribution and stimulating investment in the EVSE sector.

Codes impact one of the most significant values derived from EV use—the ability of the EV driver to charge directly from the grid—anywhere, anytime. According to University of British Columbia (BC) researcher and city of Vancouver sustainability engineer Malcolm Shield, an estimated 80%–90% of EV charging will happen at home,[3] EV drivers will also need access at work and other common driving destinations in order to achieve this key EV value proposition.[4] Where, when and how drivers are able to charge is at the discretion of the state and local jurisdictions[5]

[2] Refer to Appendix A for further description and illustration of EVSE systems and requirements.
[3] Malcolm Shield, (presentation, 2012 BC Power Symposium, Vancouver, BC).
[4] For at-home charging, multiunit dwellings and commercial locations.
[5] The term "local jurisdiction" refers broadly to municipalities, counties, towns or other designated administrative subdivisions having some powers of self-government. For the purposes of this report, local jurisdictions will primarily include incorporated municipalities or other legally separate entities with some

that regulate and permit new charging infrastructure. Of course, other significant market factors influence the value of EVs as well. For example, the regulation of electricity protects the consumer from the price fluctuations that affect petroleum fuel.

The extent to which codes and other regulatory tools can impact EV and EVSE markets has yet to be demonstrated in most U.S. cities. Case studies and expert interviews with code officials, utility representatives, planning and installation practitioners and state and local government agencies were undertaken and describe ways in which codes adopted by states and other jurisdictions having authority can be an instrumental part of an EVSE-ready planning toolkit. A handful of jurisdictions across North America have already taken steps to include EV-ready provisions in some part of their building or electrical codes, and their experiences demonstrate many of the reasons and benefits of approaching this type of infrastructure planning from the perspective of codes. A lack of specific code language addressing EVSE deployment allows for both flexibility in a developing market and the continued possibility for confusion about how to use codes to influence EV readiness, and it represents a missed opportunity in many areas for a smoother transition. This report highlights key challenges and opportunities associated with the building and electrical codes implemented nationwide. A first step is to understand which codes regulate the built environment and whether they cover EVSE, and then understand what can be gained, if anything, by altering them.

Critical and Transportation Infrastructure Development

The market for EVs is growing. There are now 11 highway-capable EV models and approximately 13,000 plug-in EVs already on the road across the United States. Anticipated changes in technology will continue to make these vehicles an increasingly viable consumer choice over the next decade. Just as gas stations provide a critical service to gasoline engine vehicles, charging infrastructure will be necessary to serve this expanding group of drivers. Further, the technological advancement projected for this field will continue to redefine this class of energy-efficient vehicles and, as such, it is critical that innovation and industry growth occur in accordance with uniform policy and high levels of safety.[6] Codes should be comprehensive but not overly restrictive to ensure this advancement.

1.1. Project Origins

The research leading to this report is supported by the New York State Energy Research and Development Authority (NYSERDA) in association with PON 2392, Electric Vehicle Supply Equipment Support, and it has been conducted by WXY Architecture and Urban Design in partnership with TCI, Energetics Incorporated and Bruce J. Spiewak, AIA, Consulting Architect LLC, with funding provided by the U.S. Department of Energy (DOE).

TCI is a collaboration of the transportation, energy and environment agencies from the 11 Northeast and Mid-Atlantic states and Washington, DC, focused on reducing greenhouse gas (GHG) emissions from the transportation sector. Jurisdictions participating in this TCI project are Delaware; Washington, DC; Maine; Maryland; Massachusetts; New Hampshire; New Jersey; New York; Pennsylvania; Rhode Island and Vermont. TCI states work closely with Clean Cities Coalitions throughout the region through the Northeast Electric Vehicle Network.

1.2. Codes Regulate the Built Environment

This report considers the policy framework and state- and local-level adoption and amendment processes specific to the two key national model codes that impact EVSE installation and

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corporate powers. Ideally these powers include the authority to amend and adopt codes, but this will vary from state to state.

[6] James McCabe (ANSI), interview, July 12, 2012.

inspection: the National Electrical Code (NEC), published by the National Fire Protection Association (NFPA), and the International Building Code (IBC), published by the International Code Council (ICC). While there are other aspects of EVs and EVSE that will require the attention of other standards and code-setting bodies, such as communications technology and utility connections, these two model codes relate most specifically to the construction and electrical installation associated with EVSE.

In concert with zoning and other state laws and local ordinances, these structural codes determine what, where and how different types of buildings and facilities can be built, modified and used. EV infrastructure will be a critical part of the built environment in future cities and towns, and developing an understanding of the way these regulations impact the deployment of EVSE is central to planning effective infrastructure deployment across the region.

Several central considerations in planning for EVSE deployment relate to code-based regulation:

- Safety requirements for charging infrastructure
- Interoperability of EVs and EVSE across boundaries, including manufacturers, service networks and jurisdictions, as well as future-proofing against technology changes
- Implications for the electrical grid
- Growth of EVs as a viable consumer choice in a transitioning market

Unlike zoning or parking ordinances, codes are developed at the national or international level in an advisory capacity. However, states and localities generally have jurisdiction and wide latitude to adopt their own building and electrical codes and administrative permitting processes. One of the best ways of generating uniformity in design, manufacture and installation of charging facilities is to ensure the key safety and user concerns and parameters are regulated through the national codes, so that local codes operate in service of these goals.[7] Other standardized aspects of EVSE deployment and site design, such as signage, handicapped accessibility, communications systems and user interface, will require uniformity as well for effectiveness and efficiency, but fall outside the scope of the codes addressed in this report. EV infrastructure will be a critical part of the built environment in our future cities and towns, and developing an understanding of the way these codes impact the deployment of EVSE is central to planning a broadly distributed infrastructure deployment across the region and encouraging EV adoption through the elimination of barriers to charging vehicle batteries at home, at work and in transit.

As the EV market grows, the process of code writing is also evolving toward increased cooperation. Codes and standards organizations such as the ICC, the NFPA and the American National Standards Institute (ANSI) recognize that for mutual economic development across state, regional and national divisions, it is important to have consistent rules across these boundaries and to actively work toward harmonizing codes and filling gaps.[8]

1.2.1. The Infrastructure Domain

Codes and standards related to EVs apply to the vehicle and related systems in four general categories: vehicle systems, batteries, vehicle interface and charging infrastructure. This report focuses most closely on the electrical and building codes—those that directly impact installation and have implications for site design and zoning regulations and that fall under the purview of state and local governments.

ANSI's 2012 comprehensive standards and code review document for vehicle charging infrastructure, *The ANSI EVSP Standardization Roadmap for Electric Vehicles*, defines this area of

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[7] Michael Pfeiffer (ICC), interview, July 20, 2012.
[8] Fred Wagner (Program Director, Energetics Incorporated and editor of ANSI's EVSP Roadmap), interview, August 13, 2012.

standardization as the "infrastructure domain," which "generally encompasses the technologies, equipment, components, and issues that fall within the confines of the charging infrastructure up to and including the connector portion of the charge coupler." This area of standardization includes the following:

- The charging system itself
- The vehicle interface, comprising the points of contact with the vehicle and power supply, as well as onboard communications systems
- Infrastructure-grid communications
- Electrical installation

Overall, standardization of EVSE relates to five central product and service goals: product design and durability, power use and communication with the utility grid, environmental impacts, user safety and interoperability of the device.[9] The last two goals fall under the infrastructure domain.

There are codes and standards that apply to every aspect of the EVSE that connects the vehicle to the power source. These standards supply a basic framework for electrical safety for charging equipment that covers the EVSE from coupler to transformer in a variety of typical installation contexts. Electrical and building codes and standards govern the installation of the physical and electrical infrastructure that connects the EV to the grid.

1.3. Codes Contribute to EV Readiness

The central finding of this report is that while there are **no specific barriers to EVSE installation** embedded in the existing building and electrical codes, **there is room within the existing codes to more clearly encourage EV readiness** and, in some contexts, increased electrical safety.[10] Codes do not function to anticipate new technology, so they are not an appropriate tool to foster market development or specific technological innovation.

EV readiness in policy and regulation at the state and local levels will take a wide range of forms along the spectrum of allowing, incentivizing or requiring EVSE infrastructure deployment, including eliminating procedural barriers, considering potential for financial incentives or mandating pre-wiring for EVSE installation.

The current model codes do not inhibit the ability to safely install and use the most common types of EV charging units (level 1 and level 2 charging). Neither level 1 nor level 2 charging requires significant electrical work so long as the existing circuitry supports the device.[11] The safety of EVSE design and electrotechnical components is regulated by other standards that deal with products and production processes, such as those issued by the Society for Automotive Engineers (SAE), and provisions exist within the NEC in other chapters and articles for their safe installation based on the components and wiring requirements.

Code officials and local practitioners have noted that, in general, a state or local jurisdiction would have limited reason to amend the model codes, unless a state law or other similarly compelling requirement for compliance exists. For example, local environmental conditions such as high heat applications or high alkalinity of the soil would require specific instructions for certain electrical installations.

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[9] Electric Vehicles Standards Panel, *Standardization Roadmap for Electric Vehicles*, Version 1.0 (Washington, DC: American National Standards Panel, April 2012), http://publicaa.ansi.org/sites/apdl/evsp/ANSI_EVSP_Roadmap_April_2012.pdf.

[10] In some states, single-family residential self-installation of EVSE is permitted to bypass the inspection process, depending on the type of residential code adopted.

[11] See Appendix A for a review of levels of charge and their attributes.

ANSI senior director James McCabe notes that, at the national level, the main idea supporting the generation of national model codes is to provide a baseline for jurisdictions to be able to follow best practices in terms of safety as well as other concerns relevant to the locality. These baseline provisions address specific issues, including EVSE; according to ANSI, "Standards, code provisions, and regulations, as well as conformance and training programs…are a critical enabler of the large-scale introduction of EVs and the permanent establishment of a broad, domestic EV and infrastructure industry and support services environment."[12] EVSE appears to be a compelling reason for code changes in some cases. A number of states have adopted amended codes specific to EVSE. In these cases, climate action plans and carbon emissions reduction goals, executive orders regarding emissions and other environmental policies that turn to transportation electrification as a strategy have compelled states and local jurisdictions to make EV-ready amendments. A secondary reason for supporting EV-ready plans and policies is the economic benefits associated with attracting EVs, infrastructure and related services and production to an area. A handful of states and jurisdictions across North America have taken steps to include EV-ready provisions in some part of their structural code, and **the lack of EV-specific code language may be an opportunity** that the Northeast and Mid-Atlantic states can capitalize on as the region seeks to prepare for the arrival of consumer EVs in greater numbers.

1.3.1. EV-Ready Planning for Networked Infrastructure

EV-ready planning is a comprehensive approach to the creation of regulatory and physical environments that support EV and EVSE. EV readiness has different components, and policies and programs to bring EVs and EVSE to an area may include financial incentives such as discounted tolls, tax credits or grants to finance charging equipment. However, non-financial incentives can also be effective in paving the way for EV-charging infrastructure. Project Get Ready cites preferential parking spaces, access to HOV-style lanes and expedited permitting processes as examples of these incentives.[13] As outlined in the Project Get Ready Casebook and profiled in other similar studies, many cities have taken steps toward EV-ready development and the creation of an EV-friendly regulatory environment.

In the case of any type of regulation, EV readiness can be interpreted at a minimum as the removal of barriers to easy, safe and cost-effective EVSE installation. At maximum, codes can be utilized to impact the scope of EVSE deployment in a given jurisdiction.

In general, EVSE-ready policy does not necessarily require installation of charging stations, but instead takes the approach that future technology and consumer preferences may change. In this way, EV readiness can include up-front planning for current and future infrastructure needs while remaining conscious of costs. In several of the model jurisdictions profiled in this report, such planning initiatives range from limiting the cost and time associated with permitting and inspections to mandating a certain percentage of new construction parking spaces be pre-wired for future EVSE installation.

Stakeholders consulted for this report widely agree that EVSE policy and planning should not tie hands at the local level. As with most regulatory and governance issues, there is no one-size-fits-all plan of action for creating the ideal scenario for EVSE deployment. The jurisdictions profiled in this report have been actively engaging in initiatives that have the goal of accelerating EV adoption. These case studies demonstrate that while different localities have a range of goals, such as reducing greenhouse gas (GHG) emissions or petroleum imports, the use of state or

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[12] National Fire Protection Association, "Article 625 – Electric Vehicle Charging System Equipment," in *NFPA 70 National Electrical Code* (Quincy, MA: National Fire Protection Association, May 2001), http://www.nfpa.org/assets/files/pdf/A625-675.pdf.

[13] Electric Vehicles Initiative, *EV City Casebook* (Paris: International Energy Agency/Boulder, CO: Organization for Economic Cooperation and Development, 2012), www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf.

local codes to promote EV readiness is an effective tool to achieve differing goals and can take several approaches.

1.4. Code Modifications are Just One Tool at a Jurisdiction's Disposal

This report finds that the scope of best practices for EV readiness includes codes in two important ways: (1) establishing minimum parking requirements, and (2) addressing permitting or other administrative processes. Each of the jurisdictions profiled for this report has enacted its provisions for EVSE relatively recently (with some changes pending: Los Angeles County and the City of Vancouver will vote on new mandatory measures in August 2012).[14]

Modification of the state or local structural codes to encourage and incentivize EVSE installation is a direct action that enables jurisdictions to establish a pro-EV regulatory environment, either alone or in concert with state-level legislation; simplification of the administrative permitting process and changes to zoning and parking ordinances,

The national and local relationships to the model code development process are outlined in Section 2 of this report; case studies profiling EV-ready code actions taken by jurisdictions at different levels and lessons learned can be found in Section 3. This document provides a primer on the relevant structural codes and processes, as well as on opportunities and challenges for states and local jurisdictions seeking to regulate for and to encourage EVSE deployment.

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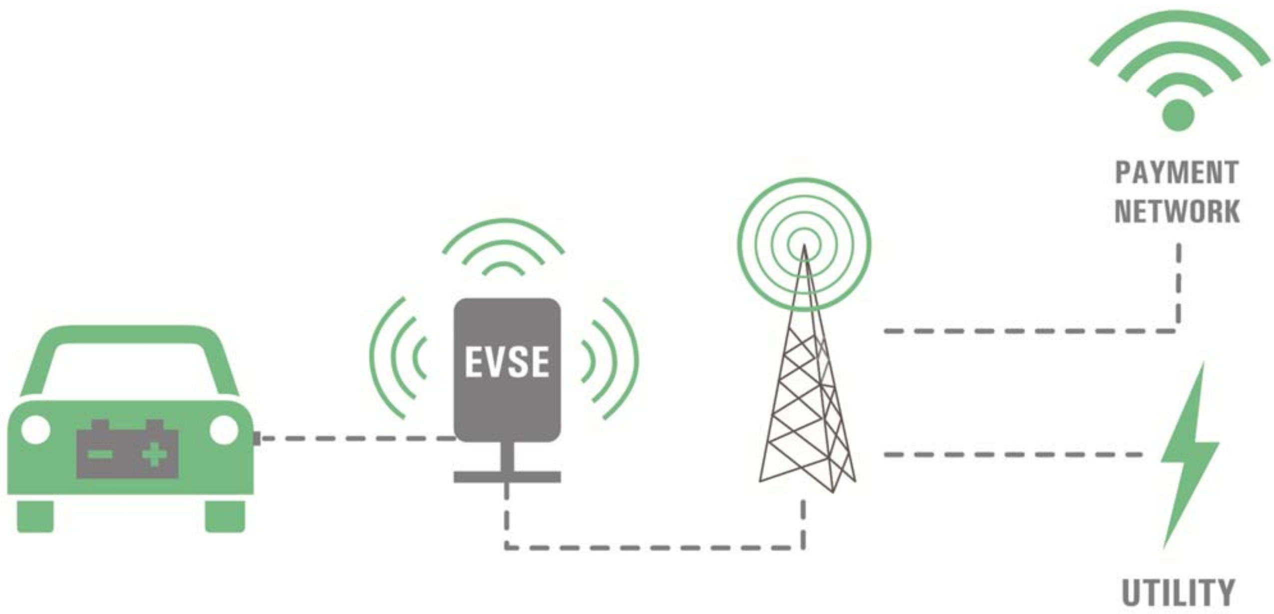
[14] Beth Neaman (Southern California Edison), interview; Malcolm Shield (City of Vancouver), interview, July 18, 2012.

Codes and Standards Topics for EV and EVSE



VEHICLE DOMAIN

Power Rating

Battery
- Safety
- Testing
- Storage
- Recycling

Crash Tests/Safety

On-Board Wiring

Emissions

User Interface
- Graphic Symbols

INFRASTRUCTURE DOMAIN

Electric Vehicle Supply Equipment

Charging Stations
- Power Quality
- Charging Levels/Modes
- Off-Board Chargers
- EV Couplers

Vehicle as Supply

Alternative Power Sources

Infrastructure Communications

Utility
- Metering
- Sub-Metering
- Load Balancing

Charge Network Service Provider
- Payment
- Accessibility and Locating EVSE
- User Information Exchange
- Notification

Infrastructure Installation

Site/Power Capacity Assessment
- Loads and Circuitry
- Ventilation - multiple vehicles

Urban Planning and Design
- Parking and Siting
- Environmental and Use Conditions
- Accessibility

Administration
- Permitting
- Inspection

Figure 1: Code Issues for EVSE

1.5. Objectives and Methodology

The aim of this report is to aid local and state practitioners in developing an understanding of what, if any, barriers to EV readiness exist in the current codes, what code provisions would encourage a basic or advanced level of EV readiness and how model codes are created and translated from national or international policy to locally administered regulations.

The primary objectives of this report are the following:

- To help the municipal, state or regional planner understand and expand on the high-level implications of codes and related policies that regulate EVSE
- To establish the role of state and local jurisdictions and legislatures, private industry and interest groups in setting and implementing codes in the EV infrastructure domain
- To describe the general process and potential associated with amending and adopting building and electrical codes as well as the specific lessons learned from jurisdictions that have adopted EVSE-related amendments
- To distill best practices and formulate initial recommendations for EVSE-friendly codes and the generation of consistent regional infrastructure networks

Expert interviews formed the basis of this report and included in-depth consultation with EV and EVSE specialists at the nation's primary code-setting organizations, the ICC and the NFPA, which develop and publish the IBC and the NEC, respectively. For the purposes of this high-level review, the project team focused on engaging code experts at the national level and in model cities and states, but it should be noted that every state and many municipalities have agencies and/or departments that oversee the adoption, implementation and enforcement of state building and electrical codes. These experts in local policy and implementation should be consulted in further detail as well.

In-depth expert and stakeholder interviews with planning and transportation practitioners, policy makers, EVSE installers and licensed electricians and other stakeholders from the Northeast and Mid-Atlantic Clean Cities' communities and beyond were conducted between June and August of 2012.

This work is supported by secondary analysis and literature review of reports and existing studies, market-based analysis and mapping.

Through case studies of model jurisdictions, this report examines the efforts of, and lessons learned by, jurisdictions at state and local levels to incorporate EVSE-specific provisions into the building code, and considers lessons learned for model code development. Case studies include the following:

- Municipal planning in Vancouver, British Columbia, Canada
- State-level planning in Oregon
- Regional approaches linking city, county and utility planning in Los Angeles, California

These case studies were selected based on an analysis of new and existing research and recommendations by the U.S. Department of Energy (DOE) Clean Cities Coalitions, the Transportation and Climate Initiative (TCI) regional stakeholder group and ANSI, among others. These case studies profile options and opportunities at different levels of government in order to illustrate challenges and choices from various perspectives.

Criteria for case study selection included the following:

- The jurisdiction must have an implemented code change specific to EVSE
- Examples were sought to provide insight at multiple levels of government

- Case study localities should have addressed issues of jurisdictional boundaries
- Depth of local experience with EVSE and EVs
- Examples should offer breadth with respect to potential lessons learned

The case studies were selected based on an analysis of new and existing research and recommendations by the DOE Clean Cities Coalitions, the TCI regional stakeholder group and the American National Standards Institute (ANSI),[15] among others. These case studies profile options and opportunities at different levels of government in order to illustrate challenges and strategies from multiple perspectives.

The report offers brief recommendations to multiple stakeholder categories for the codes modification process and for critical, related elements of local infrastructure planning that should accompany and inform jurisdictional or state-level change.

1.6. Report Structure

Section 1: Introduction

Section 2: Codes in Policy and Practice: National Landscape
This section develops an understanding of and expands on the national code-setting system and how codes apply to EVSE deployment.

Section 3: Local Codes from Model States and Municipalities
This section examines the efforts of jurisdictions at state and local levels to incorporate EVSE-specific provisions into the building codes, and considers lessons learned for model code development.

Section 4: Summary and Next Steps
This section synthesizes implications of case study jurisdictions' efforts and outcomes on the code-setting process for permitting (administration) and siting (design and zoning), and suggests next steps in the form of key recommendations and future study.

Appendices

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[15] ANSI is a standards-setting organization that published a critical reference for codes relevant to EV and EVSE. The EVSE Standardization Roadmap for Electric Vehicles, published in April 2012, is available at: http://publicaa.ansi.org/sites/apdl/evsp/ANSI_EVSP_Roadmap_April_2012.pdf.

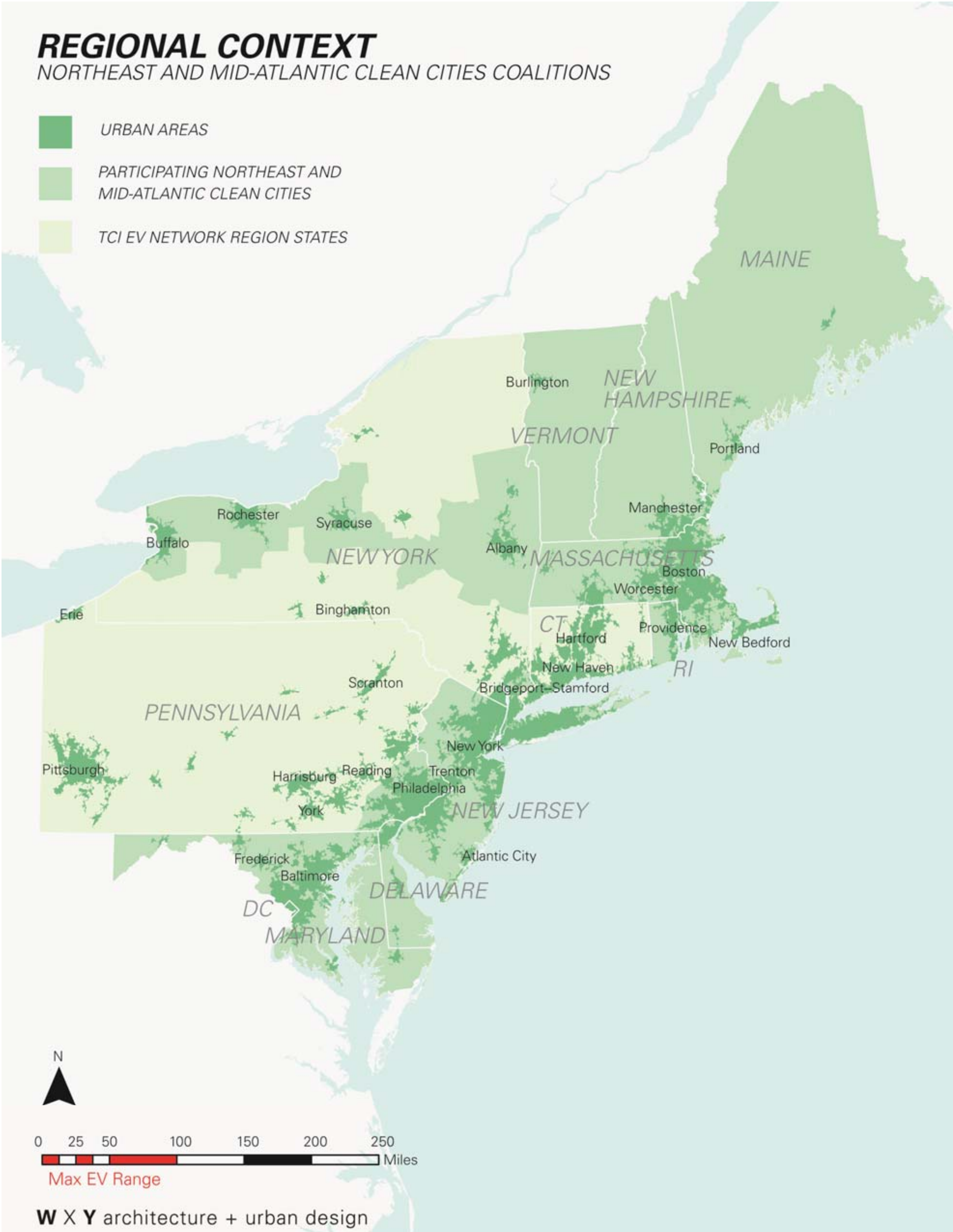

Figure 2: TCI Region Map. Sources: U.S. Department of Energy, Alternative Fuels Data Center and U.S. Census Bureau via ESRI

2. CODES IN POLICY AND PRACTICE: NATIONAL LANDSCAPE

Section 2 of this report takes a general approach to understanding the purpose of codes, their role in regulating EVSE-specific issues and the respective roles of various stakeholders: federal, state and local governments as well as code-setting entities and businesses in the EV sector. Understanding the theoretical underpinnings and processes behind the establishment of the primary model codes will aid states and local jurisdictions in their decision-making processes regarding if and how to make amendments to include EVSE-specific provisions to their respective regulatory processes.

2.1. What are Codes and Standards?

Codes are systematic statements of a body of law, especially one given statutory force.[16] According to the NFPA,

> *A **code** is a model, a set of rules that knowledgeable people recommend for others to follow. It is not a law, but can be adopted into law. A **standard** tends be a more detailed elaboration, the nuts and bolts of meeting a code.* [17]

At the most basic level, codes provide the minimum requirements to ensure public health, safety and welfare, and constitute the administrative framework through which governments extend safety protections. There are model codes—those that are developed at the national level for adoption by states and local jurisdictions—for every aspect of the built environment. For this report, the code discussion is focused on the NEC and the IBC, created by the NFPA and the ICC, respectively. Both of these are model codes, adopted in all 50 states and the District of Columbia.[18]

If codes provide the "what," standards often provide the "how." Standards are benchmarks that can provide descriptive language indicating accepted ways of doing things. They are rules, conditions, guidelines or characteristics for products, processes, production methods and management system practices.[19] Within the regulatory environment, codes and standards work together to create a framework of safety requirements and best practices; codes typically reference consensus standards developed by standards-developing organizations. As such, standards play an important role, "enabling technological innovation by defining and establishing common foundations upon which product differentiation, innovative technology development

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[16] "Code," Merriam Webster, copyright 2012, http://www.merriam-webster.com/dictionary/code.
[17] "About Codes and Standards," National Fire Protection Association, accessed October 23, 2012, www.nfpa.org/itemDetail.asp?categoryID=1332&itemID=31068&URL=Press%20Room/A%20Reporter's%20Guide%20to%20Fire%20and%20the%20NFPA/About%20codes%20and%20standards.
[18] While adoption of a building or electrical code is not required by federal law, the IBC is adopted or in use in 50 states and Washington, DC. The NEC is adopted similarly and has the distinction of being the least-amended model code. Some jurisdictions, notably New York City, have or have previously written their own building provisions, oftentimes to deal with local complexities, such as New York City's high-density population.
[19] "OMB Circular A-119," Standards.gov, accessed October 23, 2012, http://standards.gov/a119.cfm.

and other value-added services" are developed and are "essential for enabling seamless interoperability across products and systems."[20]

The American standardization system relies on private-sector involvement led by nongovernmental code-setting entities, and it is supplemented by federal involvement, in particular regarding regulatory processes.[21] In the United States, codes and standards are developed in an advisory capacity at a national scale—for example, the model codes created by organizations such as the ICC and the NFPA, which develop the IBC and NEC, respectively.

2.1.1. Model Codes Adopted by States and Local Jurisdictions

When this report references codes, it will refer to both *model* codes and *adopted* codes. Model codes are those created at the national or international level. Model codes are adopted by states and local jurisdictions through the legislative process. Adopted codes are the version of the model code approved at the state or local level, enforced by the local administrative agency having jurisdiction.

The IBC and NEC are adopted in their entirety or with amendments into law by the states; states further stipulate whether local jurisdictions are then permitted or required to adopt local amendments. Statewide adopting authorities, policies and procedures differ greatly from state to state, and again from local jurisdiction to jurisdiction, regardless of whether the state or jurisdiction is adopting a code as is or with amendments.[22] In part, this is a consequence of a limited federal role.

All codes are voluntary, carrying no legal status until they are adopted by states and/or local governments. Only adopted codes have the force of law. In this way, code-setting organizations are effectively responsible for developing and revising policy documents that advocate for public safety and consistency within the industries covered by the given code. When a jurisdiction adopts a model code or standard, it becomes enforceable under state or local law through the administrative process of the authority having jurisdiction, which may be a state, county or municipal government—and typically regulation requires action at multiple levels. Local amendments spell out code enforcement in the language of the code itself. Furthermore, code appendices offer optional compliance requirements that, when adopted, provide flexibility for jurisdictions to meet the demands of local conditions.

In the United States, conformance with electrical and building codes relies on four interrelated mechanisms: (1) product safety standards and certification, (2) plan approval, (3) application of installation codes and standards and 4) inspection. [23]

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[20] Subcommittee on Standards, *Federal Engagement in Standards Activities to Address National Priorities: Background and Proposed Policy Recommendation* (Washington, DC: National Science and Technology Council, October 2012), http://standards.gov/upload/Federal_Engagement_in_Standards_Activities_October12_final.pdf.
[21] Office of Management and Budget, "Circular No. A-119 Revised," The White House, February 10, 1998, http://www.whitehouse.gov/omb/circulars_a119.
[22] International Code Council, "Code Adoption Process by State," (Washington, DC: International Code Council, n.d.), http://www.iccsafe.org/gr/Documents/AdoptionToolkit/HowStatesAdopt_I-Codes.pdf.
[23] See note 13.

2.1.2. Pathway to Local Codes

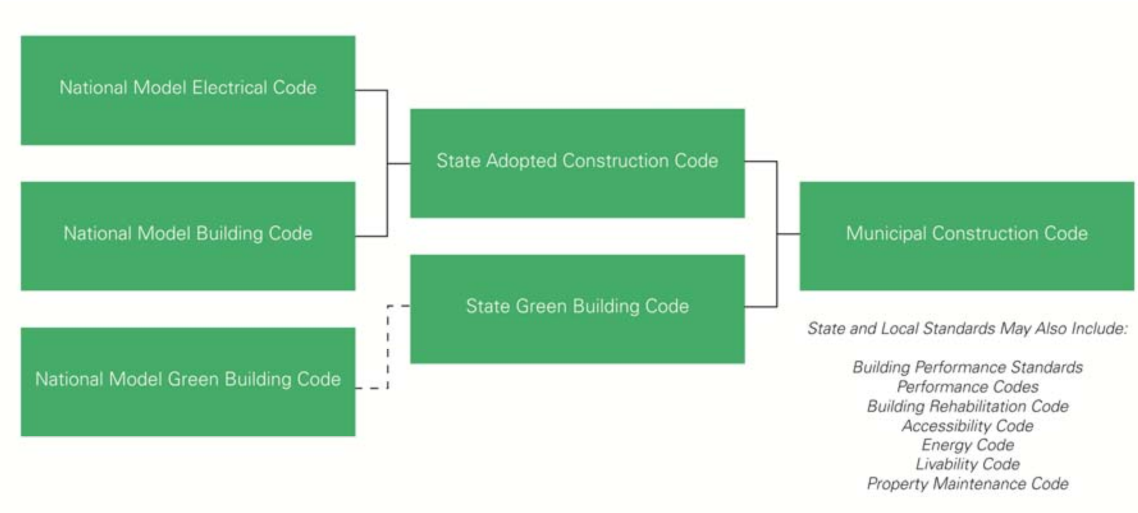

Figure 3: Hypothetical Code Adoption Pathway

2.1.3. Safety Considerations are Central to Codes

Codes ensure user safety and the long-term durability of EVSE hardware and its connection to the power source. There are three widely recognized elements to the safe installation of electrical equipment, including EVSE:

- The use of certified and listed equipment
- Development of clear building and installation plans
- Enforcement through permitting and inspection

EV infrastructure will be installed in a variety of different conditions, such as in single-family homes, on-street parking and public parking lots.[24] In each individual electrical installation, both electrical and building codes will dictate clear processes and procedures for site planning and electrical installation. While a great majority (an estimated 90%) of the charging infrastructure installations will be in residential settings, EVSE will be present in public and shared spaces as well, introducing potential safety hazards into the public realm. Although charging stations most closely resemble such innocuous household appliances as a dishwasher or clothes dryer, safety for all those who come in contact with powered appliances is paramount for the organizations that develop codes and the agencies and inspectors who administer them.[25]

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[24] Washington State passed legislation requiring jurisdictions throughout the state to specifically allow EVSE, including battery swapping, by target dates. Washington State's efforts are also explored in the next chapter.

[25] Although not determined to be major code-related concerns, the safety issues associated with typical EVSE designs and site installations that may lead to increased risk of shock or fire due to heightened continuous electrical loads will be discussed further in this report and in the EVSE site design guidelines.

2.1.4. Interoperability

Interoperability refers to the compatibility of products, systems and processes. Interoperability standards increase user value and improve user experience by providing not only a seamless interface but also peace of mind in terms of relying on the long-term viability of a technology investment or consumer purchase. Such standards reduce the risk of large-scale public and private investments in technology becoming prematurely obsolete.[26] More broadly, interoperability standards can also help maximize levels of coordination and compatibility within the EV industry domestically and internationally. This type of standardization contributes to market stability and could help increase adoption rates, supporting growth even in a transitioning marketplace. Interoperability also has an administrative component. From the perspective, for example, of permitting processes, the amendment of codes at the state level can make charging infrastructure more seamless to install and inspect, as well as to plug in to.

Finally, interoperability standards also relate to uniform signage, easy-to-use site design and other systems that ensure universal access and a safe user experience.

2.1.5. Adaptability

Changes in technologies and infrastructure in terms of the linkage of the EV with the electrical grid are invariable, and it is paramount that these new processes occur in a way that protects the environment.[27] In order to ensure a smooth transition to a future where the EVs are a widespread transportation option, a range of changes in regulatory environments will be necessary.

International consistency will underpin trade between the global automotive industry and local markets as well as compatibility of the charging infrastructure.[28] Compatibility of products in an international marketplace is a critical aspect of reducing production costs. Furthermore, the United States EV industry has the opportunity to advocate for the acceptance of its own standards at the international level, aiding in the competitiveness of U.S.-designed or U.S.-made products. EVSE manufacturers and network service providers see their role in setting standards as changing the marketplace and setting a path for the industry.[29]

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[26] "Memorandum for the Heads of Executive Departments and Agencies: Principles for Federal Engagement in Standards Activities to Address National Priorities," The White House January 17, 2012, http://www.whitehouse.gov/sites/default/files/omb/memoranda/2012/m-12-08_1.pdf.
[27] Stephen Brown, David Pyke and Paul Steenhof, "Electric Vehicles: The Role and Importance of Standards in an Emerging Market," *Energy Policy* 38, no. 7 (July 2010): 3797–3806, http://www.sciencedirect.com/science/article/pii/S0301421510001631.
[28] Ibid.
[29] Steven Dorresteijn, "Epyon: Your Partner in Fast Charging Solutions" (presentation, March 2011).

2.1.6. Code-Related Goals and Applicable Codes by Type

Issue	Code Type	Model Code
Structural Safety	Building Code	IBC, International Residential Code (IRC), International Green Construction Code (IgCC)
Fire Safety	Electrical and Building Code	IBC, IRC, NEC
New Technology	Electrical Code, Installation Standards	NEC, National Electrical Installation Standards (NEIS)[30]
Energy Efficiency	Building Code, Installation Standards	IgCC, NEIS
Scoping Requirements	Building Code	IBC, IRC, IgCC
Administrative Streamlining	Electrical and Building Code	IBC, IRC, IgCC, NEC

2.2. National Codes and the Federal Role

The U.S. federal government plays no official role in developing model codes or setting national standards, although it occasionally utilizes these documents to guide legislation and policy. In a 1997 article, University of Washington professor Peter J. May notes, "With the notable exception of building provisions for the disabled, the federal role is largely restricted to funding research programs in areas such as energy efficiency."[31] Instead, there is extensive reliance on private-sector code-setting bodies for the development of relevant standards.[32] The National Technology Transfer and Advancement Act (NTTAA) requires federal agencies to rely on standards developed by the private sector for regulatory or procurement processes unless there is impetus to do otherwise.[33] The NTTAA directs the National Institute of Standards and Technology to bring together federal, state and local agencies and governments to achieve greater reliance on voluntary standards, such as nationally accepted model codes, and decrease dependence on in-house single-agency standards.[34] The purpose of such legislation is to achieve openness, transparency and multi-stakeholder engagement through the engagement of the private sector in government process.[35]

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[30] NEIS provides quality and performance standards for electrical construction work that go beyond the NEC. As standards, they are beyond the scope of this document's analysis. However, it is important to note that NEIS has developed helpful EVSE-specific guideline materials for licensed electricians, and it is engaged in instructing technical courses to familiarize professionals with higher-level requirements and best practices associated with EVSE than required in the NEC's minimum installation safety standards. For more information, see: www.neca-neis.org.
[31] Peter J. May, "State Regulatory Roles: Choices in the Regulation of Building Safety," *State & Local Government Review* 29, no. 2 (Spring 1997):70–80.
[32] Ibid.
[33] See note 8.
[34] Standards.gov homepage, accessed July 24, 2012, http://standards.gov/.
[35] See note 28.

Many national policies intend to increase clean energy and EV use and their associated markets. President Obama's initiative to increase the number of EVs on U.S. highways to 1 million vehicles by 2015 includes the proposition that vehicles, parts, support equipment, batteries and other components will be made and serviced in the United States. Clean energy goals represent another area where the federal government is currently making significant policy and financial investments, and in which there is potential opportunity for the federal government to accelerate standards development activities in the process of promoting market-based innovation and competitive market outcomes.[36]

The national framework has also included funding, such as through the American Recovery and Reinvestment Act (ARRA) or DOE, which has been channeled into such related initiatives as the EV Project, a $230 million investment in EV infrastructure deployment and data collection that offers EV owners access to charging stations free of cost, as a means of both incentivizing uptake and evaluating the effectiveness of the charging infrastructure and network business models.[37]

However, it is the states and local jurisdictions that will directly confront feasibility, market development, application for and allocation of transportation and energy grant funding and evaluation of costs and benefits of public EVSE infrastructure programs.

2.2.1. Private-Sector Participation Links Code-Setting Process to Local Development

There is extensive reliance on private-sector code-setting bodies for the development of relevant standards.[38] Model codes are developed by private-sector not-for-profit membership organizations that unite concerns for public safety with those of industry. It is the role of these organizations to carry out the process through which the model building and electrical codes are created.[39]

This process features a high level of industry representation with a clear market component and is "informed by market needs…play[ing] a foundational role in facilitating competition, innovation and global trade."[40] Codes and standards are thus keystones of EV-ready economic development policies and practices. From the international level to the local level, government decision making surrounding the EV and EVSE industries and EV and EVSE deployment will react to changes in technology and markets—stimulating market uptake of new products, technologies and services; increasing safety to assure for consumer; increasing interoperability for affordability and consumer access; and making strides in innovation for creation of new business models and job growth potential. Code-making bodies and standards organizations effectively broker the transaction between industry interests and government interests in the intersecting arenas of economics and public safety.

2.3. Overview of National Model Codes and their Purview

Understanding the respective purviews of the various code-setting bodies and the range of potential goals and outcomes associated with code modifications points to the ways in which local changes can inform model codes in the future. For the purposes of this report, the ICC and NFPA will be considered the primary code-setting bodies, due to their focus on infrastructure. Their standards govern the built environment from structural and electrical perspectives and provide the critical link between vehicles and the power grid.

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36 Ibid.
37 "Overview," The EV Project, accessed October 23, 2012, http://www.theevproject.com/overview.php/.
38 See note 33.
39 See note 9.
40 See note 42.

2.3.1. NFPA and the NEC[41]

The NFPA is an international nonprofit organization focused on reducing the risk and damage from fire and other hazards through research, training and the development of codes and standards. The NEC is the infrastructure standard for electrical construction in the United States, developed by the NFPA and in use since 1897. The primary concern of the NFPA is electrical safety.[42] The NEC provides requirements for typical hard-wired connections for all types of electrical installations, including wiring methods, equipment construction, grounding and protection and equipment location to prevent exposure to energized live parts. The scope of the NEC with respect to EV infrastructure[43] includes the relevant conductors and equipment external to the vehicle, the connection of the EVSE to the electricity supply, the conductive or inductive means required to make the connection and the installation process itself.[44] The electrical code will deal exclusively with the installation of the infrastructure, including electrical safety provisions that impact siting and design, such as minimum heights and maximum cord lengths, and should be amended for electrical safety purposes only, such as those that pertain to local environmental conditions.[45]

NEC Article 625 provides specific requirements for the following:

- Placement of unit (height from ground)
- Length of cable (25 feet max)
- Number of cables per unit
- Connections and couplers
- Rating (level of charge)
- Markings
- Overcurrent protection
- Personnel protection
- Interactive systems
- Ventilation
- Supply circuits
- Indoor versus outdoor installations

EVSE Provisions

The NFPA introduced EVSE in the 1996 edition of the NEC, a response to the expected release of a number of EV models by large original equipment manufacturers to meet the initial phase of the zero emission vehicle mandate. Revisions have been included in the 1999, 2002, 2005, 2008 and 2011 editions of the NEC based on changes and evolution in battery, automobile and supply equipment technology, along with other industry and user-based needs.[46] The NEC also acknowledges EVs and charging infrastructure in Article 625 of the code.[47]

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[41] NEC consists of an introduction and nine chapters. Chapters 1–4 of the NEC cover general requirements that are widely applicable to electrical wiring and installations of all kinds. These first chapters set up the fundamental rules and cover specific technical installation requirements for electrical installations; later chapters in the code establish more specific thematic rules that regulate installations by topic, for example, EVSE. Chapters 5–7 cover special occupancies, equipment and conditions, and supplement the regulations set out in the first part of the code. The remaining chapters cover communications systems, reference tables and appendices. These last chapters are only requirements when specifically referenced in other parts of the code; otherwise they are for informational purposes.

[42] Mark Earley (NFPA), interview, July 18, 2012.

[43] NFPA NEC 70 Article 625 defines EVs as those that are highway-worthy autos. It additionally distinguishes between battery electric vehicles, plug-in hybrid electric vehicles and hybrid electric vehicles.

[44] See note 15. Inlets and corresponding couplers are currently standardized not by the NEC, but by the SAE J1772 standard.

[45] The NEC deals with the consumer side of the electrical installation, while a separate code developed by the Institute for Electrical and Electronics Engineers (IEEE) called the National Electrical Safety Code deals with the manufacturer side.

[46] Donny Cook, "Electric Vehicles and Electric Vehicle Charging" (presentation).

[47] Furthermore, Article 626 regulates electrical systems on freight trucks.

Electrical Loads and EVSE Safety

Because the NEC is exclusively concerned with electrical installation, the model code only directly determines design parameters that dictate safety requirements related to circuitry design.[48] Even the lower-voltage level 1 charger generates system impacts due to the fact that the eight or more hours required to charge a vehicle represent a unique instance for residential applications because such installations do not typically generate continuous loads of more than three hours.[49] Continuous electrical loads generate more heat in the local system, which is a cause for concern, and have implications for the utility grid. The continuous loads of EV charging stations present the central challenge to efficient and safe ongoing use, both in the home and on local transformers. Alternating current (AC) levels 1 and 2 are considered continuous-duty loads; that is, they are on for more than three hours. The NEC provides minimum requirements for performing site assessments.[50]

Although the cumulative effects of EV battery charging on both the circuitry at the point of installation and at the local network scale is outside the scope of this report, and at present EVSE is or could be considered minor work in many jurisdictions, these effects should still be taken into account. The safety implications that may arise from either overloading household circuits or local transformers, or collectively burdening utilities with increased loads at prime charging hours, may become issues for homeowners and for the utility grid. In general, the NEC provides guidelines for overload protection and load calculations, as do the EVSE installation standards published by professional organizations and interest groups.[51] Jurisdictions are also taking steps toward increasing requirements for reporting EVSE installation to local utilities.

NFPA views system capacity issues related to EV charging loads as central to the EVSE installation discussion because a homeowner or developer—or even a municipality—installing EVSE does not want to "surprise" the utility. For new installations (new construction with EVSE or EVSE-ready installation), the load issue will come to light through the permit application or inspection process where one exists. However, for existing installations (the addition of EVSE to a previously constructed circuit), this issue is not addressed by the current code.[52] While ideally this is an issue that could be addressed locally through relationship-building between utilities and local or state governments, it is the case in most TCI region states (e.g., New Jersey and Rhode Island) that the privacy issues associated with notifying utilities of an EV purchase or EVSE home charging units remain an ongoing concern that, without legislation mandating EV reporting (Maryland), has yet to be solved.

Expected NEC 2014 Revisions

The NEC is currently in the middle of the development cycle for its updated 2014 edition, which is scheduled for publication in fall 2013. Significant work is underway on Article 625, pertaining to EVs. In addition, revisions of the sections pertaining to alternative energy are expected. There is a need for the code to more specifically recognize some new DC-related technologies, even

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[48] See note 44.
[49] According to NFPA expert Mark Early and utility representative and EVSE program manager Beth Neaman at SCE, other household appliances, such as refrigerators or air conditioning units, draw a similar amount of power in cycles. The cyclical nature of the electrical loads associated with virtually all other standard household electrical equipment makes the 6–8 hour continuous charge a substantial power drain on a typical household system.
[50] See note 15. Specifically, articles 210, 215 and 220, which include rules related to calculations/loading of services, feeders and branch circuits in all occupancies. Annex D of the NEC provides load calculations in examples that include several EVSE scenarios including multifamily dwellings, store buildings, multi-structure industrial facilities and single-family residences.
[51] For example, see Advanced Energy's guide: http://www.advancedenergy.org/transportation/evse/Charging%20Station%20Handbook%20Rev2011.pdf and the National Electrical Contractors Association EVSE installation guide: http://www.necanet.org/index.cfm?fa=newsAboutNecaItem&articleID=5536.
[52] See note 44.

though DC has been addressed in the NEC since its first edition in 1897. The DC initiative underway is primarily focused on low-voltage DC as well as updating general DC requirements throughout the code.[53] A key factor in all of these articles is interactivity. A new article is in development that will cover energy management in interactive electrical systems that are capable of storing and supplying energy back to the grid. Energy management systems can be used in a variety of applications, but for EVSE they provide a means by which the charging infrastructure and vehicle battery can help store and supply power in a way that reduces peak demand.[54]

2.3.2. The ICC and the IBC

The ICC is a member-based association that works to help the building safety community and construction industry provide safe and sustainable construction through the development of codes and standards that apply to the design, construction and compliance process.[55] The IBC is used around the world.[56] As publisher of the IBC, the International Residential Code for One- and Two-Family Dwellings (IRC), the International Fire Code, which is used in 43 states as the fire code and the International Green Construction Code, the ICC has a significant role in establishing standards for much of the built environment.

For simple, plug-and-play outdoor EVSE installations, the building code is not a major consideration. For certain built environment conditions, such as inside a garage, it is presumed that the applicable version of the building code will have required all that is necessary from a fire safety standpoint.[57]

IRC: Purview and Challenges

The IRC governs construction for single-family homes of up to three stories. The residential code is written for the designer and builder of a single-family home who may not necessarily be a licensed architect; as such, it attempts to be entirely self contained, meaning that it does not require the designer or builder to reference any additional standards or codes.[58] The commercial code (the IBC) refers to other standards, including the NEC, based on the assumption that licensed professionals who are well versed in the standards and their applications will be carrying out the work.

Residential installations will compose an estimated 80%–90%[59] of the EV charging stations installed, followed in number by office locations and then by publicly accessible charging.[60] One of the most significant opportunities for improvement to the model building code thereby comes from the IRC–for single-family home installations in jurisdictions where the IRC has been adopted and where the local code does not require an electrician to perform work on a private residence. The typical homeowner is likely not going to be concerned with or knowledgeable of the capacity of his home's electrical system. A homeowner installing a charging station purchased independently and without consulting the local utility may create safety hazards due to additional and continuous loads associated with EV charging.[61] It is particularly critical to be wary of these

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[53] See note 10.
[54] "NFPA 70 National Electric Code," National Fire Protection Association, www.nfpa.org/70.
[55] Although ICC is an accredited ANSI standards developer, ICC develops its code using its own "Governmental Consensus Process" (added by David Karmol).
[56] See note 8. Despite the fact that the model IBC is adopted in all 50 states and Washington, DC, it is not considered an American National Standard due to the fact that the IBC is not vetted through the American National Standards accreditation process (see next section).
[57] See note 44.
[58] Bruce Spiewak, phone interview, July 20, 2012.
[59] See note 5.
[60] Brian Kiley, interview July 27, 2012; See note 17.
[61] Kiley, interview.

safety hazards in homes built in the 1960s and before, which would benefit from a service upgrade for safety purposes. Although the number of installations fitting this particular scenario may represent a small amount of total residential EVSE, it is a clear area for potential improvement.

2.3.3. ANSI

ANSI is a member-based nonprofit organization that plays many interrelated roles within the world of standardization. In general, ANSI acts as the administrator and coordinator of the U.S. private-sector system of voluntary standardization, overseeing the creation, promulgation and use of thousands of guidelines that apply to many economic sectors. The organization provides accreditation services whereby standard-setting bodies can be recognized as conforming to due process procedures for standards development, and certification programs can be recognized as complying with national and international norms. In its role as accreditor of standards developers, ANSI does not participate in a discourse on the technical merits of a given standard, but rather approves standards if the process followed by the standard-creating organization adheres to ANSI's essential requirements for due process. ANSI's membership comprises government agencies, organizations and companies from the private sector, international bodies and individuals.

ANSI is itself the official representative member from the United States to the International Organization for Standardization and, via the U.S. National Committee, the International Electrotechnical Commission, both of which are involved in the development of international standards related to EVs and charging infrastructure manufacturing.[62] As a member of these international organizations, ANSI represents the interests of its own members and their respective standards across a variety of industries in the international realm, and it serves those interests by advocating where requested for the adoption of U.S. standards as the international norm.[63]

ANSI's general interest as a standards umbrella organization in optimizing processes and harmonizing standards and codes created by multiple organizations has spurred action on the front of EVs and charging infrastructure. Inspired by standards' roadmaps created by both Germany and the European Union, ANSI established an organizational arm to address this emerging area of work. The ANSI Electric Vehicles Standards Panel (ANSI EVSP) is a cross-sector coordinating body within ANSI whose objective is to foster coordination and collaboration on standards to enable the safe, mass deployment of EVs and EVSE, engaging stakeholders to generate international-level coordination, adaptability and engagement.[64] Key stakeholders include the automotive industry, utilities and power authorities, electrotechnical manufacturers and other standards organizations. The primary product of the ANSI EVSP has been a roadmap document (*ANSI EVSP Standardization Roadmap for Electric Vehicles)* released in spring 2012. The roadmap catalogs all relevant entities operating in the EV standards space, identifies central issues to EV and EVSE standardization and codes, discusses product and infrastructure standards related to EVs and identifies existing needs and gaps as well as existing efforts at harmonization. The analysis provided by the roadmap is a critical review of existing codes and standards across all aspects of EVs and EVSE, and the roadmap will be an important resource for the field and EV-ready planning going forward.[65] One of the key takeaways from the roadmap

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[62] "About ANSI Overview," American National Standards Institute, accessed October 23, 2012, http://www.ansi.org/about_ansi/overview/overview.aspx?menuid=1.
[63] See note 8.
[64] "Electric Vehicles Standards Panel," American National Standards Institute, accessed October 23, 2012, www.ansi.org/evsp.
[65] See note 13.

exercise is the confirmation that for EVSE installation, safety issues are largely accounted for in current standards and model codes.[66]

2.3.4. The Code Revision Process

Codes and standards are updated regularly in set cycles with the intent to incorporate new science, lessons learned from disasters and new technologies and products.[67] Both the ICC and the NFPA operate on a three-year code revision cycle, with designated periods for proposals from the industry and public for additions or amendments to the code. Following the proposal period, the proposed changes are made publicly available for comment and review.[68] The relevant committees within each organization then determine which, if any, of the proposals will enter the next version of the model code.

The process by which model codes are developed and revised is open to input from the public, which includes all concerned parties ranging from industry to local government to concerned practitioners, as well as from internal committees in the case of the NFPA. The ICC receives code change proposals from its members and from the public, but it does not generate changes within the organization. Similarly, a majority of code change proposals for the NFPA originate as public proposals, although the NFPA's internal committees and working groups generate new code concepts as well.[69]

The NFPA's committee-based proposal allowance permits the organization's members to become more proactive in the code cycle; task forces and technical committees, comprising NFPA members, examine the technology landscape to ensure all relevant safety concerns are addressed in the next revised model code.

It is important to consider impacts and rank priorities for code changes. Cost barriers that impede local jurisdictions, even states, from updating the code on the standard three-year cycle are real and reflect a larger economic situation more than disinterest in pursuing the adoption of the most up-to-date standards.[70] The added costs of training and staff time should be taken into consideration, even with temporary amendments or interim changes to the code. The NFPA permits interim changes in the event that the organization becomes aware of a significant new technology that poses immediate safety concern. Such changes are referred to as "tentative interim amendments."[71]

The key to developing and proposing successful model code changes is not only the development of a widely applicable rule or process, but the language used in writing the proposed changes; code language must provide clear guidance but be generic with regard to projects or products.[72]

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[66] See notes 10 and 13.
[67] "NFPA, ICC Create Coalition to Advance Public Safety in the Built Environment," National Fire Protection Association, June 5, 2012, http://www.nfpa.org/newsReleaseDetails.asp?categoryid=488&itemId=57256&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+nfpacodesandstandards+%28NFPA+codes+and+standards%29.
[68] As of writing, both the NEC and IBC are in the public review phase for the next edition of the codes, which will be available in 2013.
[69] See note 44.
[70] See note 60.
[71] See note 44.
[72] See note 9.

2.4. New Technology Outlook

Innovations will define the technological and electrical components that relate to evolving safety and infrastructure issues in EVSE installation. Codes and standards must be forward-thinking as policy and planning tools to anticipate the need to cover changing infrastructure technology. However, while it is critical that interface and infrastructure standardization are undertaken so as to anticipate and be compatible with future technological advancements in EV electrotechnical systems, safety and environmental sustainability, it is widely accepted that codes should support existing technology rather than attempt to anticipate the next innovation.[73] The development of such standards and their inclusion in model codes is a work in progress. Upcoming innovations and areas for consideration can be divided into several key categories: updates to the stations themselves, innovation in power sources and connection to the utility grid. In all of these areas, public education will be critical component of future success.

2.4.1. Charging Stations, Design and Networked Communications

There are gaps regarding emerging issues, including standards for DC fast charging.

- DC fast charging will be useful for long-distance travel and public charging stations and in commercial applications
- Future standards in connector design should take into account current how-to-use issues. International energy technology firm Efacec, one of the leading DC fast-charging manufacturers in the U.S. market,[74] reports that 90% of the calls to the company's customer service line are regarding how to plug in the DC connector, which has not yet been standardized.[75]

Currently, no standards exist to cover wireless charging.

- Inductive or in-ground wireless charging presents another interesting future advancement and codes challenge.
- This topic is presently being addressed under SAE 2954 and Underwriters Laboratory (UL) 2750, but not in the NEC or the IBC.

No international standards exist to address battery swapping safety and interoperability.

- The ANSI EVSP roadmap has identified this gap as a priority.
- Washington State has referenced battery swapping stations in a proposal for local zoning ordinances to address EVSE.
- Battery banks will be addressed in a current code proposal for NEC section 625.4 to include power sources of up to 600 volts DC.

Communications standards are lacking and will impact site design and construction best practices.

- Smart grids, communications systems that connect the EV driver's mobile device to the vehicle, such as through mobile technology, or the vehicle to the grid, such as through

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[73] See notes 17 and 29.
[74] "Transportation," Efacec, accessed October 23, 2012, www.efacecusa.com/Transportation.aspx.
[75] Mario C. Santos, EPRI Infrastructure Working Council on Electric Transportation meeting, Chicago, IL (presentation), June 28, 2012

charge point monitoring software, are areas of communications-related standards that require additional work.[76]
- No standards currently exist to provide for generic locating and reserving of public charging stations, the interconnectivity (e.g., through roaming) of EVs between EVSE service providers, offline access control at private charging stations or communications from EV meters to the vehicle or sub-metering scenarios.[77]

Electrical loads and alternative power standards that address reverse power flow, both communications and safety aspects, are still in development.

- Sections of the relevant codes from SAE need to be completed to include this information, although existing standards cover information design, use cases and safety aspects for reverse power flow.[78]
- Codes relating to the load balancing required for energy storage systems are another potential area of development.

Alternative power sources represent an interesting future option for generating power, and while many areas and companies are experimenting with this technology, model and local codes have not yet seen the need to address it.[79] Generally this area is already covered by standards, but there remain areas on which to improve:

- The NEC does not specifically address the integration of EV/EVSE with a facility high-voltage DC power distribution system for either charging or reverse power flow.
- NEC requirements are needed for high-voltage DC power distribution systems and the integration of DC loads within the system.
- Solar is addressed by ANSI/UL 1703 and NEC article 690 for safety of photovoltaic equipment, and small wind systems are covered in NEC article 694.
- Communication with various state utility commissions should take place to make sure that vehicle-to-grid technology can be used as a part of a state's distributed power system. Distributed power can be an effective tool for leveling the spikes in power requirements.

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[76] The National Institute of Standards (NIST) has released a February 2012 document: "NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0." In that document, there is a complete summary of the efforts to date on the development of plug-in electric vehicle interoperability standards (http://www.nist.gov/smartgrid/framework-022812.cfm).
[77] See note 13.
[78] Ibid.
[79] Ibid.

3. LOCAL CODES FROM MODEL STATES AND MUNICIPALITIES

3.1. Local Planning for a Regional Infrastructure Network

A key strategy for capturing the many benefits of EVs will be the development of policies and programs that aim to deploy EVSE infrastructure to meet today's charging needs and prepare cities, towns and regional corridors for growing EV use. Every jurisdiction is different, yet there are select, key factors necessary in order to successfully advance policy, legislation and ordinances pertaining to EV infrastructure. The building and electrical codes examined in this study represent just one tool available to governments, and may or may not be the ideal solution to regulate EV-charging infrastructure deployment everywhere. EV-ready planning should include consideration of the following goals:

- Ensuring that new construction is wired for EVSE
- Clearing administrative pathways for residential service upgrades and EVSE retrofit
- Guaranteeing safe, consistent and accessible infrastructure installations and implementing good site planning and design
- Ensuring that new construction can support a higher pull on the utility grid, with the potential of adding future vehicle battery charging capacity and eventually energy storage devices
- Aligning EVSE deployment with policy and environmental mandates to achieve emissions reductions, air quality improvements, transportation technology advances and energy independence

Each of these goals will require actions by state and local governments and authorities, private-sector stakeholder, nonprofit EV proponents and other EVSE stakeholder groups. In planning for EV readiness, the question is what jurisdictions or agencies can do to enhance EV readiness. For example, zoning and parking ordinances, along with permitting, comprise potential approaches at the local level that can work alone or in combination with the structural codes for the implementation of EV-ready policies. These are just a few of the policy levers available to jurisdictions. Legislation, environmental benchmarks, economic development planning, real estate incentives or advocacy-based outreach and education are also critical approaches that were determined as a result of this report's research. These policies should be noted as areas for further study as a part of the emerging EVSE ecosystem.

Considering the limitations in current EV battery technology and the range anxiety associated with a vehicle's battery, the primary existing infrastructure need is the development of a consistent, accessible charging network. However, for EVs, infrastructure begins at home. Ensuring safe, accessible and cost-effective EVSE installation in a variety of vehicle home contexts—the places that vehicles will receive their regular charge—represents the first step in EV-ready planning. Connecting home charging to other charging scenarios would enable EV owners to increase the effective range of their vehicles by making it possible to charge at home, at work and in commercial and public locations, thus extending vehicle reliability over longer trips and better integrating EVs into regional transportation networks. Effectively doing this requires cooperation among jurisdictions, and interviews and case studies also indicate the importance of a high-level, flexible EVSE code framework at the state or regional level designed to encourage local adaptability.

Timing and Costs Complicate Code Regulation

Irregular timing of technology development and rates of EV adoption combine with a wide variation in administration and local conditions—such as extreme weather or high population density—and may encourage localities to amend national model codes to better suit the safety and public welfare requirements necessary. Many states across the country have passed environmental or other related laws that may include provisions or language that require changes to the state-level codes in order for the included jurisdictions to be in compliance with the full spectrum of regulation.[80] There are also high costs associated with changing codes—from staff time to inspector training—and many states and local jurisdictions opt to amend codes once every six years rather than three.[81] Finally, the staggered timelines for revision by code-setting bodies and for review at the local level means that the local jurisdictions adopting codes are often simply behind the times, if being up-to-date is viewed from the perspective of adopting the most recent edition of the code. Together, these factors create a high degree of inadvertent variation across jurisdictional boundaries.

Acknowledging the high costs to local jurisdictions, this report does not at this time recommend changes to the local code revision cycle that would require states or municipalities to update their codes more regularly.

3.1.1. Opportunities to Harmonize Regulations and Promote EV Adoption

Some sources suggest that states or other local jurisdictions should have no reason to deviate from a national model code unless there are provisions written into the applicable state or local laws that require the jurisdiction to do so.[82] Yet federal, state and local laws can lead jurisdictions to amend national model codes. Legislation is typically the incentive to act on codes, and it may include goals related to economic opportunity, environmental conditions or local factors.

There is no one-size-fits-all policy approach to increase EV readiness and serve EV users—or to achieve environmental benefits. Each state or local jurisdiction needs to evaluate the objectives (compliance, economics, and environment) behind any potential policy, code or other change, and follow a path that best suits the available and appropriate menu of options for that jurisdiction. Code modifications can help municipalities, states and regions to promote EV adoption by raising the bar on infrastructure development requirements.

There are implications for the administrative enforcement of local codes that, in turn, impact anyone interested in installing EVSE. Perhaps most significantly, inconsistent business or regulatory environments create complications for those entities providing EVSE infrastructure, from developers to charge networks. Administrative timelines and costs vary widely, and infrastructure providers must navigate a new system with every infrastructure deployment.

Tackling these issues will require cooperation and advocacy. Creating regulatory consistency will be a dual function of the ongoing work of code-setting organizations to incorporate EV- and EVSE-specific provisions, and of the place-based efforts made by the jurisdictions with authority over state and local codes.

The case studies in this section discuss several scenarios in which local and state codes require amendments that arise for particular policy reasons, such as the following examples:

- State or local code changes may be required in order to comply with environmental, transportation or clean energy target legislation established at the federal or state level.

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[80] See note 60.
[81] Ibid.
[82] See note 8.

- The building code can include scoping requirements, enabling jurisdictions to self-tailor regulations through a selection of the most appropriate mandatory and optional provisions.

3.1.2. Model Jurisdictions: Case Study Overview

The purpose of the following case studies is to profile different approaches, scales and outcomes to changing building codes to more seamlessly allow the incorporation of EVSE infrastructure. The three case studies focus on process and outcomes, highlight best practices for implementation and seek to understand benefits of "EV-ready" codes. The purpose is not necessarily to provide a standard format for writing local codes—ideally greater harmonization will continue to happen at the international and national levels.[83] Instead, the case studies attempt to show the process and outcomes of changing codes to be more EVSE-friendly under different circumstances. What are the key components of EV-readiness? What experiences are replicable? What are the lessons learned from state and local processes for encouraging EVSE deployment?

The case studies in this section elaborate on ways that jurisdictions are currently modifying existing model codes in order to create and implement improved local codes that speak to the needs of jurisdictional authority. Although there is wide variance among local jurisdictions, the process of revising codes is available to states and local authorities and also provides flexibility that leaves room for state-level interpretation. Within a framework of consistent guidelines, this flexibility could be utilized to generate more uniform codes, and determine when and where states and jurisdictions choose to adopt them.

The case studies also outline scenarios in which economic drivers (such as a local EV-related manufacturing base, a desire to generate high-tech jobs or a desire to improve quality of life to attract residents and workers) are relevant, particularly in the way they interact with local conditions (such as the relative economic and environmental cost associated with the local energy supply).

[83] See note 5.

VANCOUVER, BRITISH COLUMBIA, CANADA

Summary
Vancouver is the first North American city to require EV charging station connection points for EVs in all new homes and developments.

Focus
Municipal building code

Code Outcomes
Modification of the city's building by-laws to require EVSE-ready wiring in new single-family and multifamily residential construction. Twenty percent of multifamily new construction and 100% of single-family new construction must be built EVSE-ready.

New code updates for 2012 will increase the residential service request to 220 volts to accommodate uniform level 2 charging, and will introduce a 10% EVSE-ready parking requirement to new commercial construction.

3.2. Vancouver: An EV-Ready Building Code

Vancouver, BC, in Canada is known as one of the most forward-thinking cities with respect to its transportation electrification policies and efforts. Yet the city staff stresses that the city is ahead of the curve not because the city is somehow better or more knowledgeable, but because the municipality had the opportunity to move ahead quickly with EVSE planning. EV infrastructure plans and pilots have only just launched in BC. By incorporating EVSE into long-range goals for buildings, transportation and economic planning, the city has taken a holistic approach to EV infrastructure deployment. At the center of Vancouver's strategy is the city's building by-law—the city's building code.

Above and Beyond Approval

The original proposal for a by-law amendment required 10% of the parking stalls within multifamily residential developments to be wired for EVSE installation. Vancouver's City Council approved the by-law amendment and doubled the required amount of parking stalls to be wired for EVSE to 20%.

Unique Considerations

Along with Halifax, Vancouver is one of just two Canadian cities with jurisdictional authority to modify its building by-laws at the municipal level.

Utility

BC Hydro, a Crown corporation, provides much of BC with clean hydropower, with 93% of the electricity in the province generated by clean or renewable resources, meaning that EVs have the potential to dramatically reduce GHG emissions in a local well-to-wheel analysis in addition to eliminating them at the tailpipe.[84]

Pilot Funding

The city of Vancouver secured $800,000 (Canadian) for an EV infrastructure pilot project. Project financing includes funds in the amount of $120,000 from BC Hydro, the Vancouver power authority. A portion of the total funding also came from the provincial government (a partial allocation of an approximately $14.6 million BC-wide EVSE project that will install 1,000 charging stations throughout the province—570 public, 400 in multiunit residential buildings and 30 DC fast chargers on the Canadian spur of the Pacific Coast Electric Highway). A minimum of 67 charging stations will be part of the Vancouver pilot.[85]

3.2.1. Cutting-Edge Code Policy Supports EV-Ready Green Buildings

In July 2008, as a part of the Green Homes Program, the Vancouver Council enacted new regulations in the building by-law[86] aimed at reducing the environmental impacts of new one- and two-family homes; the amendments to the code made the Vancouver building by-law one of the "greenest" residential codes in the world.[87] With the successful implementation of the Green Homes Program goals, and to move forward with provisions in the city's EcoDensity Charter,[88] the Vancouver Council passed a second building by-law amendment to require the electrification of a portion of residential parking stalls in all new buildings containing three or more dwelling units; the provisions were required for all new projects applying for permits after April 20, 2011.[89] The by-law required a minimum of 20% of parking stalls associated with multifamily dwellings to be outfitted with an electrical inlet and conduit/panel capacity to accommodate level 2 EVSE installation, and stated that it is the responsibility of the electrical engineer of record to assess the electrical system capacity required. Further, in buildings with an electrical room containing a transformer, the room is required to contain enough physical space capacity to accommodate future installation of the equipment necessary to provide charging stations at 100% of the building's parking stalls.[90]

3.2.2. Location Advantages: Vancouver's EV Suitability

Vancouver is a compact, high-density city with a population of about 600,000 people in roughly 114 square kilometers (44 square miles).[91] Demographics support the EV market, indicated by the high level of alternative vehicle technology uptake (in Vancouver and in BC, the Toyota Prius sold at more than twice the national rate). In a city with a relatively small land area, about 95% of car trips are less than 30 kilometers (19 miles) and about 70% of car trips are less than 10 kilometers (6 miles), making EVs highly viable for daily transportation. Furthermore, Vancouver's power supply is unique for two reasons. First, less than 10% of the province's power comes from non-renewable sources (natural gas); like much of the Pacific Northwest, BC has a supply of

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[84] "Plug-In Vehicles," BC Hydro, accessed October 24, 2012, http://www.bchydro.com/about/sustainability/climate_action/plugin_vehicles.html.
[85] See note 17.
[86] City of Vancouver, By-Law No. 9691 (Building By-Law, January 30, 2007), http://former.vancouver.ca/blStorage/9691.PDF.
[87] City of Vancouver Committee on Planning and Environment, *Green Rezoning Policy Report* (February 4, 2009).
[88] http://vancouverpublicspace.ca/index.php?page=ecodensity-liveability.
[89] City of Vancouver By-Law No. 9936.
[90] City of Vancouver Community Services Group, Bulletin 2011-002-BU/EL, March 17, 2011.
[91] With a population density of approximately 13,000 residents per square mile, Vancouver compares most closely to Boston or Chicago among major U.S. cities. In land area, Vancouver is comparable to Boston and San Francisco.

clean, renewable energy, largely hydropower. As a result, a transition to EV use would represent an approximate 98% reduction in carbon dioxide emissions.[92] Second, Vancouver has the largest price differential between gas and electricity in North America.[93] Together, these factors exponentially increase the environmental and economic benefits of EV adoption, providing serious policy and financial incentives for the city to invest in studying and deploying EV charging infrastructure.

In addition to these incentives, Vancouver has the advantage of already being known as one of the world's most livable cities.[94] The benefits of the "Pacific Northwest mindset" and 40 years of forward-thinking local policy from the Vancouver City Council also contributed to the ease of adoption of the Building By-law amendments.

These factors should not be seen as setting Vancouver apart as an anomaly; every city is unique in its combination of economic, energy and planning policies and agendas; real estate development industry; political will; stakeholder buy-in and realistic action items. Instead, other cities should look to a broad range of market, environmental and political factors to consider the feasibility of a particular path to EV readiness in their communities.

3.2.3. Policy Origins

In March 2005, Vancouver's Council approved a Community Climate Change Action Plan to reduce GHG emissions to 6% below 1990 levels by 2012, and two years later, in March 2007, the City Council passed a motion directing city staff to plan for significant, long-term GHG reductions with the goal of carbon neutrality. In May of the same year, the Vancouver Council adopted a building by-law that included environmental protection objectives, opening the door to the facilitation of future development of the city's Green Building Strategy.[95]

BC Plug-In Electric Working Group

In response to these city-wide goals, a working group emerged from an early partnership started by the former Climate Programs Engineer for the city of Vancouver, the power authority BC Hydro and the BC provincial government, when it was realized early on that three people—or even three agencies—could not guide the entire planning process. Ultimately, the BC Plug-In Electric Working Group was composed of 10–12 carefully selected institutional members representing different levels and agencies within the provincial and city governments, nongovernmental organizations, the electrical utility and academia. In its bimonthly meetings, the working group sought to understand the large-scale questions in the context of what small steps could be taken.[96]

The first of those steps was recognizing the ability of the province to secure EVs for sale in the local market. BC signed memoranda of understanding (MOUs) with vehicle manufacturers, notably receiving early shipments of the Mitsubishi i-MiEVs. After establishing that getting the vehicles to the area for sale was the first step, the city and province, through the working group, began to consider the required infrastructure.

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[92] See note 17.
[93] See note 5.
[94] Consistently ranked highly by *The Economist*, *Monocle* and *Mercer*: http://www.mercer.com/press-releases/quality-of-living-report-2011#City-Rankings.
[95] "Policy Report on Development and Building" (Vancouver: City of Vancouver, June 9, 2008), http://www.docstoc.com/docs/5427511/CITY-OF-VANCOUVER-POLICY-REPORT-DEVELOPMENT-AND-BUILDING-Report.
[96] See note 17.

The BC Plug-In Electric Working Group united interests and expertise from local and provincial government, utilities and energy resources and academia around creating a comprehensive EV-ready and infrastructure deployment strategy.

Building Code Amendments[97]

The BC Plug-In Electric Working Group looked to areas that the city could control; that is, the regulatory tools available that would have the ability to build awareness and interest as well as hard infrastructure for EV charging.[98] With the working group and other stakeholders, the city's Office of Sustainability, Planning, Development and Engineering, the office responsible for making final recommendations, realized that a primary challenge is the ability of the EV owner to install or access a charging station at his home.[99] In 2008, Vancouver began working on its building code, or building by-laws. The ability of the city to do so is unique (with Halifax being another exception to the rule) in Canada; municipalities typically do not have jurisdictional authority over the building code. The building code rose to the top as the most critical option for city policy changes to drive EV development because of its ability to garner larger interest, policy buy-in and market uptake.[100]

In Vancouver, amending the building by-laws for the EV provision was not a process that differed from amending the code for other reasons. Essentially, there is a standard approach and process that must be followed for such an amendment. Because the potential change would necessarily impact real estate developers—from whom the city can expect a certain degree of push back on proposed changes that will increase construction costs— BC Plug-In Electric Working Group attempted to craft a standard that would keep any cost increase below 2% of total construction costs.[101] This 2% maximum construction cost increase limits the scope of any building code amendment in the city.

The amendments included the following:

- Single-Family Dwellings: Vancouver Building By-law No. 9691 (2008), which requires each dwelling unit to be constructed with a cable raceway capable of supporting level 2 charging infrastructure.
- Multifamily Dwellings: Vancouver Building By-law No. 9936 (2009), which requires 20% of the parking stalls in multifamily construction (three or more dwelling units) to be equipped with a receptacle to accommodate EVSE use.

For the city, addressing the residential building code was a "clear decision area."[102] Not only does it fall clearly within the jurisdiction of the city and the code, but the city took the position that a majority of future EV charging will be done at home. In planning for infrastructure deployment with a limited budget,[103] it was critical for Vancouver's planners and the BC Plug-In Electric Working Group to consider the tools available that could create the maximum impact.

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[97] See Appendix D for code language from Vancouver.
[98] See note 17.
[99] See note 98.
[100] See note 17.
[101] Vancouver's 2% figure is standard for any building by-law amendment, largely due to the fact that such a minimal overall increase is effectively lost in the project details. Additional development costs are not always passed on directly. Vancouver's current Climate Programs Engineer, Malcolm Shield, explains that the total development value is based on a combination of developer profit, hard costs, soft costs and land costs. Considering that the price to the buyer is fixed by the market value of the unit—the developer will not shift its profit margin—and that hard and soft costs are effectively fixed, the increased cost associated with EV-ready construction will be reflected in the one remaining variable: land price.
[102] See note 17.
[103] CAD 800,000 for the infrastructure deployment program.

3.2.4. A Measured, Holistic Approach

Another key element to Vancouver's planning approach is the holistic nature of the issues and actions considered by the Vancouver City Council and the BC Plug-In Electric Working Group. The city's relatively limited resources created a need to plan very carefully due to smaller project budgets than those available for similar projects in U.S. cities.

However, the combination of working in a number of related but distinct areas to advance the city's EV readiness contributes to the broad perception of Vancouver's success and leadership in the EV field. In reality, Vancouver has just six public charging stations owned and run by the city. By the end of 2012, this number will increase by between 20 and 25 stations as a part of the publicly funded pilot.[104]

Next steps for the city will prioritize rolling out the charging infrastructure trial, assessing sites and understanding the best locations for EVSE location. Steps forward will also include continued innovation through industry partnerships and a focus on understanding EVs as an aspect of multimodal transportation planning. In many ways, Vancouver's approach to EVSE deployment demonstrates that the proof is not in the numbers, but in the creation of a strategy that leads to a more favorable EV market.

Vancouver, BC, Stakeholder Outreach by Category

Category	Action
Business Partners	car2go car sharing partnered with the city to share a fleet vehicle, kept in a high-visibility parking spot. The vehicle is designated for public use during the day and is available to car2go customers during non-business hours.
Business Partners	TELUS has designed concepts for integrated EV and cellular infrastructure that will be deployed in Vancouver parks.
Utility Relations	Development of energy price structures BC Hydro acts as consumer resource for EV and EVSE
EV-Ready Roadmap	Project Get Ready/Rocky Mountain Institute created a plan for an EV-ready Vancouver, including a menu of EV-ready action items.

3.2.5. Key Takeaways

Summary:

- Foster continued growth of EV policy and working groups
- Implement small-scale change for big results in the long-term
- Encourage flexibility at the municipal level to adapt to markets and local conditions
- Link clean power sources to EV planning efforts, maximizing environmental impacts

In **Vancouver**, a municipality created a collaborative working group to develop EV-readiness strategies with the intent of meeting long-range GHG reduction goals. Because of the ready

[104] See note 17.

availability of clean hydropower, the replacement of gas engine vehicles with EVs was determined to have a disproportionately dramatic effect on GHG emissions, making the stimulation of the EV market a smart choice for the area. In meeting the anticipated needs of future EV owners, the Vancouver City Council took advantage of its unique ability among Canadian cities to modify its building codes in order to require a substantial percentage of parking stalls in new construction to be EV-ready. At little added cost to developers, amending the scope of the local building code to include mandatory minimum requirements for the future electrical installation of charging stations illustrates a relatively simple, feasible solution to a complex problem. In doing so, Vancouver became the first North American city to require EVSE connection in all new development.

In the **TCI region**, fostering continued growth of EV policy and working groups created by states, municipalities and regional planning organizations is a very important step. Working groups can look to Vancouver's successes in negotiating with the development community to recommend EV-ready strategies that are considerate of economic development as well as public benefits associated with transportation electrification.

Another important lesson learned from Vancouver's sustainability planning in the EV arena is the understanding that the "low-hanging" fruit, in this case the building codes, can have large-scale impacts. Moving ahead on one focused policy can create a ripple-effect once acceptance has been achieved and benefits understood in one area.

Vancouver has the unique ability to amend building codes at the municipal level. Each US state has the ability to draft code amendments, and can include provisions that set broad policies and standards, but allow flexibility to municipalities to accommodate local conditions and markets, much like in British Columbia and Vancouver.

The predominant use of hydropower in Vancouver and throughout the Pacific Northwest makes the relative impact of reducing tailpipe emissions including GHGs and CO_2 a dramatic one. However, jurisdictions in the TCI region have the opportunity to take advantage of the extended benefits of cleaner power sources as well. Nearly every electrical utility is now providing consumers with the option to choose clean or renewable power sources. While anticipation of the expansion of this type of service in the TCI region is outside the scope of this report, the potential to continue to link EV charging and clean power through utility participation in policy and planning is an important consideration to pursue. In the interim, state and municipal officials can refer to the existing literature (e.g. impact studies produced by local utility companies) to estimate the relative positive benefit of introducing EV charging to the local grid.

LOS ANGELES, CALIFORNIA

Summary
High statewide standards required by CALGreen, the California State Green Building Code, and local amendments work in concert with utility-led efforts to plan for EV readiness across complex jurisdictional boundaries.

Focus
State and local Green Building Code and utility infrastructure and service planning.

Code Outcomes
CALGreen includes mandatory provisions and optional appendices. The city of Los Angeles takes a more restrictive approach and requires EV-ready construction of all new single-family and multifamily dwellings and of commercial properties. Los Angeles County is considering mandatory measures that will create greater harmony among the region's many individual jurisdictions.

3.3. Los Angeles: Green Construction Codes and Utility Planning

Best practices from the city of Los Angeles, Los Angeles County and the surrounding metropolitan area illustrate the importance of multi-agency cooperation across jurisdictional boundaries and demonstrate that there are multiple potential leaders among EV and EV infrastructure stakeholders.

In southern California, emission reduction goals and working with aging energy infrastructure are central concerns relating to the regulatory environment surrounding EVSE. However, regulation of any kind in Los Angeles is a complex process because the county's many jurisdictions are not only irregularly bounded, but they also have the opportunity to adopt their own codes.

Measures specific to EVSE included in the state's mandatory green building code, called CALGreen, in concert with utility-led work on infrastructure in the Los Angeles metropolitan area, have created a standard framework for incorporating charging infrastructure into the built environment in the form of a mandatory state green building code and two tiers of voluntary appendices. These appendices include a set of universal choices and requirements for EVSE for jurisdictions choosing a more stringent route. State-level work on codes has resulted in unique local opportunities to enforce or mandate more restrictive codes. Jurisdictions voluntarily adopt right-sized regulations to meet local needs, but the details of optional code appendices have been set out in advance, creating a consistent typology across the state. The city of Los Angeles is one example of a jurisdiction seeking a higher degree of regulation and EV readiness; it already requires EV-ready wiring in one- and two-family homes, and it is in the process of reviewing a proposal to adopt the extended voluntary CALGreen appendix covering EVSE into the mandatory code at the county level.

The intersection of local and state code-based strategies and the unifying activities of utility service providers give rise to an EV-friendly environment that crosses jurisdictional boundaries.

3.3.1. California Green Code

The new California Green Building Code, governed by the California Building Code Commission, is unique.[105] The new standard was introduced in 2008, with the mandatory measures included therein enforceable as of January 2010. Currently, the EV- and EVSE-related codes are included as voluntary appendices, available for adoption by local jurisdictions by amendment via the local code adoption ordinance.[106] A key feature of the CALGreen code and appendices is a two-tiered system that is designed to allow jurisdictions to adopt codes that go beyond the state's mandatory provisions.[107] The tiers enable standard options for local jurisdictions that choose to adopt more stringent regulations.

The intent of the optional, or voluntary, approach was to allow the industry and enforcement agencies to prepare for the new code before it became mandatory. However, several jurisdictions immediately adopted the 2008 code as mandatory. A process of revision based on further stakeholder conversations, working groups and feedback on the implementation of the 2008 edition of CALGreen enabled improvements at the state level prior to the introduction of the 2010 mandatory code. [108]

CALGreen addresses the issue of compliance and training by incorporating the new code into existing code enforcement infrastructure and requiring public agencies to incorporate the new provisions into their inspection process.[109] Unlike some state building codes, California's Green Code is available online, increasing access to new standards. In addition, the state's Building Standards Commission is pursuing training related to the code through partnerships throughout the state.[110] As in Vancouver, the state of California's new regulations only increase the construction costs associated with a new home by a minimal amount.[111]

CALGreen requires the designation of parking stalls for zero-emission vehicles as an aspect of the nonresidential mandatory measures.[112]

EV Charging in State and City Codes

CALGreen's 2010 edition contains voluntary measures for nonresidential construction that require 10% (tier 1) and 12% (tier 2) of total parking spaces be designated for zero-emission or fuel-efficient vehicles. Further, EV supply wiring is required for EV charging stations for between one and four parking spaces, depending on the lot or garage capacity.[113]

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[105] CALGreen is available online at: http://www.documents.dgs.ca.gov/bsc/CALGreen/2010_CA_Green_Bldg.pdf.

[106] The voluntary appendices A4 and A5 of the California Green Building Code thus depend on the choice of builders in each jurisdiction to execute. That is, the appendices make guidelines for EVSE available if and when a developer chooses to incorporate such infrastructure into a project.

[107] "The 2010 California Green Building Standards Code" (California Buildings Standards Commission, n.d.), http://www.documents.dgs.ca.gov/bsc/CALGreen/The-CALGreen-Story.pdf.

[108] Ibid.

[109] Ibid.

[110] Ibid.

[111] The California Building Standards Commission estimates that all new green building regulations, not just EVSE, will increase the average cost of home construction by about $1,500.

[112] California Building Standards Commission, *Guide to the (Non-Residential) California Green Building Standards Code*, Second Edition (Sacramento, CA: November 2010), chapter 5.2, http://www.documents.dgs.ca.gov/bsc/CALGreen/Master-CALGreen-Non-Res-Guide2010-sec-ed-final-3-1-11.pdf.

[113] CALGreen Nonresidential Voluntary Measures A5.106.5.3 requires one 120 VAC 20 amp and one 208/240 V 40 amp, grounded AC outlets or panel capacity and conduit installed for future outlets.

As of January 1, 2011, all single-family residences, multifamily dwellings and commercial properties constructed in the city of Los Angeles will have EV-specific requirements.[114] EV supply wiring is mandatory for residential construction as per Article 9, Division 4 of the city's adopted version of CALGreen. The city ordinance requires a minimum of one 208/240 V 40 amp, grounded AC outlet for each dwelling unit or the panel capacity and conduit for future EVSE installation for each unit. For multifamily occupancies or single-family attached occupancies with shared parking, Los Angeles currently requires a minimum of 5% of total parking spaces to be wired with EVSE capacity and requires EV readiness through additional service capacity.

Currently, Los Angeles County is discussing the mandatory adoption of the non-residential CALGreen appendix, a proposal that, if passed, would include an amendment of the State Green Code to require new commercial construction of 10,000 square feet or more to be EVSE-ready, representing a decrease in the minimum building size to trigger EV-ready electrical systems.[115] This proposal would include more construction and building typologies.

3.3.2. State Policy Origins

California aims to reduce its GHG emissions by 33% by 2020. In 2004, then Governor Arnold Schwarzenegger signed an executive order to create the "Green Building Action Team" to address efficiency for state-owned buildings. Another order the following year established the "Climate Action Team," which called for the overall reduction of GHG emissions in the state. The emission reduction goals were solidified in law with landmark legislation AB32. CALGreen standards were developed in cooperation with the California Air Resources Board, the Department of Housing and Community Development, the Division of the State Architect and the Office of Statewide Health Planning and Development.[116]

In California, a West Coast sustainability mentality meets a high dependence on personal transportation. Emissions can be broken down into the activities that produce them. The state's on-road emissions from the transportation sector represent the largest source of California's gross inventory of emissions (more than 35%).[117] By contrast, the California Air Resources Board found that emissions from commercial and residential buildings remained steady from 2000–2009, even as the number of housing units and commercial and institutional floor space grew substantially. Observation of steady emissions despite increasing building area indicates that fuel use per unit of consumption has actually declined.[118] A serious policy discussion of what measures could achieve GHG emission reductions goals pointed to the building code, where an existing willingness to adopt green building practices became an opportunity to incentivize EV adoption.

The mandatory standards adopted in 2010 were initially introduced as voluntary measures two years prior. CALGreen, adopted unanimously by the California Building Standards Commission, allows cities with more stringent green building codes to retain their existing standards—or to modify them further to be more restrictive.[119]

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[114] See note 17.
[115] Ibid.
[116] See note 110.
[117] Air Resources Board, "Trends in California Greenhouse Gas Emissions for 2000 to 2009" (Sacramento, CA: California Environmental Protection Agency, December 2011), http://www.arb.ca.gov/cc/inventory/pubs/reports/ghg_inventory_00-09_trends.pdf.
[118] Ibid.
[119] Kristina Shevory, "California Adopts Green Building Codes," *The New York Times*, October 24, 2012, http://green.blogs.nytimes.com/2010/01/15/california-adopts-green-building-codes/.

EVs in Southern California

Home to early adopters in clean energy technologies, the Los Angeles metropolitan area is anticipating a surge in consumer and municipal uptake of EVs based on market forecasts utilized by Southern California Edison (SCE).[120]

California already has several decades of experience working with and planning for EVs. While this has proved beneficial, it also generates unique challenges: in Los Angeles and throughout the state there are hundreds of existing low-technology charging stations from the first release of EVs in the state, dating to the mid-1990s. The state's experience has resulted in an existing inclusion of EVs within the motor-vehicle-related occupancies section of the California Building Code, section 406.7, which provides the minimum EV-related code requirements referenced in the Green Building Code.

3.3.3. Challenges Related to Jurisdictional Boundaries

Cooperative efforts in EV readiness across the Los Angeles metropolitan area are not limited to the county and city of the same name. There are 88 incorporated cities, numerous unincorporated areas and almost 10 million residents within Los Angeles County, and the irregular municipal boundaries of the city of Los Angeles envelop or abut many of these. This arrangement produces an astonishing number of city officials: there are more than 450 mayors and city council members in the county.[121]

Furthermore, there is a strong home-rule tradition in California that has impacts on collaboration around energy and infrastructure—and nearly everything else.[122] However, there is also an established tradition of regional planning, area Councils of Governments and Metropolitan Planning Organizations playing roles in large-scale plans.

A recent report on the government structure of Los Angeles summarizes the difficulties that surround representation, regulation and enforcement in the metropolitan area:

> *Los Angeles is a different kind of city. It is huge in land area, decentralized in living arrangements, marked by an individualistic culture that pays little attention to politics and government. Many residents of Los Angeles have never seen an actual map of Los Angeles. Others are not certain whether they live in Los Angeles City, in another smaller city, or in an unincorporated county territory. While public officials are important and powerful, they do not have the visibility that marks public office in eastern and Midwestern cities like New York City and Chicago.*[123]

This poses specific political and administrative challenges for designing strategies relating to EV readiness that can help the region achieve more uniformity and smooth its transition to a more EV-friendly environment.

3.3.4. California Utilities and Energy Market Impacts on EV Readiness

The Los Angeles area has produced one possible solution to the challenges created by fragmented jurisdictional governance, although not by government actors: intense involvement of the utilities in programming and training, research and upgrading and monitoring the electrical

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[120] See note 17.

[121] "Mayors and City Councils Cities of Los Angeles County," accessed October 24, 2012, http://www.laalmanac.com/government/gl10.htm.

[122] Conor Friedersdorf, "Los Angeles is 88 Cities, Many of Them Corrupt," *The Atlantic*, April 28, 2011, http://www.theatlantic.com/national/archive/2011/04/los-angeles-is-88-cities-many-of-them-corrupt/237980/.

[123] Raphael J. Sonenshein, "Los Angeles: Structure of a City Government" (Los Angeles: The League of Women Voters of Los Angeles, 2006), http://www.lwvlosangeles.org/files/Structure_of_a_City.pdf.

service. This report will focus on SCE, an investor-held utility with a wide-reaching territory covering much of the Los Angeles mega-region, and touch briefly on initiatives of the Los Angeles (City) Department of Water and Power. SCE is the primary utility service provider for the county as a whole, but the city of Los Angeles has its own, fully integrated utility that performs power generation, transmission and distribution for the city only.

A full discussion of the recent history of energy deregulation and supply in California is complex and beyond the scope of this document. However, it is worth mentioning that the California energy crisis of the early 2000s has had direct effects on the current state of EV infrastructure planning in the state. A settlement reached in the spring of 2012 between the California Public Utility Commission, the agency responsible for the regulation of investor-owned utilities in the state, and NRG Energy, a subsidiary of Dynegy Inc., which was found to have manipulated the energy market during the post de-regulation crisis a decade ago, will generate an investment of $100 million dedicated to EV charging infrastructure throughout the state.[124] More than half of this settlement funding will go toward the installation of 200 commercial charging stations.[125] Despite some industry concerns over the energy company effectively being granted the monopoly-like benefits of a competitive advantage as a "first mover" in the DC fast charging market,[126] the outcome for EV users, the utility grid and the built environment will be the introduction of a significant (nearly 200%) increase in fast-charging stations in the state. The NRG settlement will include an additional $40 million toward wiring of homes, multi-unit dwellings (MUDs) and public locations for EV readiness.

Best Practices for Utility-Led Infrastructure Planning

SCE takes a pro-active approach to EV readiness. Particularly with the introduction of more widespread fast charging, the need to approach EV-ready infrastructure from the perspective of the energy grid is clear, as it becomes increasingly important for utilities and power authorities to be knowledgeable of the required service capacity within their respective territories.

Currently, SCE is involved with many organizations, pursuing a comprehensive stakeholder outreach initiative that includes other utilities, auto manufacturers, state and local governments, nonprofit entities working on EV readiness, consumer groups and community-based organizations. The primary goal behind the utility's outreach programs is the creation of a uniform message about EVs and EV charging infrastructure. The mission of the utility is to provide safe and reliable electrical service; this is the reason behind SCE's involvement in the EV infrastructure space. This relates specifically to the utility's ongoing role in upgrading the grid throughout its service area.

A unique need in California is the upgrading of existing charging infrastructure dating from the first wave of EV use in the 1990s; hundreds of older charging stations are due for an upgrade. In order to approach infrastructure upgrades in a cost-effective manner, the utilities are seeking to prioritize upgrades in the areas that are most critical. This is an issue that impacts both the distribution infrastructure (power generation and other parts of "the grid") and residential systems. The coastal climate of Los Angeles (which has not typically required residential electrical system capacity for air conditioning), combined with an aging building stock means that the capacity of many area homes may only be 40 amps—not quite able to accommodate a level 2 charger with a four- to six-hour continuous load.[127] The purchase of EV charging stations from home renovation retailers such as Home Depot for self installation—regardless of whether it is allowable in the residential building code—represents a "concern" for utilities. Part of this

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[124] For a timeline of the 2000–2001 energy crisis, see: http://www.pbs.org/wgbh/pages/frontline/shows/blackout/california/timeline.html.
[125] http://www.forbes.com/sites/pikeresearch/2012/04/27/nrg-settlement-far-from-settled/.
[126] See: http://ecotality.com/wp-content/uploads/2012/04/Motion-for-Public-Review-of-NRG-Settlement.pdf.
[127] See note 17.

concern arises out of the technology use of EV early adopters; these are often households that have already adopted other new technology that already drains home system capacity, such as plasma televisions.[128]

Monitoring EVSE deployment happens from the utility perspective in several ways: through cooperation with the auto manufacturers and dealers to obtain data on EV orders within the service area, cooperation with EV charging service providers that sell or lease charging stations and via notification systems such as permits issued for EVSE installation or for electrical service upgrades. Failing access to that type of data, the utility monitors and assesses spikes in energy use as a general practice.[129]

Additional incentives from the utility address rates, research and outreach. SCE provides an option for dedicated metering, including special EV rates. The EVSE is metered separately on a dedicated line, billed using a time-of-use rate. The installation of a separate meter does not present a code or permitting issue and is typically easy to execute. Finally, SCE leads and partners in energy-related research. Recent projects include an unreleased study assessing the charging and driving patterns of EV drivers in the SCE service territory. Working with the University of California, Los Angeles and the University of California, Santa Barbara on public infrastructure research, SCE has produced a number of research documents, the dissemination of which has occurred through transportation and regional planning organizations such as area councils of government and metropolitan planning organizations.[130]

3.3.5. Key Takeaways

Summary:

- Encourage environmental benefits in the transportation sector through regulating the built environment
- Create consistent code options for local jurisdictions by offering tiered requirements
- Work with and expand the role of utility companies in planning for EVs

In the **Los Angeles** metropolitan region, city, county and state governments have taken innovative approaches to greening buildings and the transportation sector. These efforts have been complemented by the proactive stance taken by the major electrical utility providers in the Los Angeles region. CALGreen, as the nation's first mandatory green building code, sets a high bar. The code's overall goals deal directly with the state's mandate to reduce GHG emissions, and an EV-ready policy included in the code recognizes that regulation in one high-emissions sector (buildings) can impact and incentivize greener consumer behavior in another sector (transportation). The state's approach to phasing in the code's mandatory provisions sheds light on the ways in which other jurisdictions might adopt similar code amendments, and the inclusion of "tiers" of compliance in the voluntary appendices makes it possible for the adopting jurisdiction to choose the level of deployment and enforcement most appropriate for the local market and community. Los Angeles is leading the shift to mandatory EVSE codes; both city and county have or will likely soon pass and upgrade the requirements for EV-ready construction. For a metropolitan area with an incredible number of local jurisdictions, a top-down but flexible approach such as CALGreen is a good solution. In addition, the utilities, such as Southern California Edison, are finding a niche role as a stakeholder and coordinator for EV-ready action that spans jurisdictions.

In the **TCI region**, codes that make buildings greener can create environmental benefits for the transportation sector as well, e.g. through the inclusion of dedicated EV parking spaces. The top-

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[128] See note 17.
[129] Ibid.
[130] Ibid.

down, flexible approach to setting standards by using tiers and voluntary code appendices is a best practice that could be translated to state building codes throughout the TCI region. Indeed, like California, many east coast states have a wide range of population densities across highly populous and dense urban areas and rural and agricultural areas. Codes become a tool that lets local jurisdictions assess local conditions by opting in or out of certain levels of regulation, while offering a consistency in requirements and developer and consumer expectations across a state.

Further, the focus of the reduction of transportation sector emissions is not something unique to the west coast, nor is the potential adoption of environmental standards that have originated in west coast states. Another related California initiative, Title 13 of the California Code of Regulations, sets standards for low emission vehicles, and these standards have been adopted into law by TCI region states and jurisdictions, including Washington, DC, Maryland, New Jersey, New York, Pennsylvania, Connecticut, Massachusetts and Vermont.[131]

The opportunity for expanding utility companies' roles in EV planning is illustrated by SCE's various initiatives. Considering the importance of utilities as partners and stakeholders (e.g. in EV working groups or councils) is an important step in any jurisdiction toward EV readiness. Many of the issues that TCI stakeholders cited in initial project outreach are concerns of the utilities, for example: peak rates and electricity pricing per kilowatt hour, the inclusion of dedicated (split) or smart meters that can aid EVSE installations in multi-family housing, reporting of EV purchases or EVSE installations to manage loads on local transformers.

[131] State-by-state references to California's Low Emission Vehicle standards can be found through the U.S. DOE: http://www.afdc.energy.gov/laws/search

OREGON

Summary
The Oregon Building Codes Division has developed new administrative rules to streamline permitting and inspection protocols for EVSE installation statewide.

Focus
Electrical code amendment facilitates permitting process

Code Outcomes
New, streamlined permit and inspection protocols apply uniformly throughout the state. These include Oregon's minor label program. Code changes currently address levels 1 and 2.

3.4. Oregon: State-Level Electrical Code Amendments

The state of Oregon is known as a national leader in sustainability, and as such this case study addresses state-level efforts to amend the regulatory environment governing EV infrastructure. As a sustainability leader, Oregon is home to a few unique considerations relevant to this discussion. First, as a region included in ECOtality's EV Project, Oregon has received substantial EVSE-related funding through ARRA.[132] Second, Oregon has a concentration of existing EV automotive component producers in niche manufacturing.[133] Both points are evidence of existing understanding of the value of growing the EV market.

Another distinction worth noting is actually common throughout the Pacific Northwest; more than half of the state's energy comes from hydropower. Portland General Electric (PGE), Idaho Power Company and Pacific Power provide electricity throughout the state, in addition to numerous smaller providers. As Portland's power supplier, PGE is particularly engaged in expanding EV adoption, raising awareness and generating industry economic opportunity in partnership with public and private organizations.[134]

Cooperation has been at the center of Oregon's EVSE efforts. The Governor's Alternative Fuel Vehicle Infrastructure Working Group has guided research and policy approaches for the state, recommending code changes to the Building Codes Division (BCD). BCD worked with PGE on a pilot program to install an initial five-charge point pilot project in Portland and Salem beginning in 2008. In 2010, the working group created the Transportation Electrification Executive Council in order to address the need to coordinate public, private and civic leadership in the area of EVs and

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[132] An EV Project report on EVSE deployment for the Portland, OR, and Salem, OR, areas can be found here: http://www.theevproject.com/downloads/documents/Electric%20Vehicle%20Charging%20Infrastructure%20Deployment%20Guidelines%20Oregon%2015%20Metro%20Areas%20Ver%203.2.pdf.
[133] *Report of the Alternative Fuel Vehicle Infrastructure Working Group* (Portland, OR: Multnomah County, January 2010), http://www.psrc.org/assets/3751/W_OregonReport_2010.pdf.
[134] "Electric Vehicles in Oregon," Portland General Electric, accessed October 24, 2012, http://www.portlandgeneral.com/community_environment/initiatives/electric_vehicles/evs_in_oregon/default.aspx.

EVSE. As mentioned above, cooperative efforts extend to the private sector. A coalition of Oregon cities are participants in the EV Project, a public-private partnership administered by DOE and funded by ARRA and the private investment of ECOtality, Inc. The EV Project has facilitated cooperation among public and private organizations, utilities, financial partners and the EV industry.[135]

Lessons from Oregon demonstrate how legislative effort and relatively simple electrical code changes can help specify an EV-ready policy that speaks to overall emissions reduction and sustainability goals through a safety-focused policy. The code change process has also focused on establishing best practices in the permitting and administrative arena that have made these processes more uniform and dramatically reduced the cost of permits for EVSE installation.

3.4.1. Electrical Code Change Aimed at Expediting Permitting and Inspections

Oregon’s participation in the EV Project provided funding and introduced vehicles into the market, as well as accelerated demand for charging infrastructure. The state of Oregon’s approach to streamlining the permitting and inspection process addresses this relatively high-demand condition. Overall, Oregon is actively coordinating a range of activities to facilitate widespread EV and EVSE deployment.

Targeting the structural codes presented unique opportunities and challenges for the State of Oregon. The state’s building codes are different from most other states; codes adopted at the state level set both the minimum requirements for construction statewide and the maximum requirements that local jurisdictions can enforce. In effect, state-level building code changes would establish a uniform policy for all new construction across the entire state, much like Vancouver’s Building By-laws, but over an inefficiently large geographic area, causing cost burdens in many areas, particularly those outside the urbanized Pacific coast corridors. The working group concluded that while building code changes would reduce the construction costs associated with retrofitting buildings to be EVSE-ready in the future, the increased costs for developers at the present moment would be premature.[136]

In this light, finding a way of ensuring a positive user experience, reducing the administrative costs and ensuring a path for emerging technology and its safe installation without adapting the scope or structural aspects of the building code was a challenge to the state in its approach to supporting EVSE. The solution was to ask BCD to develop a home EVSE installation process that could be completed within just a few days of purchase.

3.4.2. Minor Label Program

In 2008, BCD adopted statewide permit and inspection protocols through a rule that establishes the types and number of permits and inspections required to install EVSE. One of the central aspects of Oregon’s code change is the inclusion of EVSE in the state’s minor label program. Oregon's statewide process speeds simple EVSE installations by enabling licensed electricians to pre-purchase permitting minor installation “labels” online and inspecting only 1 out of 10 EVSE installations.

The electrical minor label program was developed and implemented in the late 1980s to allow electrical contractors to use labels in lieu of individual permits for limited, simple installations, repair and maintenance. Previously, these installations were limited to 30 amps at 40 volts; however, in examining EVSE, BCD determined that the installation of a simple 40 amp circuit in a

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[135] “Oregon EV Companies,” EVRoadmap.com, accessed October 24, 20120, http://www.evroadmap.com/orevcompanies.html.
[136] See note 135.

residential setting could also fall into this same scope of work.[137] Under the minor label program, a licensed electrician can purchase booklets of 10 minor installation labels for $140; each label allows for standard EVSE installations. The program defines standard EVSE installations as those installations that are within sight of the electrical panel supplying the charging unit, have a branch circuit that does not exceed 40 amps/240 volts and are not located in a damp place.[138] Under this program, just 1 in 10 of the electrician's completed jobs is inspected by BCD. An additional benefit of the program addresses some concerns raised by the electrical safety community around lack of control over residential installation under the IRC: only licensed professionals are permitted to purchase minor labels.

The inclusion of EVSE in the state's minor label program can be considered a best practice. Reducing the cost to the state in terms of inspections and to the EV owner makes the installation of at-home charging infrastructure that much more accessible—each permit for a basic installation costs $14, compared to permitting costs that still reach up to $700 in some areas of the Los Angeles region. The Oregon code amendment does not contradict the conclusion that the NEC provisions sufficiently cover existing technology needs; instead, it emphasizes the potential for states or local jurisdictions to amend the code to create a more pro-EVSE regulatory environment.

In addition, local jurisdictions that participate in BCD's ePermitting services are able to offer the required feeder permit for EVSE online, simplifying the process even further.[139]

3.4.3. Policy Origins: Alternative Vehicle Evolution

Consistent, predictable standards provide guidance to cities and counties on the issues surrounding emerging technologies, according to BDC.[140] In order to assist in the creation of consistent standards at the state level, the state of Oregon has adopted and continued to revise new standards that establish permitting and inspection requirements for EVSE that apply in every county and city across the state.

BCD is housed within the State Department of Consumer and Business Services, which is the state's business regulatory and consumer protection agency. The Codes Division provides code development, administration, inspection, plan review, licensing and permit services to the construction industry.[141]

The EVSE-related standards are one in a series of steps taken by BDC's Green Building Services section toward positioning Oregon as a green building innovation center; prior activities included the approval of new water conservation methods and the development of amendments to the building code to allow for greater energy efficiency.

The Oregon code amendment does not contradict the conclusion that the NEC provisions sufficiently cover existing technology needs; instead it emphasizes the potential for states or local jurisdictions to amend the code to create a more pro-EVSE regulatory environment.

Oregon has supported alternative fuel vehicles since 1991, when the state established an alternative fuel vehicle tax credit program, the precursor to the contemporary strategy of

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[137] Dennis Clements, personal correspondence, July 27, 2012.
[138] Alternative Fuels Data Center, "Oregon Deploys Plug-In Vehicles and Charging Infrastructure," U.S. Department of Energy, April 25, 2011, http://www.afdc.energy.gov/case/1000?print.
[139] See note 135.
[140] "New Building Codes Standards Support Electric Vehicle Growth," Oregon Department of Consumer and Business Services, October 14, 2008, http://www.cbs.state.or.us/bcd/notices/electric_vehicles_nr.pdf.
[141] Ibid.

focusing on GHG reduction.[142] The focus on the transportation sector seems to be a natural fit, given the relatively clean sources of electricity in the state (more than 50% of the state's electricity is generated by hydropower) and that statewide, about 38% of the GHG emissions come from transportation.[143] In September 2008, Oregon Governor Ted Kulongoski signed Executive Order 08-24, creating the Governor's Alternative Fuel Vehicle Infrastructure Working Group, which is charged with developing policies and infrastructure for Oregon to "attract car manufacturers seeking to bring the next generation of electric and alternative fuel vehicles to market in North America."[144]

Oregon: Goals and Strategies Supporting Code Changes

Goal	Strategy
Reduce Emissions	Reach GHG emissions targets of 10% below 1990 levels by 2020 and 75% below 1990 levels by 2050
Capture Energy Expenditures	Recapture a portion of the 90% of non-tax dollars spent on fuel by Oregon residents that leave the state. Oregon spends $8 billion annually on gasoline
Maximize Clean Energy	Oregon has relatively clean (low GHG) electricity sources, including hydropower
Develop Industry	Investment for Oregon's concentration of businesses in the EV sector

The working group seeks to marry emissions reductions goals with economic ones, encouraging EV adoption rates while fostering local and statewide job growth in the electrified transportation sector.[145]

In addition to the 2008 Executive Order, Oregon passed earlier enabling legislation that targeted emerging technologies and included provisions for swift regulatory action by BDC where such action is necessary to support emerging technology adoption. A follow-up executive order in 2010 established a panel to assist in creating an agenda for EV and infrastructure deployment and related services throughout the state.[146] This panel, called the Governor's Transportation Electrification Executive Council, is meant to address the "need to focus and coordinate public, private and civic leadership in ensuring that Oregon is well-positioned to capitalize on the economic benefits of transportation electrification," in addition to enhance strategic infrastructure deployment, identify opportunities and barriers to EV adoption and facilitating outreach, among other areas of related work.[147]

3.4.4. Local Plans in a Restrictive State Framework

According to the Oregon Department of Transportation (ODOT), Oregon residents in metropolitan areas travel an average of just 17.5 miles per capita per day—well within the range of any EV on the market today.[148] Portland, Oregon, has created complementary municipal policy.

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[142] See note 140.
[143] See note 135.
[144] See note 142.
[145] City of Portland and Multnomah County, "Climate Action Plan 2009 - Year Two Progress Report" (Portland, OR: Office of Sustainability, April 2011), http://www.portlandoregon.gov/bps/article/393345.
[146] Office of the Governor, "Executive Order 10-09" (Salem, OR: State of Oregon, September 22, 2010), http://cms.oregon.gov/Gov/pdf/eo_1009.pdf.
[147] Ibid.
[148] See note 135.

Although local jurisdictions are not able to create more rigorous building or electrical codes or standards, they are able to pursue other strategies to increase their EV market share and capitalize on the environmental benefits of transportation electrification. To this end, Portland has established more vigorous, but harmonious GHG standards: the Portland City Council created policies that support the city's effort to meet the emission-reduction goals of its 2011 Climate Action Plan.[149] The plan estimates that in order to meet city goals, 13% of all non-commercial vehicle miles traveled on Portland roads in 2030 will need to be traveled by EVs.

Portland has pursued a strategy of showcasing technology in partnership with Portland State University and Portland General Electric, opening "Electric Avenue" in 2011. The City of Portland has 11 (Multnomah County has four) electric fleet vehicles.

3.4.5. Innovative Partnerships Programs Channel Funding

Oregon demonstrates policy and practice integration across state and local levels. ODOT and the state's Office of Innovative Partnerships and Alternative Funding have worked with industry and government partners on EV projects and pilots, including ECOtality's EV Project, facilitating the West Coast Green Highway and administering a Tiger II EV infrastructure grant.

In September 2010, ODOT received $700,000 in federal stimulus funding to install up to eight fast-charging stations in southern Oregon. In October of the same year, ODOT was awarded an additional $2 million from the TIGER II program in order to enable the state to build necessary infrastructure to support and expand the range of existing EVs.[150] The stations "will be placed no more than 50 miles apart on highways outside of metro areas to create a continuous network."[151]

Transportation Corridor Planning: The EV Corridor Connectivity Project

These partnership programs have focused to a great extent on expanding infrastructure along major transit corridors, building and extending what is known as the West Coast Electric Highway, a tri-state network of EV DC fast charging stations along Interstate 5, connecting Northern California to British Columbia. The goal of developing a regional transportation corridor framework creates the need to address the installation scenarios with a quick and easy process. This means that partnerships must extend to collaboration among state departments of transportation—this west coast corridor project should be taken as a model for connecting Northeast and Mid-Atlantic states, where smaller land areas will require cooperation among even more interstate agencies.

Utility Role

Consistent processes are also required in a state where, in contrast to British Columbia's sole power authority, retail electricity service is offered by numerous different utilities. These include three investor-owned public electric companies, 19 electric cooperatives, six peoples' utility districts and 13 municipal utility districts.[152] In this business environment, it may be desirable for

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[149] Christina Williams, "Portland Passes Wide-Ranging Electric Vehicle Policy," Sustainable Business Oregon, July 20, 2010, http://www.sustainablebusinessoregon.com/articles/2010/07/portland_to_adopt_electric_vehicle_policy.html.

[150] Washington State was awarded a similar grant of more than $1.3 million. For more information, see: http://westcoastgreenhighway.com/projects.htm.

[151] "U.S. Transportation Secretary LaHood Announces Agreement for Electric Vehicle Charging Stations in Northwest Oregon," U.S. Department of Transportation, April 8, 2011, http://www.fhwa.dot.gov/pressroom/fhwa1114.htm.

[152] See note 135.

the state to pursue minimum electrical requirements that must be enforced across these boundaries.

Future Actions

In 2010, the working group recommended that BCD revisit the appropriateness of building code amendments requiring a dedicated EV conduit in new construction. Similar to Vancouver's calculation of a 2% increase in construction costs, Oregon assumes a market trigger of about 5% new EV market sales to justify the additional expenses of a non-health or safety building code requirement.[153]

3.4.6. Key Takeaways

Summary

- Reduce real consumer costs of EV adoption by addressing the extreme variation in permitting fees and lowering fees for residential installations
- Consider the demographic and economic impacts for urban, suburban and rural communities when choosing state-level routes to EV readiness
- Incorporate EVSE into existing regulations where possible
- Codes are complemented by other types of EV-ready planning

Oregon amended the electrical code to reflect a need to address EV charging infrastructure in a market with many early adopters concentrated in specific geographic areas and corridors. Because the state's building codes set the minimum and maximum requirements enforceable by local jurisdictions, the geographic concentration of the population along the Pacific coast would make mandatory EV-ready building policies economically inefficient in much of the state. However, a clear need to reduce costs and ease the transition to increased EV use led state officials to recommend an expedited and inexpensive permitting process. Further, two municipal and corridor planning efforts—Portland's EV priorities in its Climate Action Plan and the West Coast Green Highway—illustrate the ability of local jurisdictions and state authorities to complement code-specific policies by setting environmental and transportation-oriented goals. In addition, the inclusion of EVSE in the state's minor label program reduces costs to the state and to the EV owner, making installation of at-home charging infrastructure that much more accessible—each permit for a basic installation costs $14.00.[154] The Oregon code amendment does not contradict the conclusion that the NEC provisions sufficiently cover existing technology needs; instead, it emphasizes the potential for states or local jurisdictions to amend the code to create a more pro-EVSE regulatory environment.

The **TCI region** can use the electrical code to focus on reducing costs of permitting and installing most EVSE, particularly in situations where the electrical work is routine. Stakeholders throughout the region, as well as those interviewed from other jurisdictions for this report, cited wide variation in and often high cost of permitting as a barrier for EV adoption. Establishing a flat and consistent fee for residential EVSE installation at the state level is a clear step toward regulatory consistency that has real results for individual EV owners.

The ability of the state of Oregon to establish in the state level building code the minimum and maximum requirements for construction across the state, state officials determined that route not to be the most cost effective, instead choosing to pursue electrical code changes to reduce costs. TCI region states should first assess the costs and benefits associated with pursuing a particular code policy change, considering the uniqueness of their state's regulations.

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[153] Ibid.
[154] A minor label program designates certain simple electrical construction work as "minor work." Permits are still required, but costs and timelines are reduced. Oregon's program for EVSE is discussed further in section 3.4.

Furthermore, Oregon's regulation is exemplary in its simplicity. While the organization, goal setting, and other aspects of state-level planning discussed in this case study are important and essential steps, the conclusion to include EVSE in an established state permitting program provided a reasonable solution easily adopted by local permitting authorities throughout the state.

Finally, Oregon's electrical code changes occurred within a larger framework of EV-ready planning that has ensured compatibility/co-development of plans for municipalities, such as Portland's use of EV planning in meeting emissions goals for the city, and for regional efforts, such as the West Coast Green Highway. TCI region states can look to examples like Oregon to see that EV-ready initiatives are not mutually exclusive, and that code changes can support one aspect of encouraging EV adoption, while partnerships, local plans and initiatives in other sectors can complement work done to amend codes by extending access and ownership throughout the state.

4. SUMMARY AND NEXT STEPS

4.1. Case Studies in Summary

The case studies included in this report highlight three approaches to metropolitan area and regional cooperation to address the regulatory framework that supports and monitors EV infrastructure deployment. Looking at advanced efforts at the state, metropolitan area and municipal levels in forward-thinking jurisdictions, several common factors emerge regarding the successful creation of policy and regulation supportive of EV infrastructure:

- Each jurisdiction took specific and multifaceted steps to encourage use of EVs.
- Each jurisdiction considered opportunities and challenges associated with regulation at multiple levels of government, or with multiple layers of agency, authority or private-sector participation, demonstrating the wide range of possibility in working with codes and other components of the regulatory environment.
- Actors in each jurisdiction identified and overcame potential regulatory barriers.

In **Vancouver**, a municipality created a collaborative working group to develop EV-readiness strategies with the intent of meeting long-range GHG reduction goals. Because of the ready availability of clean hydropower, the replacement of gas engine vehicles EVs was determined to have a disproportionately dramatic effect on GHG emissions, making the stimulation of the EV market a smart choice for the area. In meeting the anticipated needs of future EV owners, the Vancouver City Council took advantage of its unique ability among Canadian cities to modify its building codes in order to require a substantial percentage of parking stalls in new construction to be made EV-ready. At little added cost to developers, amending the scope of the local building code to include mandatory minimum requirements for the future electrical installation of charging stations illustrates a relatively simple, feasible solution to a complex problem.

In **Los Angeles**, the city, county and state have taken innovative approaches to greening buildings and the transportation sector. These efforts have been complemented by the proactive stance taken by the major utility companies that provide service to the Los Angeles region. CALGreen, as the nation's first mandatory green building code, sets a high bar. The code's overall goals deal directly with the state's mandate to reduce GHG emissions, and an EV-ready policy included in the code recognizes that regulation in one high-emissions area (buildings) can impact and incentivize greener consumer behavior in another (transportation). The state's approach to phasing in the code's mandatory provisions sheds light on the ways in which other jurisdictions might adopt similar code amendments, and the inclusion of "tiers" of compliance in the voluntary appendices makes it possible for the adopting jurisdiction to choose the level of deployment and enforcement most appropriate for the local market and community. Los Angeles is leading the shift to mandatory EVSE codes; both city and county have or will likely soon pass and upgrade the requirements for EV-ready construction. For a metropolitan area with an incredible number of local jurisdictions, a top-down but flexible approach such as CALGreen is a good solution. In addition, the utilities, such as SCE, are finding a niche role as a stakeholder and coordinator for EV-ready action that spans jurisdictions.

Oregon amended the electrical code to reflect a need to address EV charging infrastructure in a market with many early adopters concentrated in specific geographic areas and corridors. Because the state's building codes set the minimum and maximum requirements enforceable by local jurisdictions, the geographic concentration of the population along the Pacific coast would make mandatory EV-ready building policies economically inefficient in much of the state.

However, a clear need to reduce costs and ease the transition to increased EV use led state officials to recommend an expedited and inexpensive permitting process. Further, two municipal and corridor planning efforts—Portland's EV priorities in its Climate Action Plan and the Green/Electric Highway—illustrate the ability of local jurisdictions and state authorities to complement code-specific policies by setting environmental and transportation-oriented goals

The inclusion of EVSE in the state's minor label program reduces costs to the state and to the EV owner, making installation of at-home charging infrastructure that much more accessible—each permit for a basic installation costs $14. The Oregon code amendment does not contradict the conclusion that the NEC provisions sufficiently cover existing technology needs; instead, it emphasizes the potential for states or local jurisdictions to amend the code to create a more pro-EVSE regulatory environment.

4.2. Central Themes and Preliminary Recommendations

Considering complexities in the state and local decision-making process of evaluating EV-ready options, there are opportunities that can be created to encourage consistent EVSE deployment planning. Structural codes do not operate alone in the local regulatory environment; they are one tool available on the regulatory menu for jurisdictions seeking to govern infrastructure deployment. Despite the environmental benefits and growing EV market in many areas across the United States and throughout the region, each state and local jurisdiction will need to assess the costs and benefits associated with its own goals pursuant to energy efficiency, transportation electrification, green construction, air quality and economic development in order to effectively prioritize EV-readiness steps.

4.2.1. Existing Codes Present No Significant Barriers to EVSE Deployment

While there are no specific barriers to EVSE installation embedded in the existing national model building and electrical codes, there is room within the codes as adopted by the states to more clearly encourage EV readiness. Despite differences between jurisdictions, the codes themselves—model and adopted—cover existing safety concerns related to existing automotive and charging technology and permit or facilitate conditions under which EVSE can be installed.

Neither level 1 nor 2 EVSE requires significant electrical work so long as the existing circuitry supports the electrical load and connection. Each installation presents unique wiring and construction challenges that can increase costs, but they are typically accounted for by the existing structural codes and standards.

For existing technology, at present there are no specific structural codes issues cited by the stakeholders, code experts or model jurisdictions interviewed for this report that prevent or inhibit EVSE installation. However, challenges to consistency and safety may arise out of a lack of familiarity with EVSE equipment, complex commercial installations (such as with DC fast-charge installations, or where loads exceed circuit or service capacity) or the single-family residential code (the IRC), because not all jurisdictions require homeowners to hire a licensed electrician to perform electrical work.

Recommendations

- Consistent with their respective missions, code-setting bodies must continue to engage stakeholders in a participatory process geared toward bringing new technologies and implementation strategies to the fore as new industry standards. Organizations such as the ICC and NFPA, for example, should further engage in outreach, actively seeking best practices from local jurisdictions.

- States that do not have some form of mandatory inspection program for construction permitted under the IRC or similar local single-family construction code should institute a more comprehensive process.
- Education and training programs for inspectors and installers have become the norm as an early evaluative step in EV-readiness planning. States seeking to evaluate the need of codes and permitting processes should initiate EVSE training for professionals in related fields.[155]

4.2.2. Codes Can Help Achieve EV Readiness and Regional Cohesion

There are specific reasons to consider changing codes at the local, state and national levels. Because code amendments are one of several interrelated strategies to encourage EVSE deployment, in considering changes, it is important to consider what codes can accomplish:

- Codes can specify scoping requirements of numerical goals or limits for certain features in new construction (e.g., percentage of required parking to be built EVSE-ready).
- Codes can provide new permitting or inspection protocols and encourage the reduction of associated administrative costs.
- Codes are revised regularly and will be adapted at the national level to meet new structural or fire safety concerns, such as those related to new and emerging technologies.

The TCI region can achieve a level of cohesive EV readiness through the building and electrical codes if similar efforts are made across the region. Local conditions will factor heavily into the decision to regulate for EVSE based on codes. Variations across the TCI region will mean that states will make different choices. States such as New Jersey, for example, with a relatively evenly distributed, dense population and centrally located transportation corridors, may find scoping requirements in the building code to be a good solution. By contrast, Maine's lack of population density and residential concentration around key urban centers may suggest a different approach.

In addition to state and local governments, Clean Cities' Coalitions and other similar groups can play a central advocacy role in this assessment at the jurisdictional scale. In Vancouver, the EV Working Group became an important source of information sharing and program development. Within the TCI region, there are examples of several similar initiatives. Maryland has created by law the Maryland State Electric Vehicle Council, housed within the state's Department of Transportation.[156]

Incentivize EVSE Parking

A hypothetical proposal for a new optional appendix to the model building code could include in its scope provisions requiring 10% of parking spaces in new construction residential garages to be EVSE-ready, creating a uniform approach across jurisdictions that adopt that regulation.

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[155] Stakeholders have indicated that while training is a clear component of ongoing successful EVSE installations, the training is more educational than technical; once an installing licensed electrician is aware of the EVSE device and components, it will be clear how to proceed with the installation. One exception is the level 3 or direct current (DC) fast-charging units, which are newer to the market and therefore have not yet been specifically addressed by these primary standards. However, even the new technology currently on the market is regulated for safety.

[156] The Maryland EV Council is discussed in detail in the companion to this report, the *EVSE Toolkit: Administrative and Planning Strategies for Local Jurisdictions*.

Over the long term, state code and local amendments and regulatory changes may influence the language of the model codes.[157] Regulation at the state level may provide the greatest consistency to metropolitan areas and corridors. The case of California illustrates the benefit of consistent, voluntary options.

Recommendations:

- Following the lead of states such as Oregon and New Jersey, each of the TCI states should conduct a review of its codes and policies to determine if residential EVSE installation can be classified as "minor label" or "minor work."
- Incentivize and encourage incorporation of EVSE by modifying building codes when appropriate to require that a percentage of accessory parking associated with new development to be pre-wired for EVSE (for example, 20%), providing flexibility for future capacity.
- Enable state and local participation in a forum for interstate cooperation.

4.2.3. EVSE Deployment as Economic Development

Codes, and the requirements that they set out, factor into economic development planning. EVs and EVSE deployment influences such disparate areas as maintaining housing affordability, providing equitable access to transportation infrastructure, creating green jobs and marketing metropolitan areas to attract new businesses, residents and institutions.

Cost Reductions

For the development and construction community, there is a need to keep costs of EVSE installation low enough to be easily absorbed into overall project costs.

Another aspect of economic development for EVSE is that jurisdictions encouraging EV readiness will likely gain growth in industry associated with EVs and charging infrastructure. The presence or stimulation of markets for EV and EV charging has primed the pump in early adopting jurisdictions. For example, Vancouver's signing of MOUs with auto manufacturers highlights an approach to capture a portion of the EV market. In most localities, however, EV readiness will bring additional electrical and green energy jobs and other economic opportunities.

Decisions to pursue an EV-focused GHG emissions reduction strategy partly through code amendments may, as it did in Los Angeles, result in additional economic benefits. With a municipally owned utility in the mix (Los Angeles Department of Water and Power), Los Angeles' support of EVs not only reduces the 43% of GHG emissions associated with on-road vehicle travel, but money previously spent on imported fuel and energy sources can stay in the city and region.[158] In this instance, local administrative action has the benefit of reducing consumer costs,

Incorporate EVSE Infrastructure Planning into Urban Development Strategies

For a downtown revitalization plan, the incorporation of EV charging stations can aid marketing strategies. Portland's Electric Avenue highlights the potential of bringing a unique amenity to Main Street.

[157] See note 62. State and model code revisions may take up to 12 years, depending on the jurisdiction's code cycle and date of proposed change.

[158] See note 16.

[3] "Renewable Energy Financing District/Solar Energy Improvement Special Assessments," Energy.gov, July 1, 2009, http://energy.gov/savings/local-option-renewable-energy-financing-districtsolar-energy-improvement-special-assessments.

[4] "Special Purpose Districts in Washington," Municipal Research and Services Center of Washington, accessed October 24, 2012, http://www.mrsc.org/subjects/governance/spd/spdmain.aspx.

capturing dollars through locally based services and improving air quality.

Raising Awareness and Profiles

Local jurisdictions also have the opportunity to create or alter perceptions of the EV market. The importance of securing vehicles has been illustrated anecdotally throughout this research process. A stakeholder described an attempt to add EVSE provisions into the parking calculations for zoning requirements in Dover, New Hampshire, that involved a similar approach to mandating parking through the building code.[159] The stakeholder's proposal suggested that developers make 2% of all parking spaces EVSE-ready for all developments exceeding 50 spaces; when the local planning board voted on the provision, the reason cited for not establishing a mandatory requirement was that there were no EVs registered in the area yet.[160] From this example, an awareness of use creates trust that administrative efforts will be worthwhile.

Portland, Oregon, has created a prominent strip of EV parking in a busy downtown area, giving prominence to EVs and creating a unique addition to the urban environment at the same time. Such profile-raising strategies show that in many places across the country local governments consider EVs a valuable commodity. Provisions for EVSE deployment can be seen as an amenity that allies the locality with green branding that can aid in attracting businesses and residents, while setting legitimate goals for sustainable energy, buildings and job growth. The question remains for new EV markets as to how the West Coast states' and provinces' approaches can be translated to the East Coast.

Finally, while codes can influence markets to some extent, codes should not be used to predict the future of EVSE infrastructure. Instead, they should be written so as to freely adapt to any installation or new technology scenario. The fact that DC fast charging and wireless charging are not yet fully accounted for in the national codes is not alarming; rather, it indicates a lack of prescriptive regulations that can negatively impact innovation and growth in the sector.

Recommendations:

- Incorporate or acknowledge EVSE deployment through TCI-region state-level economic development strategy.
- Fund further research and program assessment specific to the TCI region to enable local jurisdictions to make informed decisions about costs and benefits associated with public expenditures for EVSE, and to guide development of public-private partnerships.
- Fund ongoing demonstration programs, particularly those that focus on innovation and new technology.

4.2.4. High-Level Flexibility Creates Meaningful Local Options

EVSE policy and planning should not tie hands at the local level. California's CALGreen is an excellent example of the ability of codes to create a high-level planning framework while retaining flexibility at the local level. Codes ideally provide consistent regulation by making changes at the highest level of government reasonable.

Compliance is a Local Issue

Significantly, a local jurisdiction's codes must comply with state-level legislation, meaning state laws play a central role in establishing the range and impact of local regulatory requirements. Challenges in this arena include the creation of seamless and simple regulations using consistent language in state and local laws that limit code revision necessary to comply.

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[159] James Poisson (Master Electrician, New Hampshire Department of Environmental Services. TCI Regional Stakeholder), phone call, June 29, 2012.
[160] Ibid.

Codes can offer an a la carte menu of options, standardized at the state level but adopted through tiered systems and/or on a voluntary basis by the local jurisdiction. CALGreen, for example, lets jurisdictions prioritize code changes by providing a clear menu of options. Well-written codes may also offer phased provisions or optional parameters, maximizing adoptability and efficacy of local regulations. A pilot phase may precede mandatory enforcement of new code provisions, allowing local governments and other stakeholders to adjust to new requirements.

Outreach is a Local Obligation

In addition, jurisdictions motivated to adopt EVSE-specific codes can take on an advocacy role through local awareness building and outreach about EV benefits. The process of revising model codes at the national and international levels is open to public proposals, and local jurisdictions that have adopted EVSE code modifications have the opportunity to directly influence national EVSE policy through the proposal of changes to national model codes.

Improving upon the existing EV and EVSE knowledge base in many jurisdictions represents an important step for government officials, industry and utility stakeholders and the public. Development of an understanding of how structural codes, permitting processes and zoning ordinances relate both separately and together to EV-ready planning will require awareness building and updated training for installers, inspectors and state and municipal officials. Stakeholders, including interested members of the public, should have equal access to important EV and EVSE information and be permitted to participate in or otherwise approve of local and state-level changes.

Recommendations:

- Adopt code appendices containing voluntary scoping and implementation options, further including code phasing and tiers.
- Make consistent information and technical support available to officials across state and local agencies through the Clean Cities' Coalitions.
- State agencies having jurisdiction should introduce locally vetted modifications to the discussion of national model codes in the next possible code cycle (2015).

EV Readiness: Phasing and Tiers

Voluntary/Mandatory: Requirements included as an optional appendix; voluntary requirements create consistency among jurisdictions that choose to adopt.

Local and Developer Burdens: Code language should be enforceable in the local jurisdiction and not cause undue local burdens.

Tiered Codes: Optional appendices to the building code should be structured with additional options, or tiers, that set standards for increasing levels of participation and enforcement.

Pilot Phases: Test new codes and allow contractors, inspectors and other local stakeholders to develop a knowledge base prior to full enforcement of any new code.

4.2.5. Partnerships Guide Infrastructure Deployment across Boundaries

Successful local plans for EVSE rollout have been comprehensive in scope; because codes are one part of the local regulatory environment, they must work in concert with other legislative rules, economic policies, local planning and regulatory processes. Key factors must be in place to successfully advance policy, legislation and ordinances pertaining to EV infrastructure, and several central themes rise to the top.

Highly significant among these themes is a forum for cooperation. The reduction of barriers to EVSE deployment will not come from code amendments, but rather from the collaborative efforts that can produce such amendments as part of a comprehensive deployment strategy.

Large-scale and multi-agency coalitions and working groups, public-private partnerships and work with academic and research institutions have contributed to a broad-based understanding of intersections among local and regional goals in model jurisdictions. Partnerships are central to comprehensive planning efforts, and academia, utilities, power authorities and a range of government agencies and nonprofit groups should be involved in the planning process regardless of scale.

A key enabler for EV infrastructure deployment and installation is the local electric utility. Utilities are possibly the single most important stakeholder in the EVSE conversation and should be involved extensively. Utility companies can be privately held or public authorities.

The role of the private sector can be just as important as that of the public sector in preparing the region for more comprehensive EVSE deployment. Federal and state funding has been channeled to private infrastructure developers (ECOtality's EV Project, for example) to gather data, test business models and pilot high-visibility EV charging. Private-sector outcomes and developing business models will determine many aspects of EVSE and EV adoption.

Recommendations:

- Enable the creation of special purpose clean energy districts to connect interests and regulatory processes in the TCI region.
- Enable data exchange and access to EV ownership and EVSE installation to improve utility performance and enhance utility involvement in local and regional planning.
- Create and/or engage EVSE working groups housed within the appropriate agency in each state to leverage TCI regional stakeholder information and influence and to promote high-level cooperation.

Special-Purpose Clean Energy Districts

Special-purpose districts are independent governmental units that exist separately from general purpose government districts—states, counties, and municipalities—and deliver public services within that area. Special-purpose districts can cross jurisdictional boundaries, including states if established by interstate compact. They require state enabling legislation. Power, sewer or water authorities are examples of existing special-purpose districts. Incorporation as a special-purpose district provides benefits associated with policy, governance and the ability to tax, in some cases. Special-purpose districts often do not include cities within their bounds, but they can.

Special-purpose districts that work in concert with the electric utilities serving the jurisdictions included within its boundaries could present an opportunity for local areas with little ability to enforce green construction or other voluntary EVSE-specific provisions to enact sustainability measures at a collective scale.

EVSE-focused Clean Energy Districts would accomplish the following:

- Act as independent government units to connect energy goals across the region.
- Provide jurisdictional authority to include/permit/enforce EVSE-related standards across existing lines.
- Bring energy-related infrastructure regulations to areas outside major metros while uniting the work, goals and resources of multiple jurisdictions across boundaries.
- Access shared or collective resources.

New Mexico has created renewable energy financing districts with the purpose of enabling participating property owners to access financing for the installation of renewable energy technology. [3] Washington State allows air pollution control authorities.[4]

The proper level of focus of the special-purpose district would need further exploration. An EVSE-specific special-purpose district could address regional transportation electrification. Or, a clean energy district could provide a wider range of services and planning on behalf of the underlying zones.

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APPENDIX A: CHARGING LEVELS

LEVELS OF CHARGE: DIAGRAMS AND ATTRIBUTES

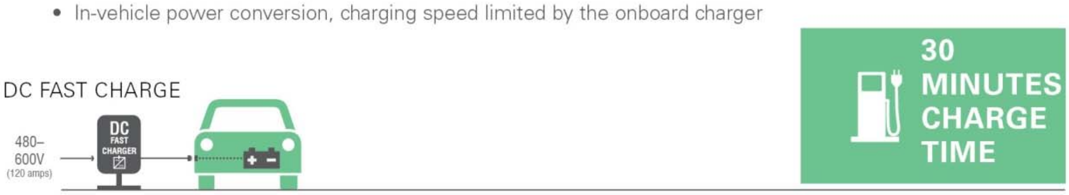
LEVEL 1

- A standard outlet can potentially fully recharge an EV battery in 8–12 hours, though larger batteries, such as on the Tesla Model S, would require between 1 and 2 days
- This level is often sufficient for overnight, home charging
- Standard outlets can also provide an option for "peace of mind" charging using on-board equipment on the go
- Uses standard J1772 coupler
- In-vehicle power conversion

LEVEL 2

- Free-standing or hanging charging station units mediate the connection between power outlets and vehicles
- Requires installation of charging equipment and often a dedicated 20–80 amp circuit, and may require utility upgrades
- Well-suited for in- and out-of-home locations, where cars park for only several hours at a time, or when homeowners seek added flexibility of use and a faster recharge
- The public charging network will comprise primarily Level 2 charging stations
- Public context requires additional design features, such as payment and provider network interfaces or reservation systems
- Uses standard J1772 coupler
- In-vehicle power conversion, charging speed limited by the onboard charger

DC FAST CHARGE



- Free-standing units, often higher profile
- Enable rapid charging of EV battery to 80% capacity in as little as 30 minutes
- Electrical conversion occurs in EVSE unit itself
- Relatively high cost compared to level 2 chargers, but new units on the market are more competitively priced
- Draws large amounts of electrical current, requires utility upgrades and dedicated circuits
- Beneficial in heavy-use transit corridors or public fueling stations
- Standard J 1772 coupler approved October 2012

APPENDIX B: SUMMARY OF EVSE STANDARDS

Organization/Code Text	Standard	Description
Society of Automotive Engineers (SAE)	J1772	Electrical and mechanical aspects of the cord set, references Underwriters Laboratory for safety and shock protection and the National Electrical Code for cord and coupler
	J2293	Electric vehicle (EV) energy transfer system
	J2293-1	Functionality requirements, system architecture
	J2293-2	Communication requirements, system architecture
National Fire Protection Association (NFPA)/National Electrical Code (NEC)	NEC 110.11	Deteriorating agents
	NEC 110.28	Enclosure types
	NEC 110.26	Electrical equipment spacing
	NEC 110.26 (A)(2)	Width of working space
	NEC 110.27 (B)	Guarding of live parts to prevent physical damage
	NEC 210.70 (A) (2)	Lighting outlets required, dwelling units
	NEC 300.4	Protection of conductors against physical damage
	NEC 334.15	Exposed work safety requirements
	NEC 334.30	Securing and supporting nonmetallic sheathed cable
	NEC 625.1-625.5	General instructions for electric vehicle supply equipment (EVSE): scope, definitions, other articles, voltage, listed/labeled
	NEC 625.9 (A-F)	Wiring methods for EV coupler
	NEC 625.13-625.19	EVSE equipment construction
	NEC 625.21-625.26	EVSE control and protection
	NEC 625.28-625.30	EVSE supply equipment locations
	NEC 626	Electrified truck parking spaces
Underwriters Laboratory (UL)	UL 62	Flexible cords and cables: required by NEC 625
	UL 2202	EVSE charging station design and construction
	UL 2231	Charging station shock prevention: grounding and ground fault interruption
	UL 2251	Cord design and safety of plug, cord, receptacle, connectors, load rating
	UL 2594	Charging station safety: off-board equipment supplying power to vehicle

APPENDIX C: OTHER LOCAL PLANNING TOOLS

Local governments have five important tools at their disposal that can be used to more successfully and seamlessly integrate electric vehicle supply equipment (EVSE) into the planning and administration of states, cities and towns. Simply put, these tools will ideally achieve the following through electric vehicle (EV)-focused policies:

- Zoning will require EVSE parking in the private realm.
- Parking will enable EVSE in the public realm.
- Codes will require wiring in parking structures and set standards for safety, operation and administrative processes.
- Permitting changes will streamline the administrative process for private installers of EVSE.
- Procurement and partnerships will build consensus and increase awareness for EVSE deployment.

The tools are summarized below and on the following page.

Zoning	**Determines where and in what fashion EVSE is allowed, incentivized or required** • Establishes allowable uses based on the municipal zoning code • Considers deployment of EVSE within the larger context of planning and land use • Incentive zoning, such as the exchange of development bonuses for the inclusion of EVSE pre-wiring or infrastructure in new development, is a potential area for EVSE deployment, but it remains largely untested • By setting development standards through zoning ordinances, municipalities can use this tool to shape the scope (how many and where) of EVSE deployment
Parking	**Sets the scope and enforcement requirements for parking with state or local laws** • Applies to publicly accessible EVSE, including on-street chargers and units in municipal lots and garages, and is therefore an important part of infrastructure development • Similar to zoning, parking ordinances provide a way to require a certain number or percentage of spaces and to restrict the use of charging stalls to EVs • Unlike zoning, parking ordinances are not tied to new development • Opportunities exist for private parking management

<table>
<tr><td>Codes</td><td>Ensure that EVSE installations are safe, and specify the scope of EVSE-ready construction
Changes to the building and electrical codes are not necessary from a safety standpoint, but they can help make places EV-ready
State and local codes may need to change to meet certain requirements, such as emissions reduction goals. This is an ideal opportunity to incorporate EVSE
Municipalities that are able to adopt their own codes benefit from a highly flexible state code—one that provides different standards for different situations
Building and electrical codes present different EV-ready opportunities</td></tr>
<tr><td>Permitting</td><td>Streamlines the administrative process so that it is uncomplicated, fast and affordable
Updating and streamlining permitting eases implementation of EVSE and reduces fees to the consumer
Permitting is a local administrative process and, as a result, may be a source of fragmentation across the region, evidenced by wide variations in permit fees
Third-party inspection firms offer opportunities for partnership and inspector training throughout the region</td></tr>
<tr><td>Procurement & Partnerships</td><td>Work closely with private or quasi-public partners to implement infrastructure in the public realm
Partnerships include working groups, which can unite government agencies with private industry and experts
Regional planning organizations such as metropolitan planning organizations and councils of government are important for building consensus and getting the word out
Governments can procure EVs for municipal and state fleets to increase awareness and meet sustainability goals
The role of the private sector can be just as, if not more, important in preparing the region for more comprehensive EVSE deployment</td></tr>
</table>

APPENDIX D: CODE LANGUAGE DOCUMENTATION

This section includes examples of building and electrical code amendments relevant to electric vehicle supply equipment (EVSE) installation. Amendments relevant to the case studies are included, along with other representative sample codes from jurisdictions in the United States and Canada.

Sample Building Code Amendments for EVSE

Require sufficient area for electrical infrastructure

Meet Future Increased Capacity Needs: Vancouver Building By-law No. 9936 (2009)

Adopted Code Language:

13.2.1.2 Electrical Room

(1) The electrical room in a multi-family building, or in the multi-family component of a mixed use building, that in either case includes three or more dwelling units, must include sufficient space for the future installation of electrical equipment necessary to provide a receptacle to accommodate use by electric charging equipment for 100% of the parking stalls that are for use by owners or occupiers of the building or of the residential component of the building.

Require a percentage of parking stalls to be pre-wired for EVSE

A strategy to encourage electric vehicle (EV) readiness through the pre-wiring of garages and parking stalls at time of construction for current or future installation of charging stations. The goal is to provide future capability for dedicated EVSE in single- and multifamily homes, as well as commercial locations.

Single-Family Dwellings: Vancouver Building By-law No. 9691 (2008)

Adopted Code Language:

12.2.2.10. Cable Raceway

(1) Each dwelling unit shall have a cable raceway leading from the electricity circuit panel to an enclosed outlet box in the garage or carport.

(2) A raceway not smaller than size 21 shall be provided to accommodate future conductors of a separate branch circuit intended to supply a future receptacle for use with the electric vehicle charging system.

(3) An outlet box for the receptacle referred to in Sentence (2) and approved for the purpose shall be provided in a parking space or parking stall of a storage garage or carport intended for use with the electric vehicle charging system.

(4) The raceway described in Sentence (2) shall be installed between the dwelling unit panel board and the outlet box referred to in Sentence (3).

Multifamily Dwellings: Vancouver Building By-law No. 9936 (2009)

In 2008, the Vancouver City Council enacted new regulations in the city's building code that require a portion of the parking stalls in all new multifamily (three or more units) residential construction to accommodate EV charging. The provisions went into effect in April 2011.

Adopted Code Language:

13.2.1.1. Parking Stalls

(1) Each one of 20% of the parking stalls that are for use by owners or occupiers of dwelling units in a multi-family building that includes three or more dwelling units, or in the multi-family component of a mixed use building that includes three or more dwelling units, must include a receptacle to accommodate use by electric vehicle charging equipment.

Single-Family and Multifamily Dwellings: CALGreen, Green Construction Code (Voluntary)[161]

Adopted Code Language:

A5.106.5.3 Electric vehicle charging. Provide facilities meeting Section 406.7 (Electric Vehicle) of the California Building Code as follows:[162]

A5.106.5.3.1 Electric vehicle supply wiring. For each space required in Table A5.106.5.3.1, provide one 12- VAC 20 amp and one 208/240 V 40 amp, grounded AC outlets or panel capacity and conduit installed for future outlets.

Table A5.106.5.3.1	
Total Number of Parking Spaces	**Number of Required Spaces**
0–50	1
51–200	2
201 and over	4

A4.106.5.4 Electric vehicle (EV) charging. Dwellings shall comply with the following requirements for the future installation of electric vehicle supply equipment (EVSE).

A4.106.6.1 One- and two-family dwellings. Install a listed raceway to accommodate a dedicated branch circuit. The raceway shall not be less than trade size 1. The raceway shall be securely fastened at the main service or subpanel and shall terminate in close proximity to the proposed location of the charging system into a listed cabinet, box or enclosure…

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[161] "Revision Record for the State of California – Supplement" in *2010 California Green Building Standards Code*, Title 24, Part 11 (July 1, 2012), www.iccsafe.org/cs/codes/Errata/State/CA/5570S1002.pdf.

[162] The California Building Code sets out definitions of EVs and installation requirements for ventilation and electrical systems. The code can be found here: https://law.resource.org/pub/us/code/bsc.ca.gov/gov.ca.bsc.2012.02.1.html.

Exception: Other pre-installation methods approved by the local enforcing agency that provide sufficient conductor sizing and service capacity to install Level 1 EVSE.

Note: Utilities and local enforcing agencies may have additional requirements for metering and EVSE installation, and should be consulted during the project design and installation.

A4.106.6.1.1 Labeling requirement. A label stating "EV CAPABLE" shall be posted in a conspicuous place at the service panel or subpanel and next to the raceway termination point.

A4.106.6.2 Multifamily dwellings. At least 3 percent of the total parking spaces, but not less than one, shall be capable of supporting future electric vehicle supply equipment (EVSE)

A4.106.6.2.2 Multiple charging spaces required. When multiple charging spaces are required, plans shall include the location(s) and type of the EVSE, raceway method(s), wiring schematics and electrical calculations to verify that the electrical system has sufficient capacity to simultaneously charge all the electrical vehicles at all designated EV charging spaces at their full rated amperage. Plan design shall be based upon Level 2 EVSE at its maximum operating ampacity. Only underground and related underground equipment are required to be installed at the time of construction.

Required Parking Stalls: Hawaii Senate Bill No. 2747 Relating to Electric Vehicle Parking (2012)[163]

Language of the Adopted Act:

Section 2. Section 291-71, Hawaii Revised Statues, is amended to read as follows:

"291-71 Designation of parking spaces for electric vehicles; charging system.

a) Places of public accommodation with at least one hundred parking spaces available for use by the general public shall have at least one parking space near the building entrance designated exclusively for electric vehicles and equipped with an electric vehicle charging system by July 1, 2012. Spaces shall be designated, clearly marked, and the exclusive designation enforced. Owners of multiple parking facilities within the State may designate and electrify fewer parking spaces than required in one or more of their owned properties; provided that the scheduled requirement is met for the total number of aggregate spaces on all of their owned properties."

Provide flexible, tiered voluntary appendices in the state building code

The California Green Construction Code (2010 edition) includes the following sections, providing for a tiered system of options for local jurisdictions that choose to adopt and enforce codes specific to low-emission vehicles and for EVSE.

[163] "SB2747 SD1 HD2," Hawaii State Legislature, accessed October 24, 2012, http://www.capitol.hawaii.gov/measure_indiv.aspx?billtype=sb&billnumber=2747.

Adopted Code Language: CALGreen Green Construction Code[164]

A5.106.5.1 Designated parking for fuel-efficient vehicles. Provide designated parking for any combination of low-emitting, fuel-efficient and carpool/van pool vehicles as shown in Table A5.106.5.1.1 or A5.106.5.1.2.

Provide 10 percent of total designated parking spaces for any combination of low-emitting, fuel-efficient and carpool/van pool vehicles as follows:

Table A5.106.5.1.1 Tier 1 10% of Total Spaces	
Total Number of Parking Spaces	**Number of Required Spaces**
0–9	0
10–25	2
26–50	4
51–75	6
76–100	9
101–150	11
151–200	18
201 and over	At least 10% of total

Table A5.106.5.1.2 Tier 2 10% of Total Spaces	
Total Number of Parking Spaces	**Number of Required Spaces**
0–9	1
10–25	2
26–50	5
51–75	7
76–100	9
101–150	13
151–200	19
201 and over	At least 12% of total

[164] California Building Standards Commission, *2010 California Green Building Standards Code* (Sacramento, CA: California Building Standards Commission, January 1, 2011), www.documents.dgs.ca.gov/bsc/CALGreen/2010_CA_Green_Bldg.pdf.

Write local codes to include multifamily and commercial installation scenarios in addition to single-family scenarios.

Sunnyvale, California[165]

Adopted Code Language:

Building Division Requirements

An electrical permit is required for installation of electric vehicle chargers…

New Residential Construction

- Garages/carports attached to individual dwelling units (typically single-family detached and townhouses) shall be pre-wired for a Level 2 electric vehicle charger.
- Shared parking facilities (typically condominiums and apartments) shall have 12.5% of the required spaces pre-wired for Level 2 electric vehicle chargers.

Non-Residential and Multi-Family Requirements

- The electric vehicle charging spaces may be counted towards the number of required low-emitting/fuel efficient parking in the CALGreen or LEED, as applicable.
- A sign shall be posted at the electric vehicle charging spaces stating "Electric Vehicle Charging Only."

Accessibility Requirements (CBC Chapter 11B)

- In each group of charging stations, one space shall be provided with an accessible loading area (a minimum of 5' wide and 18' in length and striped). These spaces do not need to include signage dedicating them for disabled access use. These spaces shall not be counted as accessible parking spaces, as required by California Building Code.
- Operational controls and receptacles for the charging station controls (i.e. on/off buttons, payment readers, etc.) shall be located between 15" and 48" from finished floor/grade.

Create a more stringent municipal code

For municipalities having jurisdiction, the ability to develop their own or choose voluntary measures provided by the state to create more stringent standards for EVSE may be a good opportunity. In 2011, Los Angeles adopted provisions of the Green Building Code into its municipal code. The city adopted as mandatory provisions of CALGreen, adapting the provisions to require a slightly-higher-than-Tier-1 level of compliance.

Los Angeles Municipal Code (2010)[166]

Adopted Code Language:

99.04.106.6. Electric Vehicle Supply Wiring

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[165] http://sunnyvale.ca.gov/Portals/0/Sunnyvale/CDD/Residential/Electrical%20Car%20Chargers.pdf.
[166] City of Los Angeles Ordinance No. 181480 (December 15, 2010), http://ladbs.org/LADBSWeb/LADBS_Forms/PlanCheck/2011LAAmendmentforGreenBuildingCode.pdf.

1. For one- or two-family dwellings and townhouses, provide a minimum of:
   a. One 208/240 V 40 amp, grounded AC outlet, for each dwelling unit; or
   b. Panel capacity and conduit for the future installation of a 208/240 V 40 amp, grounded AC outlet, for each dwelling unit.

The electrical outlet or conduit termination shall be located adjacent to the parking area.

2. For other residential occupancies where there is a common parking area, provide one of the following:
   a. A minimum number of 208/240 V 40 amp, grounded AC outlets equal to 5 percent of the total number of parking spaces. The outlets shall be located within the parking area; or
   b. Panel capacity and conduit for future installation of electrical outlets. The panel capacity and conduit size shall be designed to accommodate the future installation, and allow the simultaneous charging, of a minimum number of 208/240 V 40 amp, grounded AC outlets, that is equal to 5 percent of the total number of parking spaces. The conduit shall terminate within the parking area; or
   c. Additional service capacity, space for future meters, and conduit for future installation of electrical outlets. The service capacity and conduit size shall be designated to accommodate the future installation, and allow simultaneous charging, of a minimum number of 208/240 V 40 amp, grounded AC outlets, that is equal to 5 percent of the total number of parking spaces. The conduit shall terminate within the parking area.

When the application of the 5 percent results in a fractional space, round up to the next whole number.

Article 9, Division 5: For Newly Constructed Nonresidential and High-Rise Residential Buildings

99.05.106.5.2 Designated Parking. Provide designated parking, by means of permanent marking or a sign, for any combination of low-emitting, fuel-efficient, and carpool/van pool vehicles as follows:

Table 5.106.5.2 Tier 2 10% of Total Spaces	
Total Number Of Parking Spaces	**Number Of Required Spaces**
0–9	0
10–25	1
26–50	3
51–75	6
76–100	8
101–150	11
151–200	16
201 and over	At least 12% of total

99.05.106.5.3.1. Electric Vehicle Supply Wiring. Provide a minimum number of 208/240 V 40 amp, grounded AC outlet(s), that is equal to 5 percent of the total number of parking spaces, rounded up to the next whole number. The outlet(s) shall be located in the parking area.

Article 9 Division 12: Voluntary Measures for Newly Constructed Nonresidential and High-Rise Residential Buildings

A5.106.5.3.2. Additional Electric Vehicle Supply Wiring. Provide a minimum number of 208/240 V 40 amp, grounded AC outlet(s), that is equal to ten percent, rounded up to the next whole number, of the total number of parking spaces.

Sample Electrical Code Amendments for EVSE

Amend the state electrical code to streamline the permitting process

The Oregon Building Codes Division started developing administrative rules to streamline permit and inspection protocol for the installation of EVSE within the state. The language of the rule below applies to levels 1 and 2 charging.

Oregon Electric Vehicle Charging Station Statewide Permit and Inspection Protocol, 918-311-0065[167]

To ensure a path for the emerging technology and enable the installation of charging stations for electric vehicles, the following permit and inspection protocols will apply throughout the state, notwithstanding contrary provisions contained in the Oregon Electrical Specialty Code.

(1) Building officials and inspectors shall permit and allow installation of an electric vehicle charging station that has a Building Codes Division's special deputy certification label without further testing or certification.

(2) Persons installing an electric vehicle charging station must obtain a permit for a feeder or branch circuit from the inspecting jurisdiction. No other state building code permit is required.

(3) The jurisdiction may perform up to two inspections under the permit issued in subsection (2) above.

(4) Inspection of the installation is limited to examining the feeder or branch circuit for compliance with the following Oregon Electrical Specialty Code provisions:

(a) Overcurrent protection, per articles 225 and 240;

(b) Physical protection of conductors, per article 300;

(c) Separation and sizing of the grounding and neutral conductors, per article 250.20;

(d) Provisions for locking out the breaker for maintenance, per chapter 4.

(5) For the purpose of this rule, the service, feeder or branch circuit, and charging station pedestal will be considered a single structure as defined by the Oregon Electrical Specialty Code. The structure's owner may opt to install a grounding

[167] Electric vehicle charging station installation amendment Stat. Auth: ORS 455.065.

electrode system to supplement lightning protection, but cannot be required to do so.

(6) An electrical contractor employing a general supervising electrician in accordance with OAR 918-282-0010 is authorized to use a minor installation label to install a new branch circuit limited to 40 amps 240 volts for the purpose of installing a wall mounted Electric Vehicle Supply Equipment (EVSE) unit in the garage of one and two family dwellings, and connect a listed wall mounted EVSE unit to that branch circuit. The electrical panel where the circuit originates must be in the garage within sight from the EVSE unit. This provision does not apply to installations in wet or damp locations.

Amend the municipal electrical code

Seattle, Washington

In Seattle, Washington, the 2008 edition of the city's adopted version of the electrical code identified and added some notable changes specific to EVs, with the purpose of making it easier to install home and commercial EVSE. The Seattle Electrical Code (SEC) adds article 625.27 to address required space for physical equipment and space planning in order to install future conduit, panel and disconnect for EVSE. In addition, provisions in the SEC address outlet load calculations for residential EVSE, as well as feeder and conduit specifications for multifamily residential occupancies. Seattle's electrical code modifications speak to the potential to utilize a jurisdiction's electrical codes to meet localized market demands and projections; the city was planning ahead in the 2008 code edition to account for EVSE installation once the first Nissan LEAF vehicles hit the Seattle market in 2010.[168] Article 625.27 of the SEC may offer best practice guidance to local jurisdictions seeking to plan in advance for EVs, and may also inform the National Fire Protection Association's next revision of the national model electrical code. The full SEC is available online.[169]

<u>Adopted Code Language</u>

ARTICLE 625, Electric Vehicle Charging System

625.27 Requirements for Future Installation of Outlets.

To facilitate future installation of electric vehicle outlets in residential occupancies, the following shall be provided:
(1) Space shall be reserved in the electrical service equipment for installation of an overcurrent protective device to serve electric vehicle charging system branch circuits.
(2) A location shall be designated, together with the required working clearances, for the electric vehicle charging system panelboard.
FPN No. 1: See also 220.57, Electrical Vehicle Outlets, for calculating demand loads.
FPN No. 2: Consideration of the location of the future electric vehicle outlets is recommended when designating a location for the electric vehicle outlet panelboard.
FPN No 3: Residential occupancies are defined in Chapter 3 of the Seattle Building Code.

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[168] "Plug-In Electric Vehicles" (Seattle, WA: City of Seattle, n.d.), https://www.seattle.gov/environment/documents/Electric%20Vehicles%20FAQ_Update_070511.pdf.
[169] Department of Planning and Development, *2008 Seattle Electrical Code Quick Reference*, Ordinance 122970 (Seattle, WA: City of Seattle, June 5, 2009), http://www.seattle.gov/dpd/static/2008%20qr%20complete_latestreleased_dpdp016577.pdf.

Appendix D

Electric Vehicle Infrastructure Council

Permit Streamling Outreach Summary

Appendix D – Permit Streamlining Outreach Process

Permitting Electric Vehicle Charging Stations in Maryland

The legislation establishing EVIC directed the Council to "assist in developing and coordinating statewide standards for streamlined permitting and installation of residential and commercial EV charging stations and supply equipment." In Maryland, electrical permitting is handled by the local governments. Each jurisdiction has established its own permitting requirements and application forms.

To fulfill its charge, the Facilities Workgroup scheduled a series of regional discussion sessions with the Chief Electrical Inspectors from each county, as well as Baltimore City and several other independently incorporated municipalities. These meetings were helpful to the Council in developing an understanding of the current Electric Vehicle Charging Station (EVCS) permit process, the level of EVCS permitting activity in each of the local jurisdictions and existing or potential challenges or barriers to a streamlined permitting process, as well as in soliciting recommendations for changes to the permit process that would facilitate streamlined EVCS permitting.

The Council followed up on these regional meetings with an on-line survey distributed to representatives of each of the local jurisdictions to solicit information on the local government electrical permit process. A more detailed discussion of the survey questions and responses is set forth below. The actual survey questions and responses are attached to this Report as Appendix F.

As explained below, based on its outreach to the electrical inspectors in the local permitting jurisdictions and the survey responses, the Council has concluded that there are no significant existing barriers to permitting of EVCS in the State, and thus, makes no recommendations for changes to the current permitting processes.

The Existing Permit Process

In General. The number of EVCSs permitted State-wide to date has been relatively small. This is not surprising, given the small number of plug-in electric vehicle owners in Maryland at the time of this effort. Across the State, electrical permits for Level I and Level II charging stations are subject to the same permitting requirements that apply to installation of other 110 or 240 volt wiring and equipment. No jurisdiction has adopted any special conditions or restrictions that apply to EV charging stations.

In all jurisdictions, electrical permit applications may be submitted in person. On-line application submittal is available in a growing number of local jurisdictions. In most cases, approval to begin work can be issued on the same day the application is received. The permit turnaround time for applications with site plan reviews may be slightly longer, up to several days. In the case of most jurisdictions, inspections can also be completed on the same or next business day following the request.

The Survey. The Facilities Workgroup developed a survey for the electrical inspection representatives to help document the information heard at the regional meetings and to explore several areas of interest. The survey solicited a broad range of information from the electrical inspectors in each of the local permitting authorities on EVCSs, including the number of EVCS applications received in 2011, the current permitting process for EVCSs, processing times, typical installation costs, permit fees and problems or concerns with EVCS installations.

The survey was administered on-line by Zarca Interactive Inc ®, of Herndon, VA and was available from March 20, 2012 through April 20, 2012 and links were provided to the jurisdiction representatives in the regional meetings. A follow-up request was provided mid-way through the open survey period to encourage participation and responses. Fourteen responses were received at the survey close, representing half the invited participants. It is recognized that there were opportunities for multiple responses from a single jurisdiction, but it is felt that these did not bias the conclusions as the potential was recognized and considered as the responses were analyzed.

Summary of Survey Findings:
The survey responses affirmed the conclusions from the regional meetings. Generally:

- Current charging station installation activity levels are fairly low throughout the state, and the activity has been both residential and commercial sectors.
- All jurisdictions offer an in-person application process and several offer an on-line process. The turnaround time for most applications that do not involve a building site plan is typically within 24 business hours. Applications including a site plan review may take from 1 to 3 business days.
- When the work is complete, the installing electrician contacts the inspection office for an inspection for approval. The majority of the inspections from the requests are completed within the next business day; those with longer turnaround times may be 1 to 3 business days.
- Applications for EV Charging Equipment and wiring installations are not considered or treated differently from similar residential or commercial electrical installation work.
- The respondents were supportive of the idea to provide electric utilities with early notification of applications involving EV charging work. However, it is recognized there

may be little opportunity for real benefit with the very short turnaround time between permit application and completion of work,

There were several opportunities for the respondents to provide open ended comments. Key takeaways from those comments are noted below:

Electrical Inspectors are not seeing any new or unique problems with the installation of EV charging equipment. Problems have been few to date and are similar to those seen in other electrical work (work without a permit, work not to Code). There is a concern among the inspectors that the EV charger installations have appropriate protection from being hit and damaged by moving vehicles.

The respondents offered several suggestions for improving the permitting or installation process. They include:

- Making sure consumers are aware of the need to use licensed and qualified electricians to perform the installation work, and that a permit is required.
- Making sure consumers, and their electricians, are well aware of the requirements and, in particular, any code requirements specific to EV charging, like ventilation for the space where charging takes place.
- One respondent suggested the jurisdiction could offer reduced permit fees for green or energy saving devices as an incentive to support energy efficiency and sustainability.
- One respondent also suggested the cords be placed in the vehicles instead of being left hanging on the EV charging station (a vehicle design issue)

The respondents identified concerns relating to multi-unit dwellings and commercial sites:

- Concerns with cords going over public sidewalks in multi-family parking areas (safety)
- Protecting the charging equipment from vehicle damage
- Parking assignment issues
- Concerns with (restrictions or added requirements of) zoning and historical district areas.
- Load and circuit sizing and potential to overload existing panels or services. Suggest load studies may be necessary.

Respondents suggested the MD EVIC could provide broad scale training on EV charge installation topics. They also recommended the EVIC avoid making any State-wide requirement that could complicate the process.

Summary:
The respondents were very open and helpful throughout the regional meetings and survey participation and the participation and input is highly appreciated. The Workgroup learned the EV charging equipment is handled in the same manner as similar residential and commercial wiring and equipment installations. The permit processes are similar throughout the state, well known and do not include any special requirements or considerations for EV charging equipment. The inspectors felt that an educational effort could help inform residents of the need to use qualified installers and for building permits and to reinforce the consideration of safety in the design and installations (i.e. traffic protection).

Based on the survey findings and on the regional meeting discussions, the Facilities Workgroup does not recommend any change to the permitting processes at this time.

Proposal to Consider Providing Early Notification to Utilities on EVCS Installation Applications:
Currently, electricity utilities receive notice of the installation of EVCSs following the electrical inspection and certification. Members of the Council representing BGE and PEPCO, the State's two largest electricity suppliers, have expressed a need for the earliest possible notification of applications for EVCSs in order to ensure adequate and reliable electricity service. While this is not currently an issue, as the number of EV charging stations increases to service a growing number of plug-in EV owners, localized system reliability problems could develop due to demand on the system. However, because the period between the time when a contractor submits an electrical permit application and completion of the work is so short, the Council does not see much value added by requesting local government inspection offices to send copies of all applications for EVCSs to the electricity suppliers prior to issuance of the certificates.

Guidance to Local Governments, Electrical Inspectors and Consumers

Local permitting agencies and electrical inspectors would benefit from training and information on applicable electrical and other building code standards (e.g., traffic protection, signage, spacing, Americans with Disabilities Act requirements) to assist with review of EVCS installations. In addition, consumers would benefit from outreach and education on safe installation of EVCSs, particularly since a number of jurisdictions allow qualified homeowners to perform installations in their own homes. Finally, local governments would benefit from information on any available grant or other incentive programs that could offset costs associated with installation of EVCSs.

Appendix E

Electric Vehicle Infrastructure Council

Electrical Inspector Survey

Appendix E

Maryland EV Infrastructure Council

Facilities Working Group

Permitting Issues: Survey of Chief Electrical Inspectors

Background:

Participants in the MD EVIC Regional meetings with Chief Electrical Inspectors were surveyed to document their perspectives on questions important to understanding the permitting process and any issues associated with the installation of EV charging equipment in Maryland. The survey was conducted from March 20, 2012 through April 20, 2012. The survey was administered on-line through Zarca Interactive Inc. ®

The survey link was sent to 28 potential respondents representing all major jurisdictions across Maryland. Completed surveys were received from 14 respondents.

Survey responses were highly consistent with the discussions and comments noted at the various regional meetings. The specific questions and responses are included below.

Jurisdictions participating in the regional meetings and invited to participate in the survey include:

Anne Arundel County
Baltimore County
Calvert County
Calvert County
Carroll County (multiple)
Cecil County
Charles County
City of Annapolis
City of Baltimore
City of Frederick
City of Hagerstown
City of Rockville
Eastern Shore Counties (Caroline, Dorchester, Kent, Queen Anne's, Talbot, Wicomico, Worchester)
Frederick County
Gaithersburg (multiple)
Harford County
Howard County
Allegany & Garrett (MDIA)
Montgomery County (multiple)
Prince Georges County
St Mary's County & LaPlata
Town of Easton
Washington County

Survey Questions and Responses:

Q1. How many Electric Vehicle (EV) Charging Equipment related applications has your jurisdiction received beginning in 2011 through February 2012?			
Responses	**Count**	**%**	**Percentage of total respondents**
None	1	7%	
5 or less	7	50%	
6 to 10	2	14%	
More than 10	2	14%	
Don’t Know	2	14%	
(Did not answer)	0	0%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q2. How many have been for residential installations?			
Responses	**Count**	**%**	**Percentage of total respondents**
None	4	29%	
5 or less	6	43%	
6 to 10	0	0%	
More than 10	0	0%	
Don’t Know	0	0%	
(Did not answer)	4	29%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q3. How many have been for multi-family installations?			
Responses	**Count**	**%**	**Percentage of total respondents**
None	9	64%	
5 or less	1	7%	
6 to 10	0	0%	
More than 10	0	0%	
Don’t Know	0	0%	
(Did not answer)	4	29%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q4. How many have been for commercial and institutional installations?			
Responses	**Count**	**%**	**Percentage of total respondents**
None	2	14%	
5 or less	5	36%	
6 to 10	2	14%	
More than 10	1	7%	
Don’t know	0	0%	
(Did not answer)	4	29%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q5. What is the current process for EV charger related permit applications? (Select all that apply.)			
Responses	**Count**	**%**	**Percentage of total respondents**
In person, paper application required	13	93%	
On-line application	5	36%	
Call-in inspection	11	79%	
On-line inspection requests	3	21%	
Other (please specify)	1	7%	
(Did not answer)	0	0%	
Total Responses	**33**		**20% 40% 60% 80% 100%**
Multiple answers per participant possible. Percentages added may exceed 100 since a participant may select more than one answer for this question.			

Q6. Are applications for EV charging equipment considered any differently from similar electrical work? (Example: a 240 volt outlet installation)			
Responses	**Count**	**%**	**Percentage of total respondents**
Yes	0	0%	
No	14	100%	
(Did not answer)	0	0%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Question 7

Question 7 asked for further comment if Question 6 was answered “yes”. Since all responses were “no”, there were no responses for Question 7.

Q8. What is the typical timeframe for processing the application from time of application to authorization to start work?			
Responses	**Count**	**%**	**Percentage of total respondents**
Less than 24 business hours	11	79%	
1 – 3 work days	1	7%	
One week	0	0%	
Longer than a week	1	7%	
Other (please specify)	1	7%	
(Did not answer)	0	0%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q9. What is the typical timeframe from time of work completion and inspection request to inspection/approval times?			
Responses	**Count**	**%**	**Percentage of total respondents**
Less than 24 business hours	10	71%	
1 – 3 work days	4	29%	
One week	0	0%	
Longer than a week	0	0%	
(Did not answer)	0	0%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) specific to RESIDENTIAL INSTALLATIONS?			
Q10. Select one option for each.			
10. Select one option for each.			
(a). 120 Volt Outlet or GFCI outlet for Level 1 charging			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	4	29%	
Between $50 and $100	8	57%	
Over $100 but less than $250	1	7%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) specific to RESIDENTIAL INSTALLATIONS?			
Q10. Select one option for each.			
10. Select one option for each.:			
(b). Installation of Electric Vehicle Charging Equipment or unit on an existing 240 volt circuit and wiring (no panel work involved)			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	4	29%	
Between $50 and $100	8	57%	
Over $100 but less than $250	1	7%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) specific to RESIDENTIAL INSTALLATIONS?			
Q10. Select one option for each.			
10. Select one option for each.:			
(c). Electric Vehicle Charging Equipment or unit installation with new 240 volt wiring to panel and new breaker in panel (no other panel work involved).			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	3	21%	
Between $50 and $100	9	64%	
Over $100 but less than $250	1	7%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) specific to RESIDENTIAL INSTALLATIONS?			
Q10. Select one option for each.			
10. Select one option for each.:			
(d). Electric Vehicle Charging Equipment or unit installation with new 240 volt wiring to panel, new breaker in panel and panel upgrade or sub-panel installation involved.			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	0	0%	
Between $50 and $100	7	50%	
Over $100 but less than $250	6	43%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) specific to RESIDENTIAL INSTALLATIONS?			
Q10. Select one option for each.			
10. Select one option for each.:			
(e). Electric Vehicle Charging Equipment or unit with new 240 volt wiring, new breaker, and panel upgrade or sub-panel installation and increase to service entrance wiring.			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	0	0%	
Between $50 and $100	3	21%	
Over $100 but less than $250	9	64%	
Over $250	1	7%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) related to COMMERCIAL INSTALLATIONS?			
Q11. Select one option for each.			
11. Select one option for each.:			
(a). 110 Volt Outlet or GFCI outlet for Level 1 charging			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	3	21%	
Between $50 and $100	7	50%	
Over $100 but less than $250	3	21%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) related to COMMERCIAL INSTALLATIONS?			
Q11. Select one option for each.			
11. Select one option for each.:			
(b). Electric Vehicle Charging Equipment or unit on an existing 240 volt circuit and wiring (no panel work involved)			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	3	21%	
Between $50 and $100	7	50%	
Over $100 but less than $250	3	21%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) related to COMMERCIAL INSTALLATIONS?			
Q11. Select one option for each.			
11. Select one option for each.:			
(c). Electric Vehicle Charging Equipment or unit installation with new 240 volt wiring to panel and new breaker in panel (no other panel work involved)			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	3	21%	
Between $50 and $100	7	50%	
Over $100 but less than $250	3	21%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) related to COMMERCIAL INSTALLATIONS?			
Q11. Select one option for each.			
11. Select one option for each.:			
(d). Electric Vehicle Charging Equipment or unit installation with new 240 volt wiring to panel, new breaker in panel and panel upgrade or sub-panel installation involved			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	0	0%	
Between $50 and $100	4	29%	
Over $100 but less than $250	8	57%	
Over $250	1	7%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) related to COMMERCIAL INSTALLATIONS?			
Q11. Select one option for each.			
11. Select one option for each.:			
(e). Electric Vehicle Charging Equipment or unit with new 240 volt wiring, new breaker, and panel upgrade or sub-panel installation and increase to service entrance wiring			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	0	0%	
Between $50 and $100	4	29%	
Over $100 but less than $250	7	50%	
Over $250	2	14%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

What are the approximate or typical costs of EV related applications for electrical work (electrical work only) related to COMMERCIAL INSTALLATIONS?			
Q11. Select one option for each.			
11. Select one option for each.:			
(f). Inspection, re-inspection visits			
Responses	**Count**	**%**	**Percentage of total respondents**
$50 or less	8	57%	
Between $50 and $100	4	29%	
Over $100 but less than $250	1	7%	
Over $250	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q12. Does the fact that the work is associated with Electrical Vehicle Charging have any impact on the cost of the permit as compared to similar wiring and outlet installations?

Responses	**Count**	**%**	**Percentage of total respondents**
Yes	0	0%	
No	13	93%	
Don't know	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q13. Have there been any problems or concerns with EV charging station installations of which you are aware?			
Responses	**Count**	**%**	**Percentage of total respondents**
Yes	4	29%	
No	10	71%	
Don't know	0	0%	
(Did not answer)	0	0%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Q14. Please provide a brief description of any problems or concerns with EV charging station installations.

- Protection of equipment when installed on open parking lots
- Physical protection of equipment and designated parking areas
- Work starting without permits, coordination with electric provider

Q15. Do you have any suggestions or best practices to streamline the permitting or installation process, or to help ease consumer concerns or confusion?

- Consumers also need to be aware of any additional requirements for their specific application such as if venting for the charging units is required and how this will be accomplished. Electricians also need to be aware of the requirements.
- Place the cords in the vehicles instead of the charging stations
- Make sure that homeowners are aware that these systems need to be installed by licensed electrician, have MDE assist local agencies by supplying information to the public noting that a local electrical permit is required
- The jurisdiction could offer reduced permit fees for green or energy saving devices.

Q16. Do you have any suggestions for building code revisions that would streamline and reduce costs for the installation process?

- Make sure the installation does not impede or reduce the ADA, handicapped parking, spaces or egress to and from building or structure.

Q17. Please identify any installation or permitting issues that are particular to multi-unit dwellings or commercial sites.

- We do have concerns with cords going over public sidewalks in multifamily parking areas
- Protection of equipment from vehicular damage, cables crossing pedestrian walkways, parking assignment issues
- The load consumption, especially the 30 or 40 amp stations could overload the existing panel or service. Load study or summary may be necessary.
- Zoning concerns associated with multi-family installation, site design issues, community covenant issues
- Parking spaces, protection metering and load demand
- There could be issues with zoning ordinances and historical areas.

Q18. Is the aforementioned notification process a workable proposal?

Responses	Count	%	Percentage of total respondents
Yes	12	86%	
No	2	14%	
(Did not answer)	0	0%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

Note Q19 asked if there were any concerns with the proposal:

Q19. Please comment on your concerns.

- Presently there is no procedure in place to advise the utility of additional high-load appliances such as hot tubs, ovens, air conditioners, or building additions, etc. The placement of a charging station does not necessarily indicate the presence of an additional load...only the possibility of one.

Q20. Please provide any alternate ideas for approaching the utility notification process in a customer friendly and effective manner.

- With the understanding that this work will begin as soon as the permit is issued and for us that is within 24 hours.
- Power company needs to supply a work order number

Q21. Please provide any questions you have for the Maryland Electric Vehicle Infrastructure Council and Facilities workgroup.

- How do fire fighters approach electric vehicles involved in an accident?

Q22. Please provide feedback about how the Maryland EVIC can help you with any EV issues.

- Recommend broad scale training
- Avoid creating any State-wide requirement that could complicate the EV process

Q23. For classification purposes, please select the jurisdiction you represent.			
Responses	**Count**	**%**	**Percentage of total respondents**
Anne Arundel County	0	0%	
Baltimore County	1	7%	
BGE	0	0%	
Calvert County	0	0%	
Carroll Cty	0	0%	
Cecil County	0	0%	
Charles County	1	7%	
City of Annapolis	0	0%	
City of Frederick	0	0%	
City of Hagerstown	2	14%	
City of Rockville	1	7%	
Cty of Baltimore	1	7%	
Eastern Shore Counties (Caroline, Dorchester, Kent, Queen Anne's, Talbot, Wicomico, Worchester)	1	7%	
Frederick County	0	0%	
Gaithersburg	2	14%	
Harford County	0	0%	
Howard County	1	7%	
MDIA - Garrett & Allegany	1	7%	
Montgomery County	0	0%	
PG County	0	0%	
St Mary's & LaPlata	1	7%	
Town of Easton	0	0%	
Washington County	1	7%	
Other (please specify)	0	0%	
(Did not answer)	1	7%	
Total Responses	**14**		**20% 40% 60% 80% 100%**

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Appendix F

Electric Vehicle Infrastructure Council

Members

Appendix F

Electric Vehicle Infrastructure Council Membership	**Name**	**Position/Affiliation**
Academic Community; Maryland institution of higher education with expertise in energy, transportation, or the environment	Z. Andrew Farkas, Ph.D.	Director and Professor for National Transportation Center at Morgan State University
Maryland Association of Counties; rural region	Robert N. Rollins, Jr.	Division Chief, Fleet Maintenance & Management, Calvert County Government
Maryland Association of Counties; urban or suburban region	Theodore Atwood,	Director, General Services, Baltimore City Government
Maryland Municipal League; rural region	Hon. Kelly M. Russell	Alderman for City of Frederick
Maryland Municipal League; urban or suburban region	Daryl Braithwaite	Public Works Director, City of Takoma Park
Baltimore Electric Vehicle Initiative	Jill Sorensen	Baltimore Electric Vehicle Initiative
Electric Companies	John J. Murach, Jr.	BGE
	William M. Gausman	PEPCO
Electric Vehicle Manufacturer	Jim Kiley	Regional Director, State Relations for General Motors
Electric Vehicle Charging Station Manufacturer	Colleen Quinn	VP Government Relations, Coulomb Technology
Fleet Vehicle Operator	Gary Anderson	PHH
Electrical Workers	M. Nolan Duncan, Jr.	Generator Sales and Project Manager, Holt Electrical Contractors
Environmental Community	Scott Wilson	Electric Vehicle Association of Washington DC
Public; with expertise in energy or transportation policy	Steven Arabia	Government Relations Manager, NRG Energy, Inc.
Maryland Automobile Dealers Association	Marisa Shockley	President of the Maryland Automobile Dealers Assn. (Shockley Honda)
Retail Electric Supplier Community	Gary Skulnik	Co-founder of Clean Currents, LLC
Senators	Senator Robert Garagiola	
Delegates	Delegate James Malone	
	Delegate Brian McHale	
Acting Secretary of Transportation	Darrell Mobley	Chair
Maryland Department of Planning	Bihui Xu	
Deputy Secretary of the Environment	Kathy Kinsey	
Secretary of Business and Economic Development	Christian S. Johansson	
Executive Director of the Technical Staff of the Maryland Public Service Commission	Ralph DeGeeter Matthew Mansfield	
Director of the Maryland Energy Association	Chris Rice Fred Hoover	