ELECTRIC VEHICLES IN METROPOLITAN WASHINGTON

Understanding the Region's Current EV Readiness and Options for Expanding Their Use

Metropolitan Washington
COUNCIL OF GOVERNMENTS

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The participants in MWCOG's regional electric vehicle readiness initiative who contributed to this report represent numerous and diverse stakeholder entities, which may be impacted in different ways by state-specific policies and regulatory rules. Given the disparate nature of policies and regulatory rules in the MWCOG region, no participant should be deemed to endorse or support all of the conclusions or recommendations contained in this report.

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EXECUTIVE SUMMARY

This report seeks to provide a framework for establishing a regional readiness plan for the deployment of electric vehicles (EVs) in the metropolitan Washington region. While total EV ownership in the region is relatively low (compared with other cities such as Portland, Oregon, or Los Angeles), consumer interest in EVs is growing and more EV models are being introduced in the regional market. However, the metropolitan Washington region's charging infrastructure and EV policy frameworks are not yet positioned to accommodate greater market penetration of these vehicles. This report contains recommendations for stakeholders to promote a consistent set of practices across the region that will remove barriers to EV adoption and infrastructure planning while mitigating potential impacts on the electrical grid. This coordinated planning effort will help ensure that the region can receive the health, environmental, and sustainability benefits that EV technology offers.

BENEFITS OF EV DEPLOYMENT

EV adoption presents environmental, economic, and energy security benefits to the country and to the region. The U.S. Department of Energy (DOE) sees the electrification of vehicles as one of the highest impact strategies for reducing greenhouse gas emissions between now and 2030.[1] Due to the relatively low greenhouse gas emissions profile of the Washington region's electrical grid, EVs charged in most parts of the region produce fewer greenhouse gasses than any currently available hybrid vehicle (equivalent to 50 mpg or greater).[2] And as renewable portfolio standards and other policies increase the proportion of low- and no-emissions electricity available on the grid, the environmental impact of EVs will continue to improve.

EVs can play an important role in achieving the region's air quality goals by reducing vehicle emissions. In the metropolitan Washington region, transportation emissions accounted for 55 percent of NOx emissions and 16 percent of fine particle ($PM_{2.5}$) emissions in 2007. Because EVs produce no tailpipe emissions, they are good candidates to help significantly reduce pollution from mobile sources.

[1] U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. *Vehicle Technologies Program Multi-Year Program Plan (2011-2015).* http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf

[2] Union of Concerned Scientists. *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States.* Rev. April 12, 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html

EVs also offer economic benefits through fuel cost savings. EVs have fuel economy ratings of 75 to over 100 miles per gallon equivalent (MPGe), and cost approximately $0.04 per mile to operate when charged in the Washington region.[3] Conventional vehicles, at an average of 27 mpg, cost nearly $0.13 cents per mile.[4] According to a study by the Union of Concerned Scientists, EV drivers in the Washington region could save an estimate of $950 per year in fuel costs compared to those driving internal combustion vehicles, depending on fuel prices, electricity rates, and miles driven.[5]

Additionally, EVs offer their owners protection against future gasoline price volatility. And because EVs rely on domestically produced electricity rather than on petroleum, a largely imported fuel, they promote energy security.

CHALLENGES TO EV ADOPTION

Despite the benefits of EVs, challenges such as unfamiliarity with the technology, range anxiety, underdeveloped charging networks, limited vehicle availability, and relatively high vehicle cost have hindered their adoption. In addition, the absence of a clear policy framework for EV infrastructure planning—which considers permitting, siting, zoning, utility policy, and other issues—has amplified existing market barriers. A regional strategy is needed to bridge these obstacles and clear the way for wider EV recognition and use.

RECENT COG EV PLANNING INITIATIVES

COG held an EV Workshop in early 2011 to examine successful EV readiness strategies and to begin the conversation at a regional level on how to effectively and collectively deploy EV transportation technology. Participants, including local governments and industry experts, agreed on the need for an EV readiness strategy to facilitate deployment in the metropolitan Washington region.

In 2011, in response to interest in EV planning across the metropolitan Washington region, COG and the Greater Washington Region Clean Cities Coalition embarked on a new regional Electric Vehicle Planning Initiative. The scope of this stakeholder-driven initiative is to identify the issues for regional EV deployment and to make recommendations for the region and local jurisdictions to consider in designing and implementing programs to facilitate EV adoption.

[3] In the metropolitan Washington region, EVs are estimated to cost approximately 4.3 cents to 6.6 cents per mile to operate, based on the Pepco Standard Offer Rate. Source: Union of Concerned Scientists, *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States*. Rev. April 12, 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html. See Table 2.1.

[4] The EPA combined average fuel economy rating of U.S. compact cars in 2010 was 27 mpg, and a gas price of $3.50 is assumed. See Union of Concerned Scientists report, above.

[5] See Union of Concerned Scientists report, above.

Under this initiative, the Electric Vehicle Planning Workgroups (referred to herein as the Task Force) were focused on infrastructure development and local government policy. The Task Force considered information on vehicle ownership and usage patterns, as well as best practices locally and from across the United States, to assist in developing considerations, recommendations, and priorities for an EV strategy for the metropolitan Washington region.

Six subgroups were formed to address the specific issue areas of infrastructure siting; comprehensive planning, zoning, and building codes; permitting and inspection; electric utility policy; EV use in fleets; and outreach and education. These subgroups met regularly from February through June 2012 to develop the recommendations put forth in this report.

EV and EVSE DEPLOYMENT PLANNING

COG staff and the EVSE Deployment Planning subgroup sought to provide an assessment of the current state of EV adoption and charging infrastructure (broadly referred to as electric vehicle supply equipment, or EVSE) in the Washington, DC region. Staff used vehicle registration data, survey data on regional driving patters, and information on publicly accessible EV charging stations to assess the potential for EV expansion. Given these findings, the stakeholder group provided recommendations on strategic locations for charging stations, suggestions for incentives to promote charging expansion, provisions to reduce the cost of future EVSE installation, and considerations for multifamily residential and workplace charging.

Regional Forecast for EV Ownership

According to data provided by Virginia, Maryland, and the District of Columbia Motor Vehicle Departments, there are approximately 500 EVs registered in the metropolitan Washington region. At least three major EV and PHEV models are available in the region, and service to convert hybrids to PHEVs is available.

While it may not be possible to predict exactly how many EVs will be operating in the region in coming years, one means of estimating future EV adoption is to analyze the recent experience of hybrid vehicle adoption. According to data from the Transportation Planning Board (TBP), from 2005 to 2011, the number of registered hybrid vehicles in the region grew more than 600 percent, from approximately 12,000 vehicles to more than 70,000. COG staff determined that a conservative estimate would be 1,500 to 3,000 EVs operating in the region by the end of the decade. The high estimate could see anywhere from 50,000 to 75,000 EVs on the region's roadways by 2020. A projection conducted by the Electric Power Research Institute, based on past hybrid sales, manufacturer production estimates, and other publicly available studies, predicts that there could be 15,000 to over 30,000 EVs in the Washington region by 2015.

Potential for EV Use

COG staff analyzed the potential for EVs in the context of current driving patterns in the region. According to COG's Household Travel Survey, most vehicle trips in the region are relatively short, with an average vehicle trip length of 7.7 miles. This is well within the range of one charge for all EVs in the market today. Therefore, for most daily commutes and other trip purposes, the relatively short length of the trips would not cause significant range anxiety.

Publicly Accessible EV Charging Infrastructure

A growing EV charging infrastructure exists in the metropolitan Washington region as a result of stimulus funding through state governments and private investment. COG staff developed an inventory of EV charging stations for the metropolitan Washington region. Altogether, the inventory identified 332 chargers in 133 publicly available charging station locations, 11 of which are planned stations. The District of Columbia has the most charging stations among COG jurisdictions (36), followed by Arlington County, Virginia (15); Fairfax County, Virginia (18); and Charles County, Maryland (11). The District of Columbia and Arlington County, Virginia, have the highest number of chargers (85 and 62, respectively). About 40 percent of the chargers are Level 1, and the remaining 60 percent are Level 2.[6] No DC fast chargers were installed when the inventory was developed. The inventory indicates that building managers are installing EVSE in a variety of land uses.

LOCAL GOVERNMENT POLICY

To understand the current EV policy landscape of the metropolitan Washington region, COG conducted a survey of its 22 member jurisdictions in early 2012 about EV permitting procedures and infrastructure planning efforts. Results of the survey indicated that with some exceptions, most jurisdictions reported having no EV policy development in place. Two exceptions are the District of Columbia and Fairfax County, Virginia, which are integrating EV considerations into the permit review process, building code policy, and ADA parking restrictions. The City of Frederick, Maryland, and the City of Falls Church, Virginia, indicated that they are tracking EV charging permit applications. In other jurisdictions, electrical permits do not indicate whether an EV charging station is being installed—thus presenting a barrier to tracking. Additionally, if a dedicated circuit is already installed, EV drivers charging at 120V (Level 1) outlet would not need to obtain a permit.

The Municipal Policy and Permitting/Inspections subgroups emphasized that local governments will play a critical role in the region's EV readiness. To facilitate continued growth of the market and smooth the transition to higher rates of EV adoption, the subgroups recommend that local governments ensure that EV infrastructure development is addressed in comprehensive

[6] See Section 2 for definitions of EV charging technology.

planning efforts and that zoning, building codes, and permitting and inspection processes provide a pathway to the expeditious installation of charging equipment. Streamlined permitting and inspection processes, EV and charging incentives, infrastructure readiness, low permitting and inspection costs, and nominal installation costs all contribute to reducing barriers to greater EV adoption.

ELECTRIC UTILITY POLICY

The regulatory status of EV charging stations—contained in provisions of electric utility policy—can help or hinder the ability of private companies and utilities to provide EV charging services. Across the region, the regulatory status of EV charging service providers is inconsistent and in some cases unclear. Maryland, Virginia, and the District of Columbia have all taken steps in recent years to resolve areas of uncertainty in their electric utility policy as it relates to EVs and EV charging. However, room for improvement remains, particularly when it comes to notifying utilities about EV charging station locations.

The Electric Utility Policy subgroup found that clear state-level policies are needed to promote private investment in EV charging infrastructure for charging in the for-pay charging market. They recommend that ideally, local and state policy would allow utilities to be notified in advance about the location of EV charging equipment so they can ensure that appropriate infrastructure is in place to accommodate the increased load and avoid service disruptions for their customers.

EVs FOR FLEET USE

A 2012 survey of fleets in the metropolitan Washington region found that EVs are being adopted slowly. The Greater Washington Region Clean Cities Coalition's survey of 11 fleet managers found that most EVs currently in operation are used onsite, such as trucks used on landfills or campus landscaping equipment.[7] According to the Coalition, fleet managers cite the cost of EVs and infrastructure as obstacles to purchasing additional EVs.

The Fleets subgroup provided recommendations on promoting partnerships between governments and manufacturers to reduce costs and increase utilization of EVs in fleets, encourage charging infrastructure sharing, and promote cooperative purchasing.

OUTREACH AND EDUCATION

The public's current level of knowledge about electric vehicles is limited. Education efforts by private and public entities (including nongovernmental organizations, electric utilities, PEV

[7] Greater Washington Region Clean Cities Coalition. *Clean Cities 2011 Annual Report*. Spring 2012.

service providers, auto dealers, other businesses, and government) are needed to bridge the gap.[8] To set the stage for EV marketplace success in the metropolitan Washington region, regional partners involved in the Metropolitan COG Electric Vehicle Planning Initiative have identified key target audiences and information needs for those audiences.

In addition to identifying an initial list of resources for EV stakeholders to use in education and outreach efforts, the subgroup provides recommendations on how to increase outreach efforts throughout the region. Continuing to search for and share resources, engaging with regional partners to encourage collaboration and to share experiences, and promoting EV awareness through industry training and curricula should be priorities for the region.

SUMMARY OF RECOMMENDATIONS

Achieving EV readiness in the metropolitan Washington region will require a coordinated approach among all stakeholders, including utilities, players in the EV industry, state and local governments, and nonprofit groups. This report contains recommendations for these stakeholders to promote a consistent set of practices across the region that will remove barriers to EV adoption and infrastructure planning.

The top five recommendations to facilitate EV deployment in the region are as follows:

1. Stakeholder partnerships, such as a Washington Regional Electric Vehicle Partnership, should be formed to develop a business case for EVs, and to assess the potential for community return on investment.
2. Stakeholders should consider offering incentives such as preferred parking, HOV occupancy exceptions, and tax credits to promote EV adoption.
3. Electric permitting procedures should identify EVSE installations and notify electric utilities of their locations.
4. Outreach and education is needed to promote EV adoption and inform the public of its benefits.
5. Comprehensive plans and zoning regulations should guide EV infrastructure development and ensure that the built environment can accommodate future EVSE installations.

Further details are provided in the report and appendices.

[8] Center for Climate and Energy Solutions. *An Action Plan to Integrate Plug-in Electric Vehicles with the U.S. Electrical Grid.* March 2012. http://www.c2es.org/docUploads/PEV-action-plan.pdf

SECTION 1

INTRODUCTION

GOALS

This report seeks to provide a framework for establishing a regional readiness plan for the deployment of electric vehicles (EVs) in the metropolitan Washington region. While total EV ownership in the region is relatively low (compared with other cities such as Portland, Oregon, or Los Angeles), consumer interest in EVs is growing. However, the metropolitan Washington region's charging infrastructure and EV policy frameworks are not yet positioned to accommodate greater market penetration of these vehicles. A coordinated approach will smooth the path to EV deployment and adoption by removing policy barriers and promoting infrastructure development while mitigating potential impacts on the electrical grid. This planning effort will help ensure that the region can receive the health, environmental, and sustainability benefits that this technology offers.

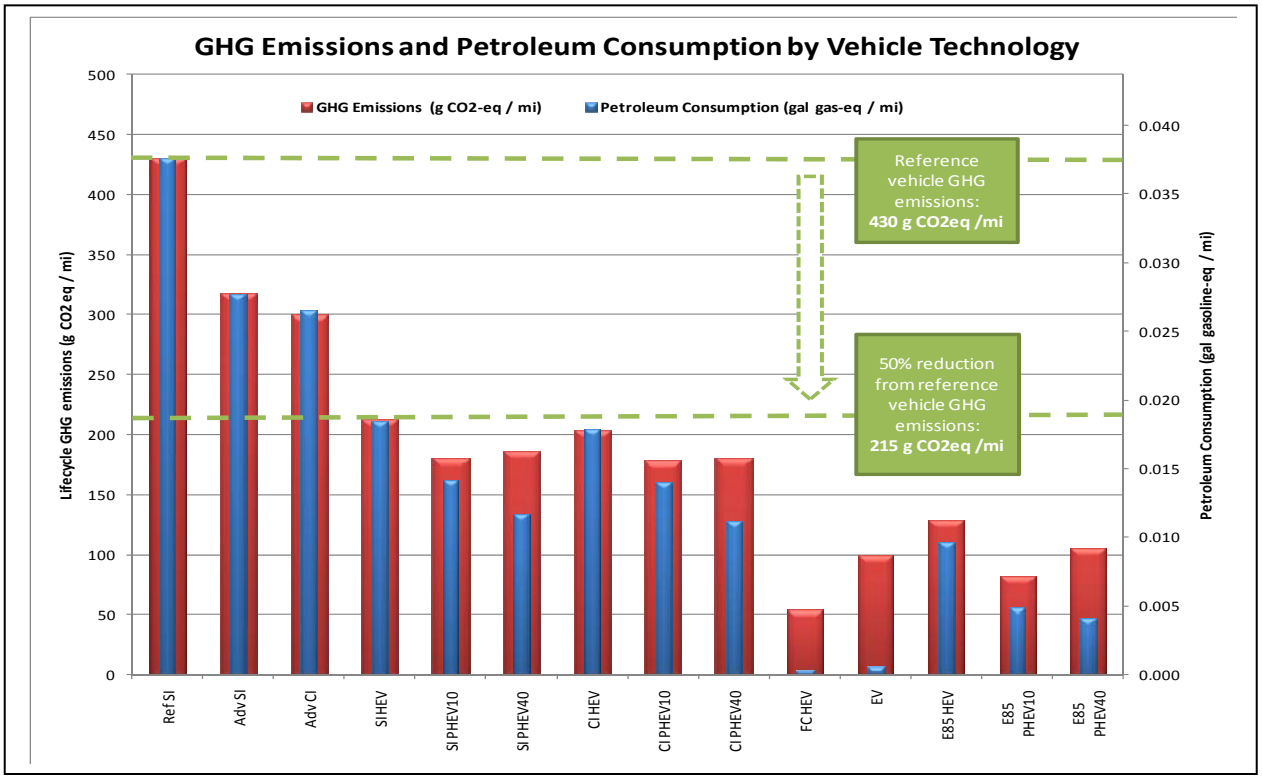
BENEFITS OF EV DEPLOYMENT

EV adoption presents environmental, economic, and energy security benefits to the country and the region. The U.S. Department of Energy (DOE) sees the electrification of vehicles as one of the highest impact strategies for reducing greenhouse gas emissions between now and 2030.[9] In particular, as a bridge to a low-carbon transportation system, electrification of gasoline-powered vehicles through approaches such as plug-in hybrid electric vehicles (PHEVs) is one way the United States could facilitate a transition to future fuel-cell electric vehicles (FCEVs), which are seen to have the lowest life cycle carbon emissions of the range of vehicles analyzed by DOE. Figure 1-1 shows the greenhouse gas emissions and petroleum consumption of alternative vehicle technologies.

Battery-only EVs (or BEVs) are often referred to as *zero emissions* vehicles because unlike internal combustion vehicles, they emit no tailpipe emissions such as ground-level ozone, fine particulate matter, nitrous oxides, volatile organic compounds, carbon monoxide, and carbon dioxide. Although the generation of electricity necessary to charge EVs may produce emissions depending on the generation source, emissions associated with EV charging are significantly lower than those produced by internal combustion engine vehicles. Furthermore, EVs do not produce the unhealthy local concentrations along roadways that conventional vehicles do.

[9] U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. *Vehicle Technologies Program Multi-Year Program Plan (2011-2015).* http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf

Figure 1-1. Greenhouse Gas Emissions and Petroleum Consumption by Vehicle Technology



Source: http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf

Legend:

Ref. S—reference spark-ignition gasoline engine vehicle
Adv. SI—advanced spark ignition gasoline engine vehicle
Adv. CI—advanced compression-ignition diesel engine vehicle
SI HEV—spark-ignition gasoline engine/hybrid electric vehicle
SI PHEV10—spark-ignition gasoline engine/plug-in hybrid electric vehicle (10-mile all-electric range)
SI PHEV40—spark-ignition gasoline engine/plug-in hybrid electric vehicle (40-mile all-electric range)
CI HEV—compression-ignition diesel engine/hybrid electric vehicle
CI PHEV10—compression-ignition diesel engine/plug-in hybrid electric vehicle (10 mile all-electric range)
CI PHEV40—compression-ignition diesel engine/plug-in hybrid electric vehicle (40-mile all-electric range)
FC HEV—fuel cell/hybrid electric vehicle
EV—electric vehicle
E85 HEV—85% biomass-gasoline blend/hybrid electric vehicle
E85 PHEV10—85% biomass-gasoline blend/plug-in hybrid electric vehicle (10-mile all-electric range)
E85 PHEV40—85% biomass-gasoline blend/plug-in hybrid electric vehicle (40-mile all-electric range)

EVs also offer economic benefits through fuel cost savings. They are highly energy efficient when compared with conventional cars. The all-electric drive vehicles available today have EPA combined fuel economy ratings of 75 to over 100 miles per gallon equivalent (MPGe), while in 2010 the average fuel efficiency of internal combustion compact cars was 27 miles per gallon. This efficiency translates directly to operational cost savings. EVs cost approximately $0.04 per mile to operate when charged in the Washington region, while conventional vehicles cost an

average of $0.13 cents per mile based on current gas prices.[10] Depending on fuel costs, electricity costs, and miles driven, annual cost savings can be as high as $950 per year.[11] Table 1-1 shows the EV efficiency ratings of four EV models.

Table 1-1. Electric Vehicle Efficiency Ratings

2012 Models	Mitsubishi "i"	Ford Focus EV	Nissan LEAF	Chevy Volt
Electric efficiency (kWh/mile)	0.3	0.32	0.34	0.36
Energy efficiency rating (MPGe)	112	105	99	94

Source: U.S. Department of Energy, www.fueleconomy.gov

While the fuel savings offered by electric vehicles will eventually offset the higher up-front cost of purchasing an EV, EV buyers are often motivated by factors other than the time it takes to pay off the initial investment in a cleaner vehicle. EVs offer their owners protection against future gasoline price volatility. In Houston, for example, members of the NRG network enjoy a low fixed monthly fee for unlimited charging at home and at any of the network locations in the metropolitan area. And because EVs rely on domestically produced electricity rather than on petroleum, a largely imported fuel, they promote energy security.

Mahi Reddy, CEO and founder of SemaConnect, and Maryland Governor Martin O'Malley celebrate the installation of eight SemaConnect electric vehicle charging stations at Baltimore/Washington International Thurgood Marshall Airport.

PROMOTING REGIONAL GOALS

The benefits offered by EVs make them uniquely positioned to contribute to regional goals of sustainability, climate change mitigation, and air quality improvement.

[10] In the metropolitan Washington region, EVs are estimated to cost approximately 4.3 cents to 6.6 cents per mile to operate, based on the Pepco Standard Offer Rate. A gas price of $3.50 is assumed. Source: Union of Concerned Scientists, *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States*. Rev. April 12, 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html. See Table 2.1.

[11] See Union of Concerned Scientists, above.

Metropolitan Washington Alternative Fuels Partnership

Since the early 1990s, COG has been committed to supporting sustainable transportation solutions in the region. Today, it continues to promote the deployment of alternative fuel vehicles, and views electric drive vehicles as an important part of the portfolio of available clean transportation options.

Planning efforts began through the Metropolitan Washington Alternative Fuels Partnership, which was created to encourage the use of alternative fuel vehicles (AFVs) as a means of improving energy security and environmental quality. Fundamentally, the Partnership was technology neutral, supporting alternative and renewable fuels such as natural gas, ethanol, methanol, propane, and electricity. In 1993 this partnership began implementing the Washington region's Clean Cities Program, a locally-based and voluntary partnership between government and industry coordinated by the U.S. Department of Energy. In 2010 the Partnership transitioned to become the Greater Washington Regional Clean Cities Coalition.

EV Stimulus Programs

In 2009, DOE's National Clean Cities Program provided $300 million in American Recovery and Reinvestment Act (ARRA) stimulus funds for projects aimed at accelerating the deployment of alternative-fuel vehicles and building the infrastructure needed to support them. Twenty-five grants were awarded in 2010 ranging from $5 million to $15 million, each with a 50 percent matching requirement. The funding was designated to accelerate the adoption of hybrids, EVs, and plug-in electric hybrids, as well as natural gas and biofuel-powered vehicles. Projects that were awarded in the metropolitan Washington region include ECOtality's The EV Project (2009), Coulomb Technologies' ChargePoint America Program (2010), the New York State Energy Research and Development Authority's Northeast Regional Electric Vehicle Network project (2011), and the Maryland Energy Administration's Maryland Electric Vehicle Infrastructure Project (2010).

DOE is actively promoting EVs through grants to Clean Cities Coalitions, local governments, and EV infrastructure companies. Although not a primary beneficiary of DOE EV grants, the metropolitan Washington region may benefit from grants supporting the development of regional strategic plans to facilitate the adoption of EVs and the associated infrastructure in the nearby cities of Baltimore and Richmond.

Regional Vision for Sustainability

COG's *Region Forward* initiative calls for "a significant decrease in greenhouse gas emissions, with substantial reductions from the built environment and transportation sector," as well as "protection and enhancement of the region's environmental resources by meeting and exceeding

standards for our air, water, and land."[12] Specifically, it sets the goals of reducing regional greenhouse gas emissions by 20 percent below 2005 levels by 2020 and by 80 percent below 2005 levels by 2050. It also calls for the region's air quality to improve by 2014 through a reduction in ambient pollutant concentrations to below federal maximums. (See Appendix A for a more extensive description of COG's mission and activities.)

Greenhouse Gas Reductions

The *National Capital Region Climate Change Report* and the action plan of the Climate Energy and Environment Policy Committee establish specific milestones to be achieved to meet the region's ambitious climate change goals. Relevant to EVs, the plan calls for increased fuel efficiency and accelerating the adoption of efficient clean-fuel vehicles.

According to the Union of Concerned Scientists, based on EPA data, "the average EPA window-sticker fuel economy rating of all compact vehicles sold in 2010 (the most recent year for which data are available) was 27 mpg, while midsize vehicles averaged about 26 mpg. This means that even when charging an EV with electricity made only from coal, the dirtiest electricity source, the EV has better emissions than the average new compact gasoline vehicle."[13] The Union of Concerned Scientists' data on the MPGe generated by alternative electricity sources are presented in Table 1-2.

Since the electrical grid serving the metropolitan Washington region has a relatively low greenhouse gas emission profile, EVs charged in most parts of the region produce fewer greenhouse gasses than currently available hybrid vehicles (50 mpg or greater). In other areas of the region, greenhouse gas emissions produced by EVs are equivalent to very efficient hybrids (41 to 50 mpg). [14]

In addition, the electricity grid may be able to more readily integrate renewable power sources than traditional transportation energy sources. The proportion of renewably produced power available on the grid will increase over the years as a result of the region's renewable portfolio standards and other renewable incentives and policies. EVs allow these emissions savings and environmental benefits to be transferred to the transportation sector.

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[12] Metropolitan Council of Governments. *Region Forward: Sustainability Targets.* http://www.regionforward.org/sustainability-targets

[13] Union of Concerned Scientists. *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States*. April 2012 prepublication version. http://www.ucsusa.org/assets/documents/clean_vehicles/electric-car-global-warming-emissions-report.pdf

[14] Union of Concerned Scientists. *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States.* Rev. April 12, 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html

Table 1-2. Well-to-Wheels EV Global Warming Emissions (mpg_{ghg}) by Electricity Generation Source

Electricity Source	EV Global Warming Emissions in Gasoline Miles per Gallon Equivalent (mpg_{ghg})
Coal	30
Oil	32
Natural Gas	54
Solar	500
Nuclear	2,000
Wind	3,900
Hydro	5,800
Geothermal	7,600

Source*:* Union of Concerned Scientists, http://www.ucsusa.org/assets/documents/clean_vehicles/electric-car-global-warming-emissions-report.pdf

Air Quality and Transportation Planning

Reducing vehicle emissions is critical to achieving the region's air quality goals, and EVs can play an important role in realizing these reductions. In the metropolitan Washington region, transportation emissions accounted for 55 percent of NOx emissions and 16 percent of fine particle ($PM_{2.5}$) emissions in 2007.

EVs' zero or low emission status makes them good candidates to contribute significantly to the regional efforts to reduce pollution from mobile sources. As mentioned earlier, electric generation sources in the region have recently either switched fuels or installed controls to dramatically reduce emissions and are for the most part located far away from highly populated areas. This means that reliance on the electric grid to provide clean reliable low-cost power for the transportation sector can contribute significantly to improving air quality.

COG's Transportation Planning Board (TPB) conducted a scenario study examining the role of regional transportation in climate change mitigation in the metropolitan Washington region called *What Would It Take? Transportation and Climate Change in the National Capital Region.*[15] The study tries to answer the question of what it would take in the metropolitan Washington region to meet aggressive greenhouse gas emission reduction goals in transportation. Although EVs were not specifically mentioned in the study, it concluded that national-level Corporate Average Fuel Economy (CAFE) standards and alternative fuel mandates are needed to

[15] COG Transportation Planning Board. *What Would It Take? Transportation and Climate Change in the National Capital Region.* May 18, 2010. http://www.mwcog.org/uploads/committee-documents/kV5YX1pe20100617100959.pdf

reduce emissions and contribute to the environmental resilience of the region. The new 2025 CAFE standards, when combined with the previous 2016 standard, will make model year 2025 vehicles nearly twice as fuel efficient as current models.[16]

NEED FOR READINESS PLANNING

Despite the benefits of EVs, challenges such as unfamiliarity with the technology, range anxiety, underdeveloped charging networks, and the limited availability and relatively high cost of vehicles have hindered their adoption. In addition, the absence of a clear and robust policy framework for EV planning and infrastructure—which considers permitting, siting, zoning, utility policy, and other issues—has amplified existing market barriers. A regional strategy is needed to bridge these obstacles and clear the way for wider EV recognition and use.

BARRIERS AND CHALLENGES

The perception that EVs are less convenient than conventional internal combustion or gasoline hybrid vehicles is a significant obstacle to EV adoption. Concerns about running out of charge and not having access to a charging station can deter potential EV buyers. Related to this issue is the perception that there is a lack of publicly available EV charging infrastructure. Increasing the number and visibility of public charging stations could reduce range anxiety and increase EV acceptance. Developing solutions for potential EV owners who reside in multifamily buildings and do not have access to a reliable electrical outlet for EV charging would also promote EV acceptance.

Additionally, there is some uncertainty about the business case for EVs and charging infrastructure. Though interest and investment in the technology is growing, a strong, viable business model for EV deployment has not yet emerged. The current low market demand for EVs had dampened both public and private sector interest in investing in EV charging networks. Adequate charging infrastructure is a prerequisite to more widespread EV adoption, but the fact that vehicle demand does not currently exist is a barrier to its construction. Additionally, it is not clear how many publicly accessible EV chargers are needed to support the existing EV fleet and promote its growth. Recognizing this, the Task Force identified building a business case for EVs as a top priority for the next stages of this planning initiative.

Furthermore, there is disagreement about the appropriate roles for the private sector and local governments, respectively, in incentivizing or promoting EV infrastructure build-out. Some stakeholders see government involvement as an endorsement of private sector products. Others

[16] National Highway Traffic Safety Administration. *Obama Administration Finalizes Historic 54.5 mpg Fuel Efficiency Standards*. http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/Obama+Administration+Finalizes+Historic+54.5+mpg+Fuel+Efficiency+Standards

see the government as having a critical role to play in EV infrastructure development, given the public benefits it offers. In fact, state government initiatives coupled with DOE investments in EV infrastructure between 2009 and 2011 have been significant factors in the deployment of EVs in California, Oregon, and Washington State.

RECENT COG EV PLANNING INITIATIVES

EV Readiness Workshop

COG held an EV Workshop in early 2011 to examine successful local and regional EV readiness strategies and to begin the conversation on a regional level on how to effectively and collectively deploy EV transportation technology. Participants, including local governments and industry experts, agreed on the need for an EV readiness strategy to facilitate deployment of EVs in the metropolitan Washington region.

COG surveyed 22 member jurisdictions in early 2012 regarding their EV permitting and infrastructure planning. Results of the survey indicated that most local jurisdictions in the region were not aware of or looking at EVs as a potential issue.

Washington Regional EV Planning Initiative

In 2011, to respond to the interest in EV planning in the metropolitan Washington region, COG and the Greater Washington Region Clean Cities Coalition embarked on a new regional EV Planning Initiative. The EV Planning Initiative is heavily stakeholder-driven. The scope of the strategy development is to identify the issues for regional EV deployment and to make recommendations for the region and local jurisdictions to consider in designing and implementing programs to facilitate adoption of EVs.

The primary Electric Vehicle Planning Workgroups (referred to herein as the Task Force) were focused on infrastructure development and municipal policy. Subgroups were formed to address comprehensive planning, zoning, building codes, permitting/inspection, infrastructure siting, electric utility policy, fleets, and outreach and education.

The Task Force members contributing to the process included vehicle owners, state and local government staff (transportation and energy planners), EV equipment manufacturers and suppliers, nonprofit agencies (e.g., the Georgetown Climate Center, the Electric Drive Transportation Association, the Electric Vehicle Association of Greater Washington DC), and electric utility representatives from the three states. The Task Force provided direction, feedback, and data sharing on EV deployment issues.

COG staff assessed the status of EVs in the region and recommended steps to improve and enhance regional readiness for EVs. The main areas of concern were EV and EVSE

infrastructure (existing and planned), as well as the range of policies that may have an impact on EV or EVSE deployment and/or public acceptance of EVs.

The following are some suggested government roles that could be considered:

- Reducing barriers to and streamlining permitting;
- Standardizing design and safety requirements;
- Disseminating information on best practices, regulations, federal tax credits, and technical assistance;
- Implementing incentives to support initial ramp-up momentum (e.g., tax breaks, EV car-sharing incentives);
- Developing requirements and guidelines for infrastructure implementation, including where and how; and
- Partnering with utilities and EV service companies around grid issues, revenue requirements, and creation of a subscription network.

The Task Force considered information on vehicle ownership and usage patterns, as well as best practices from around the United States to assist in developing considerations, recommendations, and priorities for an EV strategy for the metropolitan Washington region.

STRUCTURE OF THIS REPORT

This report sets the stage with an overview of the state of EV and EVSE technology and the extent of current and projected availability in the metropolitan Washington region of particular EV models and types of charging equipment in Section 2. (Appendix B contains a glossary of terms introduced in the report, and Appendix C provides a list of related resources and links.)

Section 3 discusses current EV ownership and charging stations in the region, with implications for infrastructure planning.

Comprehensive planning, zoning, building codes, and permitting and inspections are key to preparing for and promoting EV readiness in the region—Section 4, on Local Government Policy, summarizes current practices in the region and best practices from EV programs nationwide.

Electric utility policy is also key to EV readiness in the region. Section 5 discusses the potential for impacts of EV use on the electrical grid as well as key regulatory issues and concerns.

Section 6 explores the advantages of EVs for fleet use and the current and anticipated use of EVs in both public and private fleets.

Section 7, on Outreach and Education, defines the target audiences related to EV adoption and discusses current training resources and unmet EV information needs, including those related to public safety, payment mechanisms, available incentives, and emissions and congestion benefits.

Finally, Section 8 presents a summary of recommendations designed to promote EV readiness in the region.

SECTION 2
CURRENT EV TECHNOLOGY

This section presents some background on electric vehicle (EV) and electric vehicle supply equipment (EVSE) technologies and on current product and service offerings. First, different technologies used in EVs are discussed, followed by descriptions and photos of EV models that are currently available. Then, some background on vehicle charging technologies is presented, followed by a listing of manufacturers who are heavily invested in this market. Market participants include charging station manufacturers, those who work with EVSE suppliers to set up and manage charging networks, and those who develop and distribute related software products.

BACKGROUND ON EV TECHNOLOGIES

The major types of EVs are discussed below, along with their powering mechanism and battery range.

All-Electric Vehicles. All-electric vehicles (EVs), sometimes referred to as *battery electric vehicles* (BEVs), use a battery to store electricity that powers the motor. EVs available nationwide now have a range of 62 to 100 miles per charge, which is sufficient to cover over 90 percent of household vehicle trips according to the U.S. Department of Transportation.[17] [18]

Plug-In Hybrid Electric Vehicles. Plug-in hybrid electric vehicles (PHEVs) contain both an internal combustion engine and an electric motor and battery. The battery can be charged by plugging in, by the combustion engine, or through regenerative braking. These vehicles offer 15 to 50 miles of electric-only range. If not charged by plugging in, they achieve roughly the same fuel economy as similarly sized conventional hybrid vehicles.[19] Range anxiety is generally not a concern for PHEV drivers, as their vehicles can drive in internal combustion mode when the battery is depleted.

Hybrid Electric Vehicles. Hybrid electric vehicles (HEVs) contain an internal combustion engine that runs on conventional liquid fuels but is supplemented by an electric motor and on-board battery. The combustion engine and regenerative braking are used to charge the battery in these vehicles. HEVs cannot be charged through a plug connection. They offer better fuel

[17] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Fueleconomy.gov. *Electric Vehicles: Compare Side-by-Side.* http://www.fueleconomy.gov/feg/evsbs.shtml.
[18] U.S. Department of Transportation, Federal Highway Administration. *Our Nation's Highways: 2008*. http://www.fhwa.dot.gov/policyinformation/pubs/pl08021/fig4_5.cfm.
[19] U.S. Department of Energy, Alternative Fuels & Advanced Vehicles Data Center. *Hybrid Electric Vehicles.* http://www.afdc.energy.gov/afdc/vehicles/electric_basics_hev.html

economy than conventional internal combustion vehicles but otherwise function like traditional vehicles. Because HEVs do not have the same infrastructure and policy needs as plug-in vehicles, they are not the focus of this report.

The benefits of these three types of vehicles—in terms of fuel economy, emissions reductions, fuel cost savings, and fueling flexibility—are presented in Table 2-1. All-electric vehicles have the greatest fuel cost savings and the least fuel flexibility.

Table 2-1. Benefits of EVs

What are the Benefits of Electric Drive Vehicles?			
Benefits	**Hybrid Electric Vehicles**	**Plug-In Hybrid Electric Vehicles**	**All-Electric Vehicles**
Fuel Economy	**Better than similar conventional vehicles** The fuel savings of driving a Honda Civic Hybrid versus a conventional Civic is about 38% in the city and 20% on the highway.	**Better than similar HEVs and conventional vehicles** PHEVs use 40% to 60% less petroleum than conventional vehicles and permit driving at slow and high speeds using only electricity.	**No liquid fuels** Fuel economy of EVs is usually expressed as cost per mile, which is discussed below.
Emissions Reductions	**Lower emissions than similar conventional vehicles** HEV emissions vary by vehicle and type of hybrid power system. HEVs are often used to offset fleet emissions to meet local air-quality improvement strategies and federal requirements.	**Lower emissions than HEVs and similar conventional vehicles** PHEV emissions are projected to be lower than HEV emissions, because PHEVs are driven on electricity some of the time. Most categories of emissions are lower for electricity generated from power plants than from vehicles running on gasoline or diesel.	**Zero emissions** EV emissions do not come from the tailpipe, so EVs are considered zero-emission vehicles. However, emissions are produced from the electric power plant. Most categories of emissions are lower for electricity generated from power plants than from vehicles running on gasoline or diesel.
Fuel Cost Savings	**Less expensive to operate than a conventional vehicle** Because of their improved fuel economy, HEVs usually cost $0.05 to $0.07 per mile to operate, compared to conventional vehicles, which cost $0.10 to $0.15 per mile to operate.	**Less expensive to operate than an HEV or conventional vehicle** When operating on electricity, a PHEV can cost $0.02 to $0.04 per mile (based on average U.S. electricity price). When operating on gasoline, the same vehicle can cost $0.05 to $0.07 per mile, compared to conventional vehicles, which cost $0.10 to $0.15 per mile to operate.	**Less expensive to operate than conventional vehicles** EVs operate using only electricity. A typical electric vehicle costs $0.02 to $0.04 per mile for fuel (based on average U.S. electricity price).
Fueling Flexibility	**Same as conventional vehicles**	**Can get fuel at gas stations or charge at home or public charging stations**	**Can charge at home or public charging stations**

Source: U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center. Accessed June 2012. www.afdc.energy.gov/afdc/vehicles/electric_benefits.html

CURRENTLY AVAILABLE EV AND PHEV MODELS

The most popular light duty EVs currently available in the United States are the Nissan LEAF EV and the Chevy Volt PHEV. Both entered the market in December 2010. The Mitsubishi "i" became available nationally in the summer of 2012 and EPA recently named it the most fuel efficient vehicle sold in the country. The Toyota Prius Plug-in Hybrid entered select markets including the Washington, D.C. region in February 2012, with about 2,500 sold in the first three months of availability. The Prius PHEV is expected to be released nationally in 2013. Details and photos of these vehicles are presented below. Not pictured is the Fisker Karma PHEV, which provides an EV option in the luxury car category.

Manufacturers see EV development as a long-term strategic investment in preparation for higher gas prices. As oil prices rise, automakers expect to see increasing consumer demand for efficient and alternative fuel vehicles. On the production side, Nissan has confirmed an investment of $5.6 billion to build the production capacity to produce half a million EVs and batteries worldwide by the end of 2013.[20] It is estimated that GM has invested $1 billion to $1.2 billion in developing the Chevy Volt.[21] Additionally, as part of a broader EV research and development strategy, manufacturers are investing heavily in battery development and testing, as batteries are a major component of EV cost. The cost of an EV lithium-ion battery pack has dropped to $689 per kWh, down 14% since 2011, and 30% since 2009.[22]

On the consumer side of the EV market, auto dealers are beginning to work with EVSE installers to assist new EV drivers in installing home charging equipment. GM has partnered with SPX Service Solutions to sell and install the Voltec home charging station in homes of new Volt drivers.[23] The EVSE supplier Aerovironment is the official service provider for both Nissan and Mitsubishi to provide home charging stations for new EV drivers. Mitsubishi's partnership also includes Best Buy's Geek Squad, which provides a home electrical inspection for new drivers of the "i," then assists with the purchase and installation of the 240V charging station.[24]

[20] Loveday, Eric. "Renault-Nissan CEO still committed to $5.6 billion electric vehicle investment." Autoblog Green. June 20 2011. http://green.autoblog.com/2011/06/20/renault-nissan-ceo-5-6-billion-electric-vehicles/.
[21] Reeves, Benjamin. "Why GM Actually Is Getting Its Money's Worth From The Chevy Volt: http://www.ibtimes.com/articles/382612/20120910/general-motors-gm-chevy-volt-cost-losses.htm
[22] Bloomberg Energy Finance. *Electric Vehicle Batter Prices down 14% year on year.* http://www.bnef.com/PressReleases/view/210.
[23] Plug In America. GM Voltec EVSE. http://www.pluginamerica.org/accessories/gm-voltec-evse.
[24] Mitsubishi Motors. Frequently Asked Questions – Battery & Charging. http://i.mitsubishicars.com/faq/battery

Nissan LEAF

Fuel: electric (dedicated)
Estimated Range: 72 miles per charge
Battery: li-ion
Emission Certification: California ZEV, Tier 2 Bin 1
Engine: 80 kW e-motor
Availability: Nationwide [25]

Mitsubishi i

Fuel: electric (dedicated)
Estimated Range: 62 average miles per charge
Battery: li-ion
Emission Certification: California ZEV, Tier 2 Bin 1
Engine: 66 kW e-motor
Availability: Nationwide [26]

Chevrolet Volt

Fuel: plug-in hybrid electric (hybrid electric)
Fuel Economy: 95 MPGe city, 93 MPGe highway
Estimated Electric Range: 35 miles per charge
Battery: li-ion
Emission Certification: SULEV
Engine: 4-cyl, 1.4L , 111 kW e-motor
Availability: Nationwide [27]

Toyota Prius Plug-in Hybrid

Fuel: plug-in hybrid electric (hybrid electric)
Fuel Economy: 87 MPGe city
Estimated Electric Range: 15 miles per charge
Battery: li-ion
Emission Certification: California AT PZEV, Tier 2 Bin 3
Engine: 4-cyl, 1.8L, 60 kW e-motor
Availability: Select states, including Maryland and Virginia; national release planned for 2013. [28]

[25] Nissan LEAF. http://www.nissanusa.com/leaf-electric-car/ (Photo: http://www.nissanusa.com/leaf-electric-car/specs-features/index#/leaf-electric-car/specs-features/index)
[26] Mitsubishi i. http://i.mitsubishicars.com/ (Photo: http://evworld.com/news.cfm?newsid=19244)
[27] Chevrolet Volt. http://www.chevrolet.com/volt-electric-car/ (Photo: http://www.chevrolet.com/volt-electric-car/)

CHARGING EQUIPMENT

Different types of charging equipment are now available, and charging performance will likely continue to improve. At home, EV drivers can charge their vehicles using a standard 120 V outlet, or if faster charging is desired, they can install special charging equipment, generally referred to as electric vehicle supply equipment (EVSE). Charging time can range from 30 minutes to 20 or more hours, depending on a number of factors, including current, battery capacity and chemistry, and the battery's state of charge. Three main EVSE classes are available today—Level 1, Level 2, and DC fast charge. Level 3 charging is not yet available to consumers. All four classes of charging equipment are described below.

Level 1 Charging. Level 1 EVSE uses a cord similar to a household extension cord to provide charging. On one end is a three-prong, 120-volt AC plug, and on the other is a J1772 standard connector to connect with the vehicle. Level 1 charging is typically used in residential settings when a higher-voltage circuit is not available or is not desired. It is generally the preferred charging method for PHEVs. Level 1 charging can also be an economic and effective solution for any nonresidential location that wishes to make EV charging infrastructure available. Level 1 charging is particularly effective at locations where EV owners will park for long periods of time, such as the workplace. Level 1 charging is also well-suited to any location that wants to offer EV owners the ability to "top off" their batteries. Level 1 cordsets are typically included with the vehicle purchase and simply require access to a standard 120-volt outlet. The charging rate is generally two to five miles of range per hour of charging.

Level 2 Charging. Rather than using a standard plug, Level 2 EVSE requires installation of hardwired home charging or public charging equipment. It requires a 240-volt AC plug and a dedicated 40-amp circuit. Level 2 charging also uses a J1772 connector to connect to the vehicle. This equipment charges a typical EV battery overnight, and because most homes have 240-volt service available, Level 2 charging is expected to become the predominant residential charging method for BEVs. It is also common at public charging stations. The charging rate is approximately 10 to 20 miles of range per hour of charging.

Level 3 Charging. This charging type is still in development but is expected to provide a faster AC charging option at public stations. It would operate at a higher voltage and current than Level 2 EVSE. Level 3 charging is expected to deliver a full charge in less than 30 minutes.

DC Fast Charging. Direct-current (DC) fast charging uses a 480-volt connection to provide 50kW or more to EV batteries. It provides a nearly full charge in less than 30 minutes, enabling

[28] Honda Prius Plug In. http://www.toyota.com/prius-plug-in/ (Photo: http://www.toyota.com/prius-plug-in/photo-gallery.html)

charging along heavy traffic corridors and at public charging stations. The first generation of DC fast chargers primarily uses the CHAdeMO connectors, produced in Japan. However, in May 2012 the International Society of Automotive Engineers (SAE) developed a new plug design as the standard for American and European models. The new design, called DC Fast Charging with a Combined Charging System, offers a single port that is compatible with existing Level 1 and 2 plugs. Characteristics of these four charging options are detailed in Table 2-2.

Figure 2-1. EV Charging Connectors

Upper Left: J1772 Connector. *Photo*: ITT Interconnect Solutions
Upper Right: CHAdeMO Connector. *Photo:* EVWorld
Lower Left: Combined Charging System. *Photo:* Digital Trends

Table 2-2. EVSE Options

EVSE Options						
	Current Type	Amperage (amps)	Voltage (V)	Kilowatts (kW)	Charging Time *(for fully depleted battery)*	Primary Use
Level 1	Alternating current (AC)	Up to 15 amps	120V	Up to 1.8 kW	6 to 20 hours	Residential charging
Level 2	AC	Up to 80 amps	240V	Up to 19.2 kW	3 to 8 hours	Residential and public charging
Level 3 *(in development)*	AC	To be determined	To be determined	To be determined	Under 30 minutes	Public charging
DC Fast Charging	Direct current (DC)	Up to 200 amps	480V	50 to 150 kW	Under 30 minutes	Public charging

Source: U.S. Department of Energy, Alternative Fuels and Advanced Vehicles Data Center. Accessed June 2012. www.afdc.energy.gov/afdc/vehicles/electric_charging_equipment.html.

EVSE MANUFACTURERS AND NETWORK DEVELOPERS

Fortunately, there is a robust and growing market of EVSE suppliers. The EVSE market is expected to grow to $372 million in the United States by 2015.[29] The market is expanding rapidly, with dozens of active EVSE manufacturers and suppliers and hundreds of charging equipment models available. Typically, different charging equipment is used in home, multiunit residential, on-street public, retail/commercial, and fleet-charging settings. Two common designs are the free-standing "pedestal" and the wall-mounted charger.

Plug-In 2011 Conference & Exposition, Raleigh, NC

[29] Pike Research. *EV Charging Growing More Complex*. August 4, 2010, by John Gartner. http://www.pikeresearch.com/blog/articles/ev-charging-growing-more-complex

Major Players in the EVSE Market

- **350Green** partners with EVSE manufacturers, original equipment manufacturers (OEMs), municipalities, and site hosts to develop EV charging networks in major cities. The company works on site selection, engineering, construction, and marketing for charging infrastructure networks. It was an initial partner in The EV Project, which is described in the paragraph on ECOtality below.

- **Aerovironment**, also known as AV, produces high-power test systems and EV charging stations. It provides charging products for a range of applications, including home, multiunit residential, public, fleet, commercial, and workplace. The company also provides installation services and business system integration.

- **Better Place** provides comprehensive EV network services. The company develops battery switch stations, charging networks, EV network monitoring software, and EV driver software. The company recently partnered with General Electric to accelerate EV infrastructure deployment.

- **Coulomb Technologies** was an early entrant in the EVSE market but is now moving away from hardware manufacturing and toward management of its charging network. Coulomb sells subscriptions for access to its nationwide ChargePoint network. The company has received a $15 million U.S. Department of Energy (DOE) grant to support EVSE deployment in nine regions across the country. The program will support deployment of up to 4,600 charging stations.

- **ECOtality** is currently managing The EV Project, a $115 million DOE grant to set up charging networks in 16 cities. It will be the largest deployment of EVs and EVSE to date. ECOtality's charging infrastructure is branded as the Blink Network.

- **Eaton Corporation**, a well-established power equipment manufacturer, recently began producing EVSE. The company has partnered with Gridpoint to provide infrastructure services and aggregate data from its EVSE locations.

- **General Electric** has developed the WattStation EV charger for residential, commercial, and public charging as well as the WattStation Connect mobile app, which allows users to locate charging stations, check on availability and charging status, and pay for charging services.

- **Leviton**, which manufactures electrical wiring devices, data center connectivity products, and lighting energy management, has recently entered the EV charging market. Its Evr-Green product line provides EVSE for residential, commercial, and public charging.

- **NRG Energy** is now building out its eVgo Charging Network in Houston, which will be the first privately funded, comprehensive EV charging network in the country. NRG aims to provide complete range confidence by building up to 150 charging stations across the Houston metropolitan area. Customers will pay a flat monthly fee to access charging anywhere in the network. The eVgo network also operates in the Dallas/Fort Worth area and is expanding into other markets.

- **Siemens** offers a number of EV charging station models to homeowners, municipalities, corporations, fleets, and utilities. They offer multilevel charging, meaning that both Level 1 and Level 2 charging are supported.

There is a strong emerging market for EVs, charging equipment, and related services. The challenge for the metropolitan Washington region is to identify regional obstacles to significant local deployment and to work to make the region attractive for prospective EV owners, manufacturers, and service providers. The next section looks specifically at the current state of the local EV charging market—what drives decisions as to where to locate EV charging stations and local efforts to promote the deployment of this technology.

SECTION 3

EV and EVSE DEPLOYMENT PLANNING

While the current market share is small, interest in EVs is steadily growing. The introduction of a wider range of vehicles in coming years, coupled with greater investment in charging infrastructure, signals a shift toward wider adoption of electric drive technology. As well, newly released Corporate Average Fuel Economy (CAFE) standards and surface transportation programs under the Moving Ahead for Progress in the 21st Century Act (MAP-21) will continue to encourage investment in EVs and charging infrastructure.

Summary: Factors Affecting EV Demand

Global: Gasoline prices

National: Federal grants, CAFE standards, tax credits

Regional: Electricity prices

State & Local: Incentives and requirements

Consumer/Purchaser: Cost, range, availability of EV models and availability of charging infrastructure

To assess the future of the EV market, both vehicle sales and available charging infrastructure must be considered. EV expansion can be seen as "chicken and egg" issue, in which growth in vehicle sales is dependent on available charging stations, while new charging station installations are largely driven by increases in of EV ownership. Federal stimulus programs, private investment, and strategic partnerships among vehicle manufacturers, charging infrastructure providers, and other businesses are beginning to address this issue and promote a coordinated expansion in both the vehicle and charging infrastructure markets. State and local programs also play a role in promoting EV adoption.

At the regional level, state and local governments have an important role to play in EV infrastructure planning. Household travel behavior and EV ownership in the region are important factors to consider in deciding where and how many charging stations may be located at places of major employment, retail locations, public facilities, and entertainment destinations. Some data on these factors are presented in this report, but more analysis is needed. The Task Force addressed the question of where EV infrastructure should be located in the region, and considered the special challenges of providing charging at popular destinations and for residents of multi-unit buildings.

This section presents baseline information on EV ownership and a charging station inventory, along with general site location recommendations. Deployment planning strategies and a preliminary regional needs analysis are presented along with best practices to improve the network going forward. This section's recommendations include promoting strategic EVSE siting, reducing EVSE installation costs, and using incentives to promote investment in publicly accessible charging stations.

OUTLOOK FOR THE EV MARKET

Current EV market share is small but growing. According to the Electric Drive Transportation Association, over 17,000 BEVs and PHEVs were sold in 2011, and 25,000 were sold between January and August 2012. EVs constituted less than 0.1 percent of total U.S. vehicle sales in 2011, while all electric-drive vehicles, including hybrid vehicles, PHEVs, extended range vehicles, and EVs constituted just over 2 percent.[30] While projections for EV sales over the next 5 to 20 years vary considerably, there is a general consensus that President Obama's goal of reaching 1 million electric vehicles sold in the U.S. by 2015 is overly optimistic. Rather, most estimates predict cumulative sales will be around half a million in that time frame. [31,32]

Given that the current generation of EVs has been available to consumers for less than two years at the time of this report, analysts are limited in their ability to predict future growth from sales history alone. Most projections rely on historical data about hybrid vehicle adoption, as well as production estimates from manufacturers, to generate projections.

The Electric Power Research Institute (EPRI) has created a model based on the above factors, as well as actual EV sales in 2010 and 2011, to produce projections for EV sales nationally and in key markets. They estimate that cumulative U.S. PEV sales will reach 0.6 million to 1.2 million by 2015, and will be in the tens of millions by 2030. The model displays three adoption scenarios. The low scenario uses hybrid sales figures from 2002 to 2008 to predict EV sales through 2015. The medium scenario is based on launch announcements and production estimates from manufacturers. The high scenario represents an aggregation of publicly available forecasts, specifically selecting the top third of available studies. See Figure 3-1 for sales estimates for the U.S. market.

EV sales are expected to grow as the availability of popular models expands. Industry experts suspect that limited vehicle selection and constraints on the availability of the most popular models, the Nissan LEAF EV and the Chevy Volt plug-in hybrid electric vehicle (PHEV), have held back growth in the EV segment in recent years. In 2011, the LEAF was available in only 30 states, and all cars produced that year were claimed by preorders from 2010. This left only a few unclaimed preorders available to car shoppers that year. Chevrolet also did not begin offering the Volt nationally until fall 2011. As the roll-out progressed, sales have increased. August

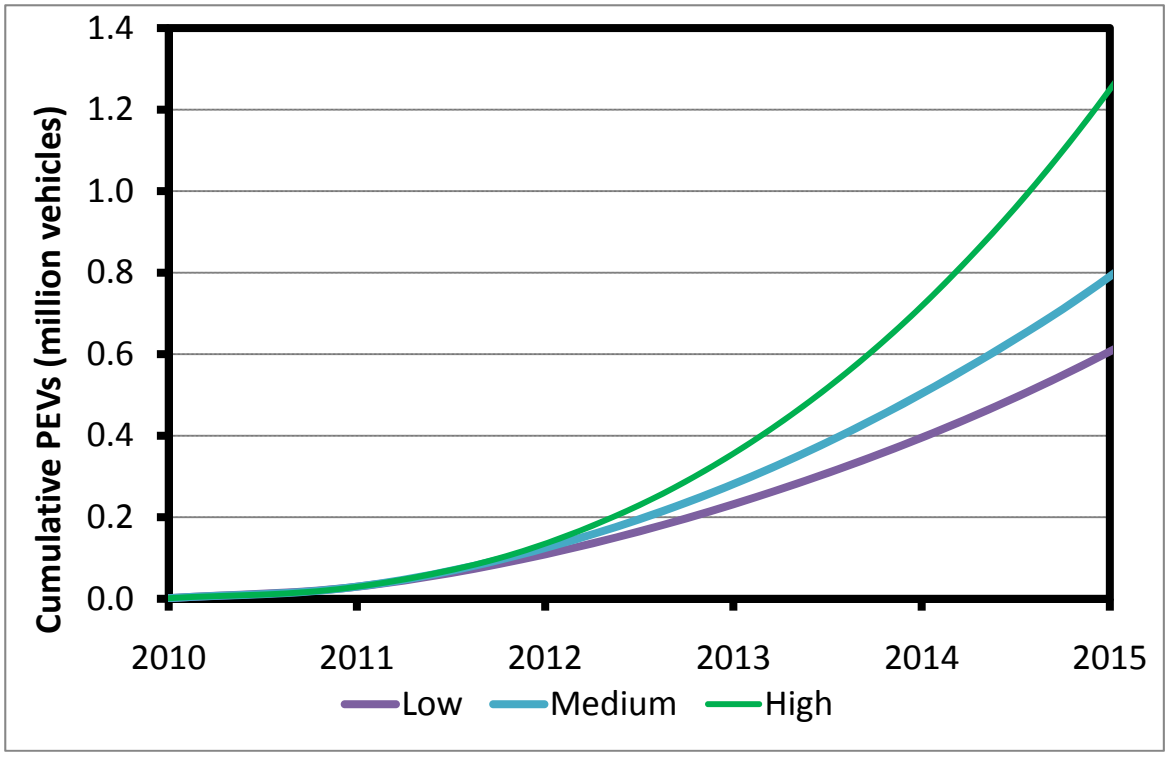
[30] Electric Drive Transportation Association. *Electric Car Sales*. http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952

[31] The Center for Automotive Research. Deployment Rollout Estimate of Electric Vehicles, 2011-2015. http://www.cargroup.org/assets/files/deployment.pdf

[32] KEMA. Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems. March 2010. http://www.ercot.com/content/news/presentations/2011/IRC_Report_Assessment_of_Plug-in_Electric_Vehicle_Integratio.pdf

2012 was the Volt's highest selling month yet, with 2,831 vehicles sold.[33] Wider availability of the LEAF and the Volt, as well as the national release of the Mitsubishi i in summer 2012, are expected to open the market to additional growth. [34] Further, a number of new EV models are expected for national rollout in 2013 and 2014.

Figure 3-1. U.S. Cumulative PEV Sales Projection through 2015



Source: Plug-in Electric Vehicle Load Estimator, Electric Power Research Institute, Palo Alto, CA: 2012.

Additionally, recent action at the federal level may promote growth the EV market. As Corporate Average Fuel Economy (CAFE) standards increase, automobile manufacturers are investing more in high efficiency vehicles, including EVs. The 2025 CAFE standards, finalized in August 2012, would require manufacturers to significantly reduce the greenhouse gas emissions impact of their vehicles through fuel economy improvements and other modifications, resulting in the equivalent of a 54.5 mpg fleetwide average by 2025.[35] EVs, which offer ratings of 75 to over 100

[33] Blanco, Sebastian. "GM sells 2,831 Chevy Volts in August, Nissan sells 685 Leafs." Autoblog Green, September 4 2012. http://green.autoblog.com/2012/09/04/gm-sells-2831-chevy-volts-in-august-nissan-sells-685-leafs/

[34] Edmunds.com. *Upcoming Revenge of the Electric Car? The Potential for Higher EV/PHEV Sales*. http://www.edmunds.com/industry-center/commentary/upcoming-revenge-of-the-electric-car.html

[35] National Highway Traffic Safety Administration. *Obama Administration Finalizes Historic 54.5 mpg Fuel Efficiency Standards.* http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/Obama+Administration+Finalizes+Historic+54.5+mpg+Fuel+Efficiency+Standards

miles per gallon equivalent (MPGe), will play an increasingly important role in auto manufacturers' fleets as they seek to meet the ambitious 2025 goal.[36]

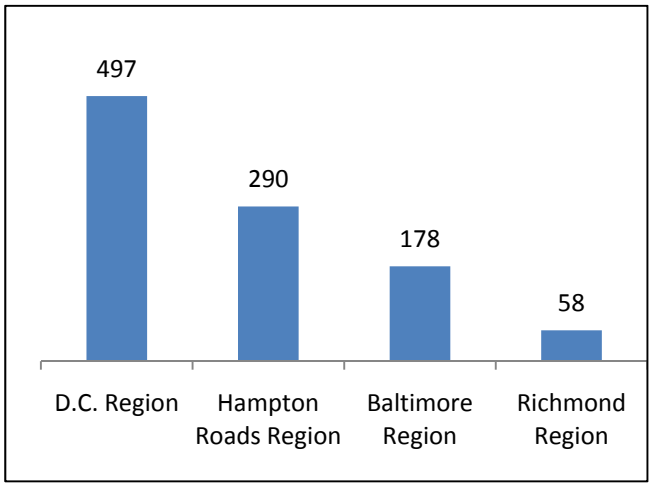
Under the new regulations, manufacturers will be granted extra credit for selling electric, plug-in hybrid, and fuel-cell vehicles. In model year 2017, each EV sold will count as 2 vehicles in the manufacturer's fleetwide average, and PHEVs will count as 1.6 vehicles. The credits will be phased down to multipliers of 1.5 for EVs and 1.3 for PHEVs by model year 2021.[37] These multipliers serve as an additional incentive for manufacturers to increase EV sales.

MAP-21, legislation that was signed into law in July 2012, contains provisions that could help expand EV charging infrastructure. It continues the Congestion Mitigation and Air Quality Improvement Program (CMAQ), which provides a flexible funding source that state and local governments use to meet requirements of the Clean Air Act through transportation projects. Under the law, areas designated as "nonattainment" or "maintenance" of fine particulate matter (PM 2.5) standards are required to use a portion of their CMAQ funds toward projects to address the issue. The metropolitan Washington region is currently in maintenance status, and is thus subject to this provision. Eligible activities include installing facilities for electric or natural gas-fueled vehicles.[38] This additional funding source, backed by federal mandate, could contribute to increased growth of EV charging infrastructure in the Washington region.

Regional Forecast for EV Ownership

Currently, there are approximately 500 EVs registered in the metropolitan Washington region (see Figure 3-2). While it is difficult to predict exactly how many EVs that will be operating in the region in coming years, one approach to predicting future EV demand is to analyze the experience of early adopters of hybrid vehicles. COG staff analyzed registration data available from the Transportation Planning Board (TPB) from 2005 to 2011. In just six years, the number of registered

Figure 3-2. Electric Vehicle Registrations (as of June 2012)

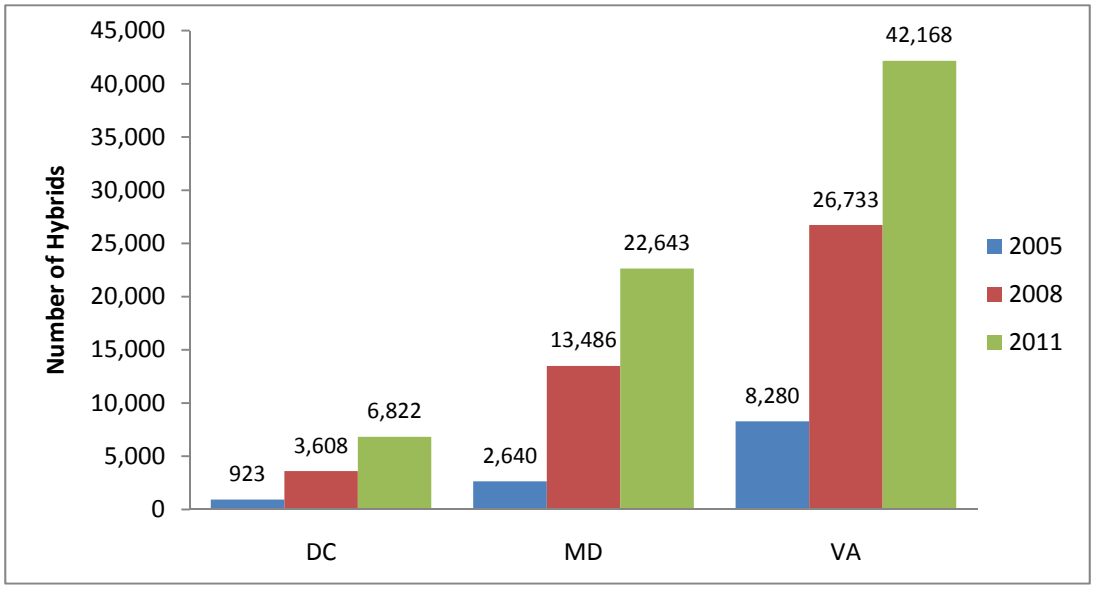


Source: DMV Registration Data.

[36] U.S. Department of Energy. *2011–12 Electric Vehicles.* http://www.fueleconomy.gov/feg/evsbs.shtml
[37] Berkowitz, Justin and Csaba Csere. "The CAFE Numbers Game: Making Sense of the New Fuel-Economy Regulations." Car and Driver, November 2011. http://www.caranddriver.com/features/the-cafe-numbers-game-making-sense-of-the-new-fuel-economy-regulations-feature
[38] Federal Highway Administration. MAP-21 fact sheet: Congestion Mitigation and Air Quality Improvement Program (CMAQ). http://www.fhwa.dot.gov/map21/cmaq.cfm

hybrid vehicles grew by more than 600 percent. However, total registered hybrid vehicles in the region still represent approximately 1.5 percent of all vehicle registrations. Figure 3-3 shows the growth of hybrid vehicle registrations in the District of Columbia, Maryland, and Virginia. Virginia's higher hybrid vehicle registration is in part due to incentives in 2005–2006 allowing hybrids to use HOV lanes.[39] Maryland began offering an HOV exemption for plug-in electric vehicles in October 2010.[40]

Figure 3-3. Washington Area Hybrid Vehicle Registration for 2005, 2008, and 2011



Source: DMV Registration Data.

Using the most conservative estimate of regional EV adoption by 2015–2020, if EVs experience a 600% increase in five years—mirroring the rate of adoption of hybrids—the region could have 1,500 to 3,000 EVs operating on the roadways (up from the current number of approximately 500 vehicles). As a high estimate, if total EV sales in the next eight to 10 years reach fleet levels comparable to current levels of hybrids, the region could see anywhere from 50,000 to 75,000 EVs operating on the roadways by 2020.

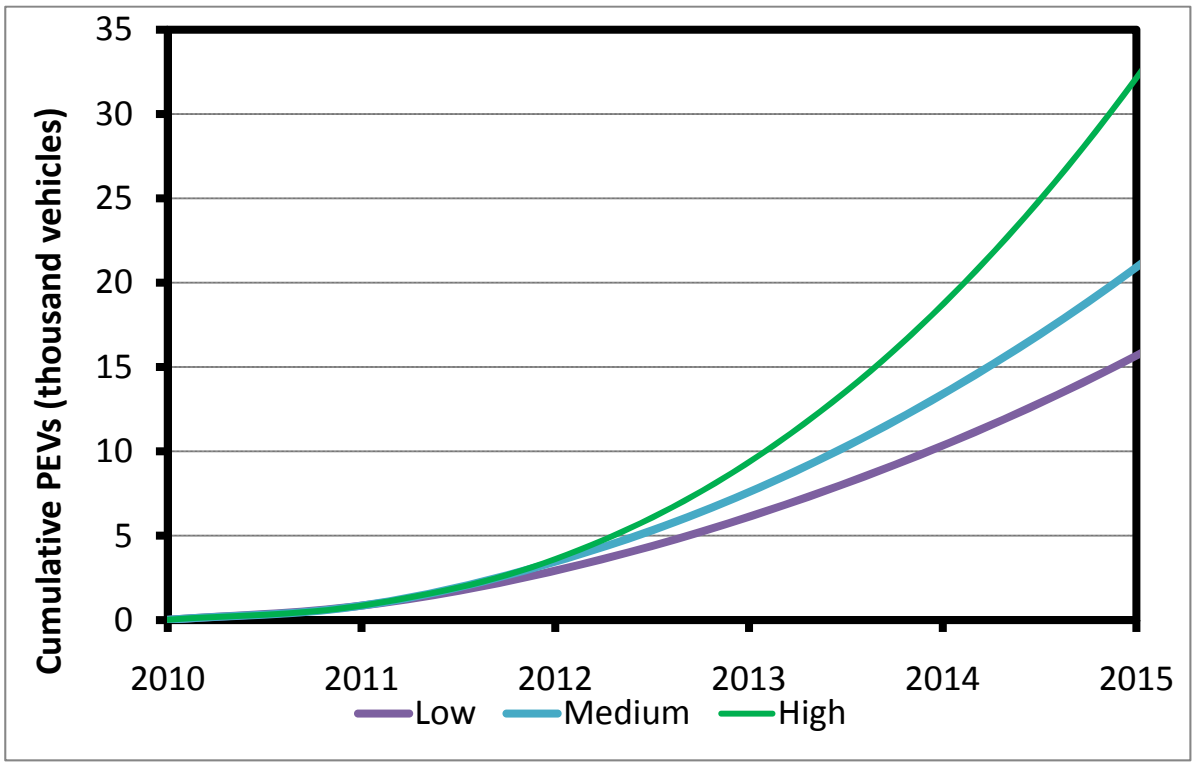
COG staff was also able to document generally where the early adopters of hybrid vehicles are located. Early adopters may be found in clusters, with potentially higher concentrations residing in Fairfax and Montgomery counties, in inner ring suburbs, and in the District of Columbia. Using this information as guidance, in the near term, the region may experience higher EV

[39] These incentives are no longer available to new hybrid owners due to congestion along I-95/395 and I-66. The original privileges were grandfathered in for earlier hybrid vehicles with Clean Car Virginia licenses.
[40] Maryland Motor Vehicle Administration. High Occupancy Vehicle (HOV) Permit Issuance for Plug-in Electric Vehicles. http://www.mva.maryland.gov/About-MVA/INFO/27300/27300-54T.htm

adoption rates in the inner suburbs and core, in areas with relatively high household income, and in households with multiple cars.

The EPRI model estimated slightly higher adoption rates for the region, as shown in Figure 3-4, ranging from 15,000 to over 30,000 vehicles by 2015. The study area includes all counties in COG's membership, and the District of Columbia. Regional estimates use hybrid adoption rates as compared to the national average to predict geographic differences in EV adoption rates.

Figure 3-4. Washington Region Cumulative EV Sales Projection through 2015



Source: Plug-in Electric Vehicle Load Estimator, Electric Power Research Institute, Palo Alto, CA: 2012.

REGIONAL EVSE INVESTMENT PROGRAMS

Using federal stimulus funding, private investment, and state government incentives, EV infrastructure is expected to continue growing in coming years. Federally funded programs in the Washington region include ECOtality's The EV Project, Coulomb's ChargePoint America Program, and the Maryland Electric Vehicle Infrastructure Program (EVIP)/BEVI (Baltimore-Washington Electric Vehicle Initiative). Additionally, the Northeast Regional Electric Vehicle Network project is also assisting local and regional planning efforts. Several COG member jurisdictions are pursuing EV programs, and state- and utility-provided incentives support these efforts. These projects are described below.

ECOtality's The EV Project

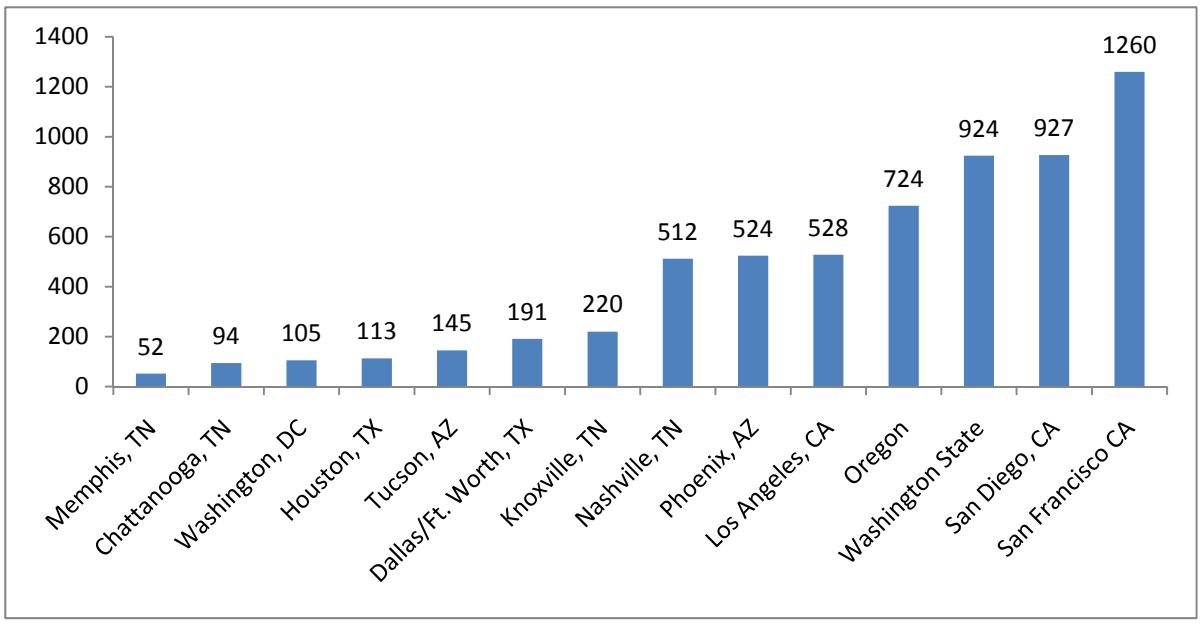
The EV Project is a $230 million project that received $115 million in stimulus grant funds to install 15,000 Level 2 commercial and residential charging stations across 18 cities and metropolitan areas, including the Washington region. The project is expected to install the infrastructure to support the deployment of 5,700 Nissan LEAFs and 2,600 Chevy Volts.

In the metropolitan Washington region, the EV Project will install residential charging stations at no cost to qualified participants. Nissan LEAF and Chevy Volt owners may apply, and in exchange for allowing the collection of information about vehicle usage and charging, participants receive a Blink wall mount charger and may be eligible for a $1,200 credit toward installation.

As of March 2012, The EV Project had installed 5,432 charging stations nationwide, including 83 residential Level 2 charging stations in the metropolitan Washington region. Ninety-nine Chevy Volts had been enrolled for data sharing. The metropolitan Washington region has seen a relatively low share of EVSE installments among participating cities. Despite being the fourth most populous metropolitan area included in the project, it ranks 11th in number of stations installed and 14th in number of stations per capita. The region has fewer than 15 EV Project stations per million residents, while the top-ranking metropolitan area, San Francisco, has 628. Figure 3-5 shows the number of charging stations installed in the 14 top-ranking metropolitan areas as of March 2012.

Between January and March 2012, there were 5,123 charging events at The EV Project charging stations in the metropolitan Washington region. These charging events consumed 32.11 AC MWh of power. Most charging occurred between 4 p.m. and midnight, with a peak at around 10 p.m. The average connection time was 10.6 hours per vehicle, but charging time averaged only two hours. Vehicles consumed an average of 6.3 AC kWh per charging event.

Figure 3-5. Total EV Project Chargers Installed by Metropolitan Area through June 2012



Note: The Oregon project area includes the Greater Corvallis, Eugene, Portland, and Salem Metropolitan Areas; Washington State includes the Greater Seattle and Olympia Metropolitan Areas. Washington, DC region EV Project stations are all home charging stations. For multifamily and all other non-residential stations, see the electric vehicle charging station inventory discussed later in this section.

Source: U.S. Department of Energy Vehicle Technology Program, http://avt.inl.gov/pdf/EVProj/EVProjOverviewQ22012.pdf

Coulomb Technologies' ChargePoint America Program

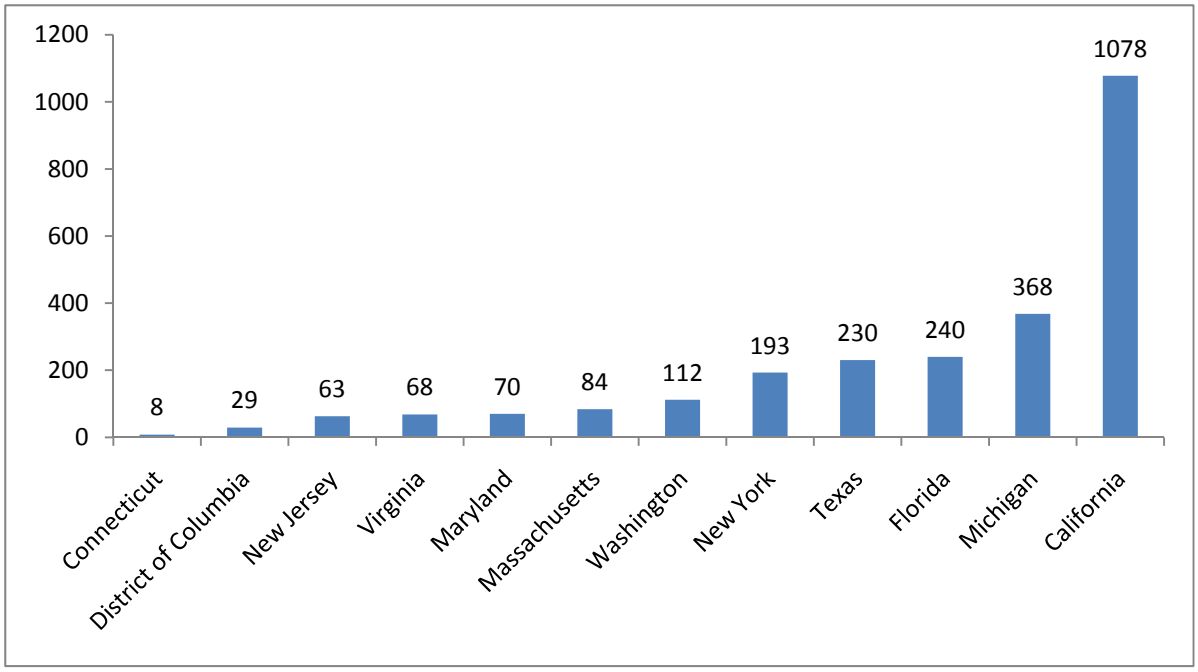
The ChargePoint America Program is a $37 million program made possible by $15 million in stimulus funding. The program is in partnership with Ford, GM Chevy, and Daimler's Smart USA and is intended to support the deployment of 4,600 Coulomb public and private residential Level 2 charging stations in 12 selected regions across the country.

Approximately 300 charging stations are expected in the metropolitan Washington region. Free residential charging stations are available to drivers who own a Chevy Volt, Ford Transit Connect, Ford Focus Electric, BMW ActiveE, Nissan LEAF, Fisker Karma, or Smart Fortwo Electric Drive and live within one of the 12 program regions.

As of December 2011, ChargePoint America had installed 1,432 charging stations across its 12 project areas. Figure 3-6 shows the distribution of charging units across the participating states and the District of Columbia. The District of Columbia received 14 stations, and Maryland and Virginia each received 37, for a total of 88 stations. Among total installations, 694 chargers are residential, 110 are private commercial, 624 are public, and four are not specified. The number

of installed ChargePoint America stations in each program region is roughly proportional to its population. The District of Columbia, Maryland, and Virginia have a combined average of just over six ChargePoint America charging stations per million residents. This distribution is similar to that of New York, New Jersey, and Florida.

Figure 3-6. ChargePoint America EV Chargers Installed by State, through March 2012



Note: Many of the Maryland and Virginia stations are located in the MWCOG Region. The ChargePoint America program is continuing to install charging stations in the MWCOG Region until funding is exhausted.

Source: U.S. Department of Energy Vehicle Technology Program, http://avt.inl.gov/pdf/evse/CoulombQ1Combine2012.pdf

Maryland Electric Vehicle Infrastructure Program (EVIP)

This project was made possible by a $1,000,000 stimulus award to the Maryland Energy Administration (MEA). The program made awards in two categories: electric recharging infrastructure and truck stop electrification (TSE). For electric recharging, MEA committed to issuing grants to entities interested in building electric charging station infrastructure in Maryland. Approximately 81 EV charging stations are currently installed statewide (12 are located in the metropolitan Washington region). The main areas of EVIP charger deployment include BWI Airport, downtown Baltimore, and Annapolis. Grants for TSE were issued for equipment and installation costs. Partnering with EVIP was the Baltimore Electric Vehicle Initiative (BEVI), which also

worked with the Tower Companies to install charging stations in the Maryland suburbs of the metropolitan Washington region.

NYSERDA's Northeast Regional Electric Vehicle Network Project

This project is in partnership with the New York State Energy Research and Development Authority (NYSERDA), the National Association of State Energy Offices, the Georgetown Climate Center, the Transportation and Climate Initiative (TCI), and 16 Clean Cities Coalitions in the Northeast and Mid-Atlantic regions. The project aims to develop a plan and guidance material to accelerate the introduction of an EV charging station network throughout the Northeast and Mid-Atlantic regions. The Greater Washington Region Clean Cities Coalition is a subgrantee on this project. COG's regional EV planning effort is also focused on assisting this larger effort in the Eastern United States. The TCI initiative is seeking EV pledges (see the following link for more information: http://www.georgetownclimate.org/sites/default/files/TCI_EV_Pledge.pdf).

Local Projects

In addition to these federal initiatives, some COG member jurisdictions and private entities are taking actions to support EV deployment in the region.

In Northern Virginia, private efforts are underway to install additional stations at Arlington Potomac Regional Park, at the Virginia Center for Innovative Technology, in Fairfax County, and at Loudoun County Park & Ride lots.

Fairfax County, Virginia, has submitted a proposal to DOE to use a portion of their Energy Efficiency and Conservation Block Grant funding for the purchase and installation of 10 Level 2 EV charging stations at county facilities. The county is also focusing on putting EV charging stations in the Tyson's Corner area; plans include guidance on anticipated needs for the future and on site design elements. Fairfax County is looking for direction from the EV Coalition to establish some model practices across the region.

A permit application has been submitted to Arlington County for the country's first all-electric taxicab fleet. Up to 50 Nissan LEAFs would be fueled through a combination of Level 1/Level 2 chargers at drivers' homes and aDC Fast Charge stations at strategically-located retail parking lots in Arlington through a strategic alliance with Nissan and an EVSE provider. This could not only expand EV charging infrastructure in the region, but also elevate the profile of EVs in the region, allowing residents to experience EVs firsthand and perhaps spurring additional interest in the vehicles.

The District of Columbia's Climate Action Plan provides for a substantial incorporation of EVs into the government fleet.[41] The District of Columbia Water and Sewer Authority plans to replace 79 utility vehicles with EVs. The Climate Action Plan aspires to convert 65 percent of the District of Columbia's utility vehicles to EVs by 2012; 200 replacements by 2020; and 350 replacements by 2050.

The Action Plan also calls for the expansion of public and private infrastructure to support EV charging stations around the city. As part of their Park and Charge Pilot Program, the District of Columbia installed the first public Level 2 curbside electric vehicle charging station in the United States at the intersection of 14th & U St., NW, in 2010 in partnership with ChargePoint America and Pepco and partially supported by federal grants. Between installation and April 2012, the station was utilized for 135 charging sessions. The District plans to open at least two more stations at Washington Canal Park in May 2012.[42]

DC's 14th and U St. EV Charging Station

EV Incentives

Perhaps the most well-known incentive for EV purchases is the Federal tax credit program. Persons purchasing an EV or PHEV in or after 2010 may be eligible for a federal income tax credit of up to $7,500. This credit significantly reduces the cost of purchasing an EV, helping to make the vehicles more competitive with conventional cars, which are on average less expensive.[43, 44]

States are also offering incentives to promote EV adoption among residents and vehicle fleets. From HOV allowances to tax credits, reduced vehicle registration fees, and fleet incentives, these programs increase the convenience and reduce the cost of EV ownership. Table 3-1 provides an overview of incentives in the District of Columbia, and Maryland, and Virginia.

[41] Government of the District of Columbia. *Climate of Opportunity: A Climate Action Plan for the District of Columbia* [draft for public discussion]. September 2010. http://rrc.dc.gov/green/lib/green/pdfs/ClimateOfOpportunity_web.pdf. See also http://sustainable.dc.gov/node/135652

[42] The District of Columbia Department of Transportation. Park and Charge Pilot. http://ddot.dc.gov/DC/DDOT/Services/Parking+Services/View+All/Park+and+Charge+Pilot

[43] U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Federal Tax Credits for Electric Vehicles. http://www.fueleconomy.gov/feg/taxevb.shtml

[44] U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Federal Tax Credits for Plug-In Hybrids http://www.fueleconomy.gov/feg/taxphevb.shtml.

Table 3-1. Overview of EV Incentives by State

	Maryland	District of Columbia	Virginia
HOV Exemptions	Drivers of plug-in electric vehicles, titled and registered in Maryland, are allowed to use HOV lanes regardless of number of passengers until September 30, 2013. (Link)	None currently.	Virginia's Clean Special Fuels HOV exemption expired July 1, 2012. It allowed vehicles with Clean Special Fuels license plates to use HOV lanes servicing the I-95/I-395 corridor.
Vehicle Registration, Tax, and Inspection Incentives	EV and PHEV owners may apply for a tax credit of up to $2,000 against the imposed excise tax. (Link)	New registrations on vehicles rated 40 mpg or greater average city fuel economy receive a 50% registration fee discount. (DC Code 50-1501.03, Link). Qualified Alternative Fuel Vehicles and those rated over 40 mpg are exempt from the 6% Title Tax. (DC Code 50-2201.03(j), Link)	EVs, hybrids rated at least 50 mpg and AFVs are exempt from biennial emissions inspections in Virginia (VA Code 46.2-1177–46.2-1178, Link).
Tax Credits	Maryland Energy Administration (MEA) offers an income tax credit of 20% of the cost of qualified EVSE (Link).	None currently.	Local governments in Virginia are permitted to reduce personal property taxes paid on AFVs, including EVs. (Link)
Grant Programs	None currently	None currently	The Alternative Fuels Revolving Fund distributes loans and grants to local and state agencies to support AFV programs. (VA Code 33.1-223.4 and 33.1-223.7, Link)
Fleet Incentives	MEA provides vouchers of up to $20,000 for qualified all-electric truck purchases. (Link)	Certified clean fuel fleet vehicles are exempt from time-of-day and time-of-week restrictions and commercial vehicle bans (DC Code 50-702 and 50-714, Link).	None currently.

EV INFRASTRUCTURE NEEDS ANALYSIS

Given the recent growth in EV infrastructure in the region, a coordinated planning effort is needed in order to direct future investment to locations in the region where it will have the most impact and best serve EV drivers' needs. The following analysis of regional travel patterns and current locations of EV charging infrastructure seeks to support this effort.

The potential need for public/private charging infrastructure siting can be informed by examining a variety of regional characteristics and trends. The following are some factors relevant to the metropolitan Washington region:

- Data on housing type (i.e., the number and distribution of households with and without access to private driveway or garage) indicate the potential location of home charging stations and the need for multifamily, EV car-share, workplace, or other destination infrastructure.
- Data on the location of hybrid vehicle owners and on households with higher income indicate possible locations of early EV adopters.
- Location of workplaces with 20–40 mile vehicle commutes can be useful because commutes of 20–40 miles are good EV candidates.[45] Shorter commutes can be made on one charge; longer commutes may be out of the range of one battery charge for some EVs.
- Identifying households with more than one vehicle can be useful because for early adopters, EVs are more likely to be feasible for households with two or more cars.
- The distribution of vehicle trips across the central core, inner suburbs, outer suburbs, and outer ring suggests locations where demand for EVSE will occur.[46]
- The number of vehicle trips to non-work and non-home destinations indicates popular recreational and retail destinations.
- Length of vehicle trips by destination indicates the relationship of trip length to vehicle charging needs.

[45] Metric used by Western Washington Clean Cities Coalition. http://www.wwcleancities.org/index.html

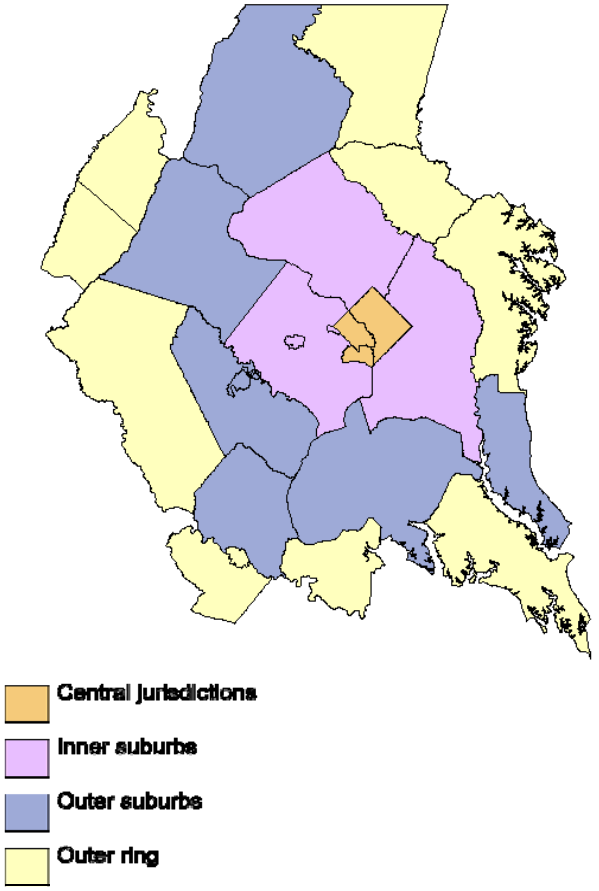
[46] COG DTP, 2009. Presentation of Some Initial Findings by Robert E. Griffiths, Technical Services Director to the National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, January 28, 2009. http://www.mwcog.org/committee/committee/archives.asp?COMMITTEE_ID=15

REGIONAL TRAVEL PATTERN ANALYSIS

Analysis of regional travel patterns found that EVs can be effectively deployed to meet the region's automobile transportation needs. Data from the COG Household Travel Survey and Travel Demand Model indicate that average vehicle trip length in the region is 7.7 miles, and therefore most trips fall well within the range covered by an EV on one charge. Many of these trips include destinations that would be good candidates for charging solutions, such as workplacs, shopping, schools, and recreational sites.[47]

The region is heavily reliant on vehicle travel. Approximately 60 percent of trips identified in the Household Travel Survey were auto-oriented trips that could potentially be served by EVs in the future. Due to EV range restrictions and access to private garages for home charging, EVs may be most suitable as the second car in two or more vehicle households located in suburban, car-dependent areas (See Figure 3-7). Outer suburbs and exurbs may require more frequent long trips that are out of the range of EVs. Core urban areas may be served by alternative transportation and car-shared EVs and may contain more one-car or no-car households.

Figure 3-7. Jurisdiction Categories Used by COG DTP to Evaluate Travel Patterns



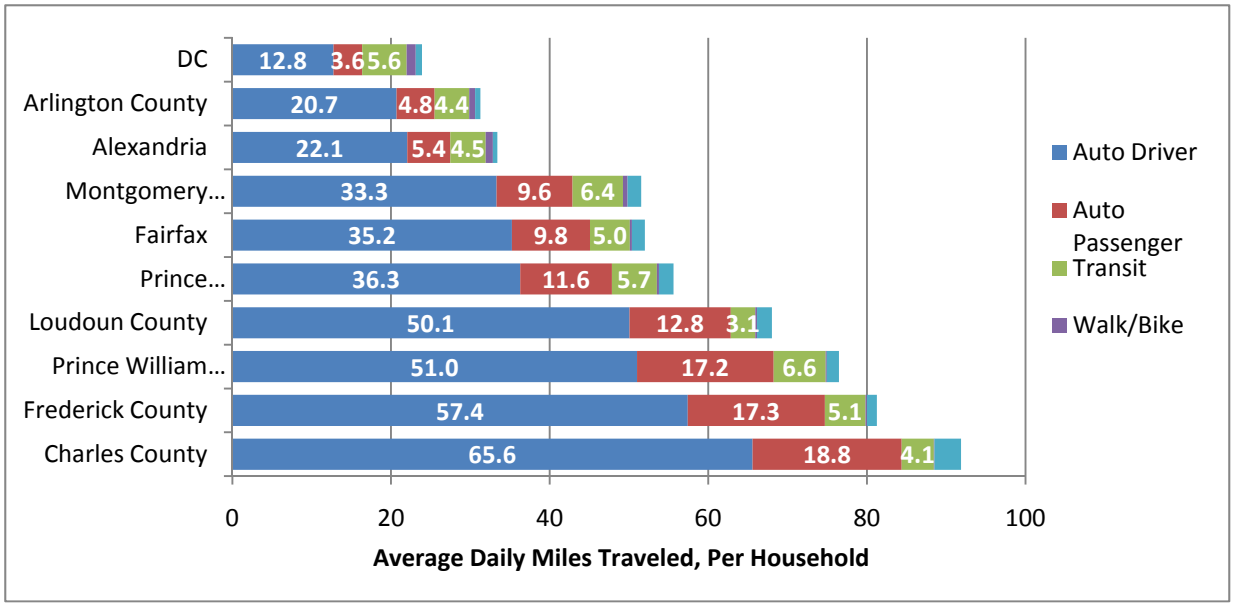
Source: COG Department of Transportation Planning, *2007/2008 Household Travel Survey*.

As Figure 3-8 illustrates, the proportion of trips made by auto varies by jurisdiction in the COG region, as does the average daily miles traveled per household. Many of the region's households have access to more than

[47] COG's Household Travel Survey is based on a random sample of about 10,000 households inquiring when, where, how, and why people travel. Survey respondents complete a 24-hour travel diary, noting mode of transport, number of trips, destination, and length in time and distance for each trip taken. This information is used in transportation planning, such as development of predictive demand travel forecasting models. Survey findings are informative in planning for EVs. The Household Travel Survey statistics reported here are based on the most recently completed survey, conducted in 2007–2008.

one vehicle, and the figure does not indicate how trips are chained. Nevertheless, daily mileage figures indicate that residents in the core and inner jurisdictions could fulfill their daily travel needs by EV on one charge. EV drivers in outer jurisdictions may need to charge at workplace or recreational destinations before returning home.

Figure 3-8. Average Daily Miles Traveled per Household by Jurisdiction and Mode



Source: 2007/2008 MWCOG TPB Household Travel Survey.

Trip Length and EV Range

Electric-only models available in the region are designed to travel from 62 to 72 miles on one charge. A fairly conservative rule of thumb for EV range is 20 miles one way, although some models handle much longer journeys, depending on driving conditions. The range of EV models that are available in the region is listed in Table 3-2.

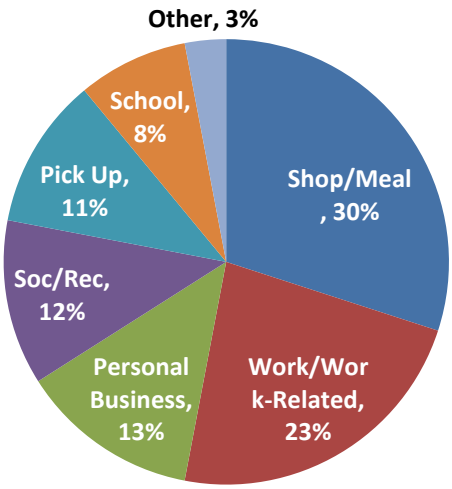
Table 3-2. Range of EV Models Available in the Metropolitan Washington Region

Vehicle	Range per charge (in miles)
Electric-only	
Nissan LEAF	72
Mistubishi i	62
Hybrid electric	
Chevy Volt	35
Toyota Prius Plug-In	15
Fisker Karma	50

Source: Alternative Fuels and Advanced Vehicles Data Center, http://www.afdc.energy.gov/vehicles/search/light/autos?fuel_type_code=ELEC

Figure 3-9 suggests travel destinations that would be good candidates for charging solutions—workplace, shopping, schools, and recreational sites.

Figure 3-9. Travel Destinations in the Region



Note: Work/Work-Related includes trips to work, trips to work after other stop, and work-related trips.
Source: 2007/2008 TPB Household Travel Survey.

Regional Activity Centers
are a tool developed by MWCOG to help guide land use and transportation planning decisions. These areas have high employment concentrations as well as residential, transit, and cultural features that make them targets for future investment. Regional Activity Centers are designated according to current local comprehensive plans and zoning, and are approved to accommodate projected employment and housing growth in the Washington region.

Find more information at **www.regionforward.org/overview**.

Trips to Work

Most automobile commuting trips in the region—55 percent—end in one of the metropolitan area's Regional Activity Centers (see sidebar). A high proportion of these commuting trips—91 percent—are shorter than 20 miles one way. A small proportion of auto commute trips—1.3 percent—are longer than 40 miles. This suggests that EVs could serve the needs of most daily work commuters headed to Regional Activity Centers.

Trips for Shopping

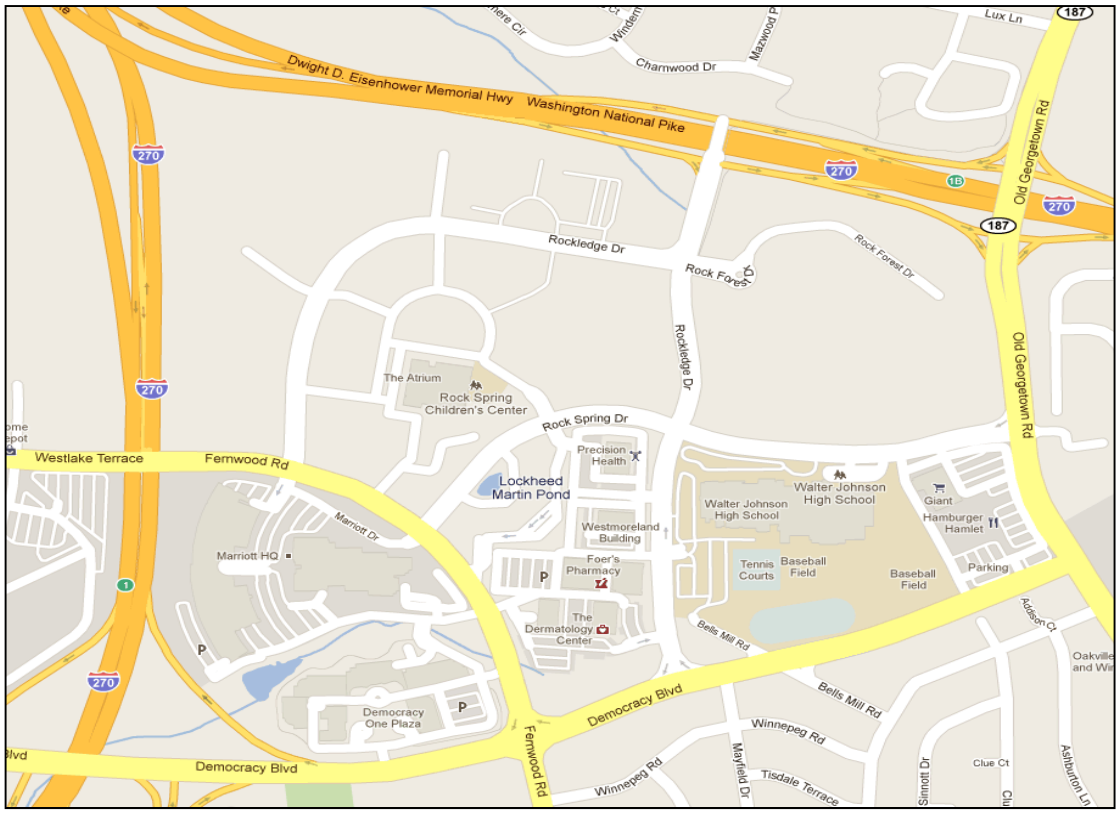
Shopping also involves a significant number of automobile trips that are less than 20 miles—96 percent. EVs could be accommodated by home charging or car-share charging, with some retail charging locations helpful as a backup or for drivers who conduct more than one trip on a charge.

Small Area Case Study: Highway 270 and Democracy Boulevard in Maryland

COG transportation staff conducted a sample siting analysis for EV infrastructure for illustrative purposes, using data from the 2007/2008 Household Travel Survey. Transportation Analysis Zones (TAZs) with the highest number of home-to-work trips made by car were identified. The zone in the region with the greatest number of these trips that was not a major military installation was found to be north of Bethesda in Montgomery County, Maryland. Zone 702, shown in Figure 3-10, exhibits several factors that indicate potential for charging station demand.

Zone 702 is difficult to access other than by private vehicle, and it contains major employers with whom local governments could partner to encourage EV usage. In addition, 77% of those working in Zone 702 live within 20 miles of their workplace, which could be accommodated by today's EV range. If commuters had access to charging stations in this area, even workers who did not have access to a private driveway or private garage could potentially commute via EV. Currently, there is just one publicly accessible charging station in the area, which is located at the SunTrust Bank at Democracy Boulevard and Old Georgetown Road, with three Level 2 chargers. Areas with these characteristics could be targeted with policies to encourage installation of additional stations, while not inducing proportionally more vehicle trips.

Figure 3-10. Transportation Analysis Zone 702



Source: googlemaps.com

EV CHARGING LOCATIONS

This subsection identifies considerations and recommendations for deploying EV charging infrastructure at specific site types, including homes, workplaces, and public locations. Many sources recommend taking an adaptive approach—laying the groundwork in new development and redeveloping areas for future infrastructure capability. The discussion below highlights the advantages and challenges of various EV charging location sites. Figure 3-11 lists the suitability of different types of charging stations for different vehicle uses and locations.

For EV owners, the majority of charging will likely occur at home, with the workplace being a secondary charging location.[48] While home charging is the most important charging location, residents of multifamily buildings and urban dwellers without a dedicated garage or driveway will require innovative charging solutions. Public charging should be provided in strategic locations on the basis of driver lifestyle destinations—shopping, theater, hairdresser, Park & Ride, and so forth. EV car-sharing and rental programs provide additional opportunities for non-PEV owners.

Homes

Figure 3-12 provides an overview of charging locations. Homes—where a vehicle spends 8–12 hours parked—is located at the base of the pyramid, indicating that it will see the highest demand for charging. The relative suitability for EV use of different types of homes is discussed below:

Figure 3-11. Charging Location Guidelines by Charging Level Type

Adapted from The EV Project

Level 1 Locations—Full charge up to 24 hours

– Residential Locations
  - Lightly traveled BEVs, PHEVs
  - All night charging available
– Workplace Locations
  - All day charging available
– Emergency Use
  - Carry converter in trunk for backup use with any compatible electric socket

AC Level 2 Location—Full charge 4 to 6 hours

– Destination Locations
  - Where people shop, play, gather
  - Target is 1–3 hour stays
  - Expand effective operating range
  - Higher turnover
– Workplace Locations
– Parking Garages

DC Fast Charging—Full charge 20–30 minutes

(None yet available in Washington area)

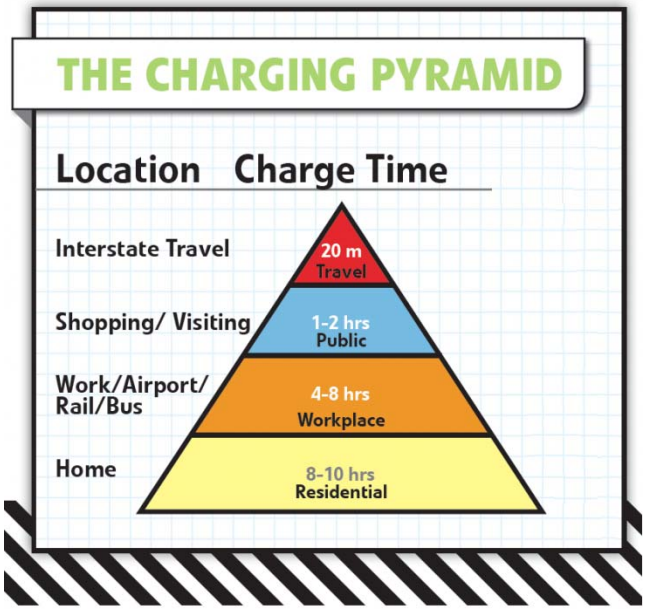
– Destination Locations
  - Short stops: convenience stores, fast food, rest stops, shopping
  - Target is 15–30 minute stays
  - "Safety net" locations
  - Serve "gargeless" EV owners
– Freeway Corridors
– Typically High Traffic Areas

Infrastructure Micro Climate Process and Data Collection. Presentation by Stephen Schey and Jim Francfort, June 21, 2010. Available at http://www1.eere.energy.gov/cleancities/toolbox/pdfs/ev_charging_infrastructure.pdf

[48] Idaho National Laboratory. American Recovery and Reinvestment Act (ARRA) – Light-Duty Electric Drive Vehicle and Charging Infrastructure Testing. See Infrastructure Summary Reports, http://avt.inl.gov/evproject.shtml.

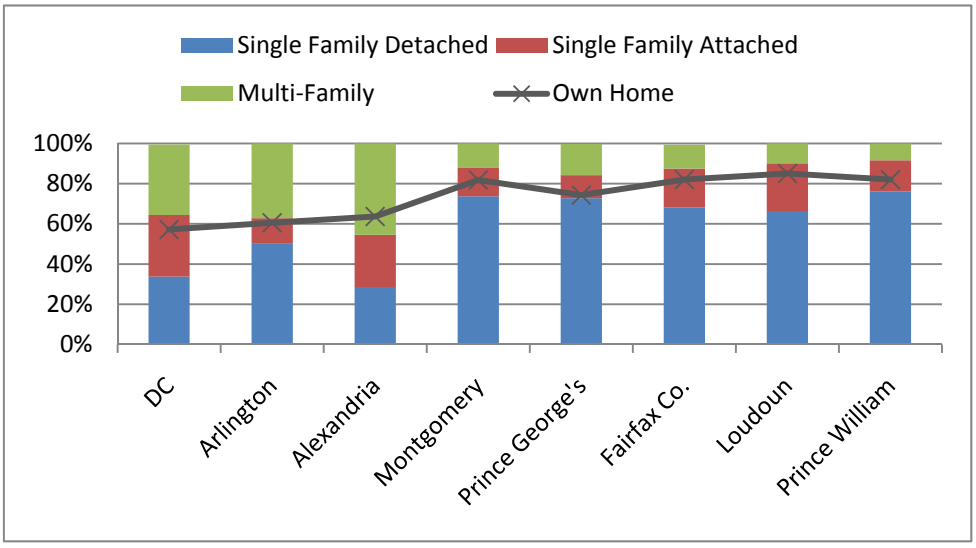
- **Single family homes** that have garages or driveways are the most straightforward locations. As shown in Figure 3-13, single-family home ownership is common in many regional jurisdictions. A local permit may be required if an EV charging unit is installed.
- **Town homes** without garages or driveways will have special charging station location needs.
- **Apartments/condominiums** and other multiunit dwellings have particularly difficult challenges due to limited and/or shared parking and lack of access to electrical conduits. Multifamily residential units vary in their needs regarding EV infrastructure implementation. Homeowners associations may need to be educated about EV charging stations, their requirements, and how to locate them.

Figure 3-12. Charging Location Pyramid



Source: Modified from Charged EV Magazine http://www.chargedevs.com/content/features-inside/where-speed-hardly-matters-level-1-charging-opportunities

Figure 3-13. Housing Type by Jurisdiction



Note: A majority of residents in DC and Alexandria live in multifamily or single family attached housing, while single family home ownership is common in other jurisdictions. *Source:* 2007/2008 Household Travel Survey.

Work

Workplaces—where vehicles spend typically 6–10 hours parked—may present another opportunity for charging EVs. Workplace charging provides employers with the opportunity to attract high-quality employees and present an innovative image. Work-related destinations may also include office parks, hotels (business trips), institutions and universities, convention centers, hospitals, fleet depots and motorpools, nonprofits, and Park & Ride lots. The Task Force found that many building owners and operators are uninformed about EV charging station installation requirements. Some workplaces have limited parking. Building owners may need to consider permitting, parking lot management, and turnover of charging parking spaces. Surface parking lots and garages have different site-level issues.

Amenities and Recreation Destinations

Vehicles spend typically 1+ hours at amenities and recreation destinations, which are the third-most-used location. Amenities destinations include surface parking lots or garages, shopping malls or other retail locations, cultural centers, restaurants, sporting venues, universities, curbside in cities, parks and recreation areas, airports, gas stations, and rest stops. Issues to consider when locating EV charging stations include permitting, training and education on technical installation practices, and parking space turnover management (less applicable than at workplaces). Gas stations and rest stops are feasible only if they are adjacent to other uses or are designed for long stays, such as mixed-use locations. EV dealerships are also advantageous locations for charging stations.

Public Facilities

Charging stations at public facilities, where vehicles spend 1+ hours, can be positioned to complement existing privately financed stations. Public facilities that could support charging stations include city halls, libraries, courthouses, town squares, and other public institutions. Beyond serving their employees, charging stations that serve customers in public facilities can educate vehicle owners and reduce range anxiety, assisting in kick-starting the market. Public facilities charging stations can demonstrate the feasibility and highlight the air quality benefits of EVs. Charging stations that serve on-street parking in the right-of-way is a special case that poses significant cost barriers and site-survey needs in order to access the power source and meet the requirements for a second utility meter (see Section 4 on Local Government Policy).

Car Rental and Car Sharing

Vehicles spend varying amounts of time parked at car rental and car-sharing facilities. These locations can provide unique educational opportunities and space-efficient solutions for travelers and urban dwellers. Charging stations for rental and car-sharing EVs could be located in car

share parking spots (i.e., Zipcar), rental car depots, tourist or business destinations, and area hotels.

EV car rental and EV car sharing are well-suited for shorter travel and errands. The Task Force sees a potential business model for a network of EV charging stations for business travelers and tourists. This system would require special agreement between rental car operators, hotels, and attractions.

Car sharing can help meet the needs of multifamily dwelling residents without increasing the need for parking spaces. Car sharing and car rental can produce additional benefits by allowing drivers to experience an EV and how it operates, serving as a stepping stone for future EV use. Table 3-3 lists the opportunities and challenges for EV charging stations that are posed by different site types.

Table 3-3. Summary of Opportunities and Issues by Site Type

Location	Opportunities	Barriers/Limitations
Single family home (with driveway or garage)	• Highest charging demand	• Many potential owners may not live in single family houses or have private driveway/garages • Knowledge • Permitting process
Multifamily residential	• Potentially high demand • Many contain parking facilities • Opportunity for car sharing	• Some may have limited parking spaces • Property owners information gap • Permitting process • Technical capability • Turnover management • Parking lot management
Workplace	• Potential high charging demand behind residential	• Knowledge • Permitting process • Technical capability • Charging turnover management • Parking lot management
Retail, amenities and recreation	• Potential high charging demand	• Knowledge • Permitting process • Technical capability • Turnover management • Parking lot management
Rentals	• Capitalize on tourism market • Stepping stone to ownership	• Need network with rental companies, hotels, and destination parking
EV car sharing	• Regular car sharing already exists • Zipcar planning to offer a few EVs	• Permitting/technical
Public facilities	• Could help kick-start market • Demonstrate environmental responsibility • Improved air quality	• Knowledge • Permitting process • Technical capability • Charging turnover management • Parking lot management • On-street—special case

PUBLICLY ACCESSIBLE EV CHARGING STATIONS

Region Charging Station Inventory

COG staff developed an inventory of publicly accessible EV charging stations for the metropolitan Washington region (see Appendix D). As can be seen in Maps 3-1 and 3-2, a robust network of charging stations is beginning to take shape in the region. Altogether, the inventory identified 332 chargers in 133 charging station locations, 11 of which are planned stations. The District of Columbia has the most charging stations among COG jurisdictions (36), followed by Arlington County, Virginia (15); Fairfax County, Virginia (18); and Charles County, Maryland (11). The District of Columbia and Arlington County, Virginia, have the highest number of chargers (85 and 62, respectively). About 40 percent of the chargers are Level 1, and the remaining 60 percent are Level 2. No DC fast chargers were installed when the inventory was developed. The inventory indicates that building managers are installing EVSE in a variety of land uses. Table 3-4 lists the number of charging stations and chargers in the region by site type.

Table 3-4. EVSE Stations in the Metropolitan Washington Region by Location Type, as of April 2012

Location Type	Stations	Chargers
Office	45	110
Shopping	20	48
Dealership	17	20
Government	11	27
University	10	25
Mixed use	10	38
Multifamily dwelling unit	7	11
Recreation	5	26
Hotel	3	6
Transportation hub	2	4
Airport	2	16
Restaurant	1	1
Total	133	332

Note: Recreation includes parks, arts centers, and recreation centers. Mixed use describes sites that have a mix of retail, offices, and housing. Multifamily dwelling units consist of condominiums or apartments. Government stations were located at facilities such as libraries, town halls, and government offices.

Home charging stations are not represented in the inventory, except for multifamily dwelling units.[49]

[49] Although many EV infrastructure development programs in the region involve installation of home charging stations, published data on these stations are incomplete for several reasons: (1) stations are not published on EVSE provider websites or on the Alternative Fuels Data Center since they are not available for public use; (2) many

The publicly accessible chargers included in this inventory are owned and operated by a number of different private and public entities. At this early stage in the infrastructure, various payment structures and methods are being tested. However, as the region's charging infrastructure expands and the market matures, there may be a need for standardized or universal methods of payment for EV charging to enhance ease of use for the driver.

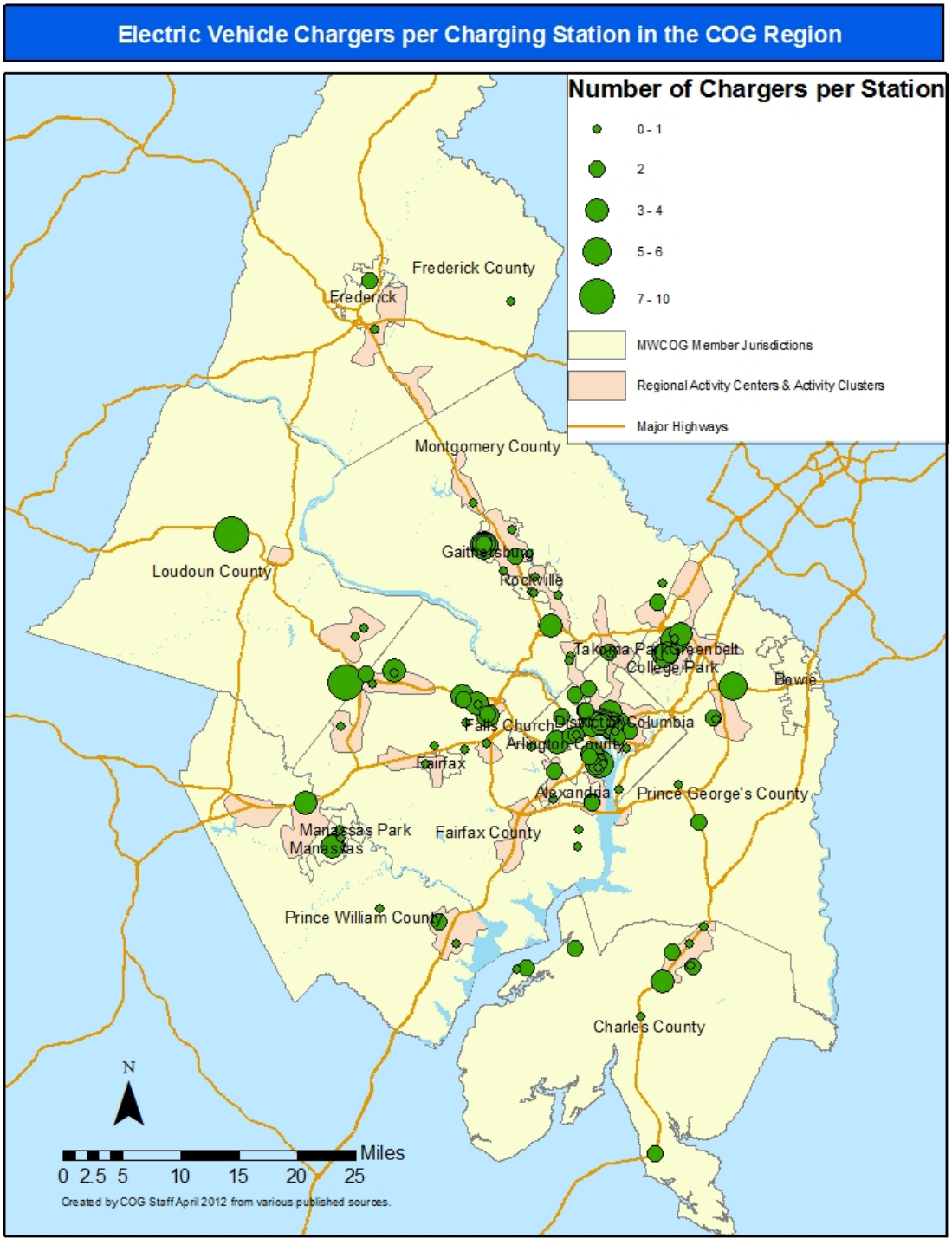
Regional EVSE Infrastructure Maps

Figure 3-14 depicts the published charging station location of existing and planned public and private stations.[50] The map also depicts the location of "Regional Activity Clusters," as defined by *Region Forward*, and major highways. Most stations are located along major highways or in activity clusters. Sources for the inventory included DOE's Alternative Fuels Data Center, a COG survey of local jurisdictions, and several EVSE websites, including ChargePoint America, SemaCharge, 350Green, Blink, and Car Charging, Inc. In addition, Plugshare, Google Maps, Clean Technica, and property websites assisted in identifying charging station location information. Some property managers provided additional information.

individuals choose not to voluntarily share their location information with Plugshare, a crowd-source EV station website; and (3) EV owners aren't required to report their home charging stations to electric utilities. Other regions that The EV Project is operating in report that 80 percent to 99 percent of Level 2 charging stations are installed at home locations.

[50] Maps do not include single-family home stations.

Figure 3-14. Electric Vehicle Chargers per Charging Station in the COG Region



EV and EVSE DEPLOYMENT PLANNING RECOMMENDATIONS

Facilitating charging station installation through investments, incentives, guidelines, and requirements can reduce range anxiety, promote innovation and environmental sustainability, and help overcome market barriers to region-wide deployment. The main barriers for all location types are cost of installation, access to power source, parking space turnover management, need for streamlined permitting and inspections, and lack of information and training resources. A regional partnership of EV stakeholders, convened under the Washington Regional EV Initiative, should be convened to collaborate and address these issues.

Recommendation 1: The Regional EV Partnership should promote EVSE siting in strategic locations and monitor EV use and EVSE installations.

a. Identify key charging locations near workplaces, shopping destinations, and transit hubs to prioritize for EVSE installation. The following are some feasible locations:
   - workplace locations with parking such as office parks;
   - surface parking lots or curbside locations;
   - hotels and convention centers;
   - hospitals;
   - transportation hubs such as airports, fleet depots, and Park & Ride facilities;
   - gas stations;
   - shopping malls and other retail locations;
   - entertainment destinations such as cultural centers, restaurants, sporting venues, and parks and recreation areas;
   - universities; and
   - government buildings such as city halls and libraries.

b. Promote additional opportunities for EV charging among car-sharing programs and rental companies.

c. Benchmark EV sales and use and EVSE installation and use in the metropolitan Washington region and compare these benchmarks with data from other cities to identify additional needs or barriers.

d. Establish network interconnectivity among all publicly accessible charging stations in the metropolitan Washington area, such as through a third-party universal membership.

Recommendation 2: The Regional EV Partnership should encourage major new construction and redevelopment in the commercial, multifamily, and public sectors to be equipped with a feasible level of inexpensive technology to reduce the cost of future EVSE installation.

a. Provide the physical space for transformer capacity to allow the future installation of full-lot electrification.
b. Provide physical space in the electrical room to allow future installation of a switchboard and capacity for submetering.
c. In parking area construction, include conduit bank and conduit between the facility's electrical room and the spaces needed for future electrification.
d. Install a conduit for future on-street EV parking during right-of-way redevelopment.

Recommendation 3: Stakeholders in the Regional EV Partnership should work together to address multifamily residential EV charging challenges.

a. Follow best practices and heed lessons learned in pilot programs from other U.S. cities.
b. Connect property owners and managers, homeowners associations, and condominium associations with educational resources relating to EVSE implementation.
c. Pursue car-sharing and charger-sharing agreements to help meet multifamily building charging needs.

Recommendation 4: The Regional EV Partnership should facilitate workplace charging by identifying prime charging locations, connecting employers and property managers with EVSE installation resources, and building partnerships between businesses and EV industry players.

a. Identify prime workplace charging locations on the basis of commuting patterns, survey of fleet needs, and EV charger installation plans.
b. Through COG Commuter Connections, the Apartment and Office Building Association, and other associations, connect employers and property managers with EVSE installation procedures and resources.
c. Develop partnerships between corporate offices and EV dealerships/service providers to deploy fleet EVs and charging stations.
d. Develop informational brochures to identify risks and benefits to employers of providing workplace charging as well as installation procedures and resources. These brochures can identify methods to mitigate or reduce risk and increase employee acceptance.

Recommendation 5: The Regional EV Partnership should develop tourist market opportunities by increasing the availability of EV rentals and developing charging infrastructure at hotels and tourist destinations.

a. Work with rental car companies, hotels, and public on-street parking locations close to tourist destinations to set up a minirental infrastructure.

Recommendation 6: Members of the Regional EV Partnership should consider offering incentives to promote investment in publicly accessible EV infrastructure.

a. Offer a variety of incentives, such as tax credits, access to HOV lanes, fast-tracking permitting processes, and/or free parking benefits to consumers who purchase and drive an EV.
b. Offer incentives, such as tax credits, for hosts who install EVSE at their destination location.
c. Provide official recognition emblems and advertising icons as "EV Friendly Business" for hosts to use in stores and advertising.
d. Offer benefits to developers who invest in EVSE infrastructure.

SECTION 4
LOCAL GOVERNMENT POLICY

Local governments will play a critical role in the region's electric vehicle (EV) readiness. To facilitate continued growth of the market and smooth the transition to higher rates of EV adoption, local governments should ensure that EV infrastructure development is addressed in comprehensive planning efforts and that zoning, building codes, and permitting and inspection processes provide a pathway to the expeditious installation of charging equipment.[51] Streamlined permitting and inspection processes, vehicle and charging incentives, infrastructure readiness, low permitting and inspection costs, and nominal installation costs all contribute to reducing barriers to greater EV adoption.

In January 2012, COG conducted a survey of its member jurisdictions to obtain information about current initiatives in the region. The purpose of the survey was to determine the current level of EV-related activity and development among jurisdictions in the region. Using information from that survey, this section addresses the current state of EV planning initiatives in COG's member jurisdictions. This section also discusses best practices gleaned from EV programs across the nation on developing model codes, on ensuring ADA accessibility at charging stations, and on developing requirements for parking spaces that can accommodate use by EV chargers. Facilitating permitting and inspections for EV infrastructure is also key to the region's EV readiness. Next, this section discusses survey results on current permitting and inspection practices in the region, followed by a discussion of best practices related to permitting, inspections, and electrical codes.

The recommendations related to comprehensive planning, zoning, and building codes include developing a guide for comprehensive planning that promotes EV infrastructure development; amending zoning ordinances to promote EV deployment, and establishing design criteria to address ADA accessibility, safety, and theft deterrence. Inspections and permitting recommendations focus on streamlining the permitting process for EVSE installation, developing a consistent set of EV permitting procedures, and amending electrical permit applications to include information on EV charging.

[51] Not all jurisdictions have the authority to initiate and implement these policies.

COMPREHENSIVE PLANNING, ZONING, AND BUILDING CODES

Regulatory Readiness for EV Deployment

Regulatory readiness for EVs is built on good comprehensive planning, building codes, and zoning done at the local level. A comprehensive plan is a general policy guide for growth and development for a local government. It acts as a long-range guide, intended to show the future use of land at some point during the planning period, which could project as far ahead as 20 years or more.

A local government's comprehensive plan can elevate the importance of EV infrastructure planning across multiple departments, highlighting the need for coordination among land use, capital facilities, utilities, and transportation planning efforts. The plan should provide guidance on where EV charging stations should be allowed, where they should be actively promoted, and where they should be discouraged or prohibited. In addition, a comprehensive plan could provide context for negotiating with developers on EV charging station commitments.

Whereas a comprehensive plan provides guidance on where EV charging stations should be promoted and discouraged, zoning ordinances dictate where charging stations are allowed or prohibited.[52] Zoning ordinances can also define priority areas where EVs may receive incentives, such as preferred parking. Coordination of comprehensive planning and zoning work ensures effective and consistent zoning decisions at the local level. Because comprehensive plans are policy and not regulatory documents, regulatory changes (e.g., zoning ordinance provisions) and legally binding commitments or conditions associated with local government zoning decisions will be necessary if plan policies are to be implemented.

Municipal and county codes are an additional component of the EV planning framework. They define specific guidelines by which developers must abide to ensure the safety, accessibility, and standardization of EV charging installments, parking, and signage. Design standards to address American with Disabilities Act (ADA) accessibility are needed to ensure that EV charging stations can serve all customers. As well, guidance on reducing tripping hazards, electrical hazards, and vandalism or theft of EV charging stations will increase the safety of EV infrastructure for the public. Consistent signage for EV charging spaces may also be defined in municipal codes, ensuring that EV charging stations are not only accessible and safe, but also easily identified.

COG Region Initiatives

Most of the COG jurisdictions reported having no EV policy development in place. Policies could include comprehensive plan language for new or redevelopment projects or zoning/land

[52] Zoning ordinances set specific standards for use, density/intensity, size, setbacks, height, and open space.

use language for existing development. The District of Columbia and Fairfax County, Virginia, have integrated EV considerations into the permit review process, building code policy, and ADA parking restrictions.

Although the COG survey of local governments' EV practices revealed that most member jurisdictions currently have little to no EV-related activity or development, the regional EV planning effort has motivated some attention to the issue. While it is expected that individual member jurisdictions will plan for and implement EV-related policies at their own pace, the metropolitan Washington region is ripe for EVs and charging deployment. With this region as a target market for deployment by top manufacturers of EVs, jurisdictions like Montgomery County, Maryland, and Arlington County, Virginia, have begun examining their processes and looking at creative ways to integrate EV planning in their already robust climate and sustainability strategies.

Fairfax County, Virginia, has examined how EV planning may be introduced into the comprehensive planning process and has begun formulating potential language to integrate into the plan. If EV-related plan text is adopted into the county's comprehensive plan, it would provide a context for the negotiation of EV-related commitments from applicants during the zoning process. [53]

The District of Columbia; the City of Frederick, Maryland; the City of Bowie, Maryland; Fairfax County, Virginia; and the City of Manassas, Virginia, currently offer incentives for EVs. The incentives offered include dedicated on-street public charging near building entrances, preferred parking in public parking decks, preferred parking for fuel efficient vehicles at government buildings, and preferred parking at some LEED (Leadership in Energy Design) buildings.

Best Practices: Developing Model Codes

Model codes can help states achieve a consistent EV framework across their local jurisdictions. Model codes should reflect best practices and ease the adoption of codes and processes by preventing local governments from having to "reinvent the wheel."

The State of Washington provides a great example for states and municipalities to address EVs through model codes and ordinances. In coordination with the Puget Sound Regional Council, they developed the *Electric Vehicle Infrastructure: A Guide for Local Governments in*

[53] Kaplan, Noel H., Fairfax County Dept. of Planning and Zoning. *Fairfax County's Comprehensive Plan and Potential Application in Support of Electric Vehicles* [presentation to the COG EV Planning and Processes Work Group]. November 29, 2011. https://ncrportal.mwcog.org/sites/surveys/EVP/Comprehensive%20Planning/Comprehensive%20Plan_Kaplan%20Ffx%20(2).pdf

Washington State, which provides model installation guidance and checklist, siting and zoning guidance for on-street and off-street, and model ordinance and regulation language for infrastructure and batteries varies parking scenarios including ADA requirements. [54] A sample of model installation guidance for charging and installation checklist is provided in the Washington State Guide Appendices.[55]

Best Practices: ADA Compliance

Title II of the Americans with Disabilities Amendments Act of 2008 (ADA) covers all activities of state and local governments and requires governments to give people with disabilities an equal opportunity to benefit from all of their programs, services, and activities. Accessibility standards specific to EV infrastructure have not been established in most jurisdictions—guidance on developing such standards should be provided to assist to local governments in meeting ADA compliance.

ECOtality's *Lessons Learned–EV Project: Accessibility at Public EV Charging Stations*, prepared for the U.S. Department of Energy, provides an in-depth review of general parking accessibility requirements and barriers to widespread acceptance and adoption of EV charging. The report provides four recommendations that address ADA compliance issues for Level 2 electric vehicle supply equipment (EVSE) and DC fast chargers. [56]

Federal standards generally call for a 1:25 ratio of parking places to be set aside for disabled persons. The State of Washington adopted guidance that the first of any EV charging parking spaces be ADA accessible and that other ADA-accessible spaces be provided at a 1:50 ratio.[57] California's Division of State Architects issued guidance, *Interim Disabled Access Guidance for Electric Vehicle Charging Stations*, requiring a 1:25 ratio of parking places at a site for accessible charging stations.[58] For examples of on-street and off-street accessible EV charging

[54] State of Washington Department of Commerce & Puget Sound Regional Council. *Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State*. July 2010. http://www.commerce.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=8851&MId=863&wversion=Staging

[55] Puget Sound Regional Council. *Electric Vehicle Infrastructures: A Guide for Local Governments in Washington State.* Appendices. http://psrc.org/assets/4326/EVI_full_appendices.pdf

[56] Sustainable Transportation Strategies. *EV Charging for Persons with Disabilities.* February 2012. https://ncrportal.mwcog.org/sites/surveys/EVP/ADA%20Compliance/ProjGetReady%20-%20EV-Charging-ADA-Version-1.0s.pdf

[57] State of Washington Department of Commerce & Puget Sound Regional Council. *Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State*. July 2010. http://www.commerce.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=8851&MId=863&wversion=Staging

[58] California Department of General Services. *DSA—2011 California Access Compliance Reference Manual Policies*. Rev. January 1, 2011. http://www.documents.dgs.ca.gov/dsa/pubs/policies_rev_01-01-11.pdf

parking design, including ADA requirements, as well as directional signage, see the Washington State guidance.[59]

As state and local governments develop code language for EV infrastructure, it is important for them to keep in mind the following criteria when designing a parking space:

- Minimum parking space width of eight feet for a car and 11 feet for a van.
- Five-foot-wide minimum access aisle. Two accessible parking spaces can share an aisle between them.
- Vertical clearance of at least 98 inches for a van.
- Nearly level (less than 2 percent slope in any direction) and firm ground surface.
- Accessible curb cut if needed to reach and operate the charging station.

Best Practices: Parking Requirements for EVSE

Parking requirements that incorporate EV charging considerations may help promote EV infrastructure and provide an incentive for EV drivers. Many localities are beginning to consider and adopt EV parking requirements in their municipal codes. In locations where a certain number of parking spaces are required at a building address, it should be specified in site plans and other documents that EVSE parking spaces do not subtract from the total number of parking spaces provided. Parking space requirements that do not include considerations for EV charging can prevent the property owner from installing EV infrastructure. As a near-term goal, building owners may install conduit and electrical capacity to accommodate future EV charging installations when demand emerges.

For example, the city of Vancouver, British Columbia, requires that 20 percent of the parking stalls that are for use by owners or occupiers of dwelling units in a multifamily building include a receptacle to accommodate use by EV charging equipment.[60]

San Francisco is also working with other Bay Area jurisdictions to add provisions to the Green Building Code that require parking spaces in new homes, apartments, condominiums, hotels, and other commercial and municipal buildings constructed in the city or major renovations to be wired to accommodate EV charging. This will avoid expensive retrofit wiring as the number of EV users increases.

[59] Washington State Department of Commerce, Electric Vehicle Infrastructure, A Guide for Local Governments in Washington State, July 2010, pp.25-31. http://psrc.org/assets/4325/EVI_full_report.pdf

[60] City of Vancouver. *Electric Vehicle Infrastructure Requirements for Multi-Family Buildings.* http://vancouver.ca/*sustainability*/EVcharging.htm

PERMITTING AND INSPECTION

Facilitating Permitting and Inspection for EV Readiness

One of the prerequisites for the growth of EV infrastructure is rapid permitting and inspection. The ease with which a consumer can obtain a permit for EV charging installation can impact how quickly the technology is embraced. Thus, local governments' streamlining of the inspection and permitting process for EV charging would facilitate market expansion of EVs.

Developing rapid permitting processes is an essential first step to facilitating EV infrastructure expansion. Providing online applications would ease the administrative burden for relatively simple installations and those conducted by certified contractors. Local governments should also be attentive to permit turnaround times. Permits for residential charging stations should be issued in no more than two business days, and same-day turnaround is preferred. Public charging stations may require longer inspection times, however, due to potential construction considerations.

To help residents and contractors successfully and safely navigate the permitting and inspection process, local governments should develop consistent permitting and inspection procedures for Level 1, Level 2, and DC fast charge installations. Written guidance and installation checklists for contractors and government installers should also be provided. Attention to the Level 2 and DC fast charge permitting and inspection process is particularly important because these options offer faster and higher charging rates that could causes surges in demand. A one-time fee for each of these charging scenarios that includes both permitting and inspection costs would further ease the process.

Charging station hardware is not required for Level 1 charging because it uses a standard electric outlet, but the installation of a dedicated circuit and other safety precautions may be needed if the existing wiring and/or panel is inadequate. Streamlined processes for simple residential installations such as these may be appropriate. In contrast, Level 2 and DC fast charging installations require special charging equipment with a dedicated higher-voltage circuit. For DC fast charging, electric utility infrastructure may also need to be installed.

Multiunit residential buildings require special attention to ensure charging availability and access for residents. Updating and enhancing building codes to encourage retrofits of multiunit buildings would help remove this barrier.

Finally, the permitting process can also help utilities plan for EV adoption and make necessary upgrades to transformers and other electric utility infrastructure. By tracking the location, voltage, and amperage of new EVSE installations, municipalities can help utilities prepare the electrical grid for the widespread adoption of EVs. In Section 5 on Electric Utility Policy,

recommendations are made that specify how permits should be managed to best provide needed information to utility companies.

COG Region Initiatives

The January 2012 COG survey on EV initiatives in the region provided an overview of the current status of the permitting and inspection processes in the region. Survey highlights are presented below.

Turnaround times for obtaining electrical permits and inspection varies, with Fairfax County, Virginia, reporting the lowest turnaround time for commercial and residential permits, and the District of Columbia reporting the fastest turnaround time for public permitting.

The cost for permitting EVSE varies throughout the region. Falls Church, Virginia, reported the least expensive permitting costs of $10 for residential, commercial, and public electrical permits, and Fairfax County, Virginia, reported the highest electrical permitting fee of $85 for both residential and commercial electrical permits. Most reporting jurisdictions indicated that they offer online permit applications.

Most jurisdictions consider EV charging infrastructure to be a standard electric appliance for Level 1 (120V, 15 amps, single phase) or Level 2 (208/240V, 30 amps, single phase) charging. In the COG survey only two jurisdictions-- the City of Frederick, Maryland, and the City of Falls Church, Virginia—indicated that they are tracking EV charging permit applications.

Best Practices: Clear Permitting Guidelines

To make the EVSE permitting process more streamlined and user friendly, municipalities should make sure that guidelines are clear and understandable to residents and businesses. The metropolitan Washington region can look to the experiences of Raleigh, North Carolina; Houston, Texas; and the State of Massachusetts for best practices on communicating clearly about the EVSE permitting process.

Raleigh, North Carolina, has developed a chart detailing a step-by-step process for residents that outlines the information required and the steps necessary for the installation of EV charging equipment in a single family home.[61] The City of Raleigh has also developed two YouTube videos on how to install public and home charging equipment. [62, 63]

[61] City of Raleigh. *Electric Vehicle Charging Station Installation.* http://www.raleighnc.gov/search/content/CityMgrDevServices/Articles/HowToElectricVehicleCharging.html
[62] City of Raleigh. *Installing Public Charging Stations* [YouTube video]. November 30, 2010. http://www.youtube.com/watch?v=jvPLvsg9y2o

Houston, Texas, has implemented an EV permitting and inspection process for a standard EVSE project that can be completed in one day. The City's Green Transportation Initiative includes an EV program that has developed a six-step installation process that includes identification, assessment, permitting, installation, inspection, and integration. Permits are issued automatically and instantly online through the City's Code Enforcement Group, with inspections being performed on the same day as the installation. [64]

The Massachusetts State Department of the Environment developed an installation guide for EV charging, *Installation Guide for Electric Vehicle Supply Equipment*.[65] The Guide includes an installation diagram and flow chart for residential charging. The Guide also specifically references NEC 625.1-625.5, the relevant National Electrical Code charging standards.

Best Practices: Online Permit Processing

Allowing permits to be processed online, rather than through the mail or in person, can speed the process. Charlotte, North Carolina; the State of Oregon; and San Francisco, California, offer examples of methods for expediting permit processing.

In Charlotte, North Carolina, the Mecklenburg County Code Enforcement and the Building-Development Commission introduced two "self-permitting" options, the Homeowner Internet Permits (HIPs) and Trades Internet Permits (TIPs). HIPs are required for homeowners making renovations on their own property, while TIPs are required for contractors. One of these permits must be secured for an EV charging station to be installed. The TIP manages 25 percent of the permit load, with a goal of a TIP-like tool managing all projects not requiring plan review. Mecklenburg County's EV Initiative uses the TIP process for EV charging permit applications, reducing the permit turnaround time to 1–2 days.

In Oregon, the Electrical Specialty Code contains the minor label program, which allows certified contractors participating in the program to install eligible equipment without having every installation inspected, as with the traditional permitting process.[66] Minor labels are inexpensive permits for minor electrical and plumbing installations in either residential or commercial settings. Contractors establish an online account, buy the labels online, perform the installations, and document how the labels were used through their account. The Oregon

[63] City of Raleigh. *How-To Charge Your Electric Car at Home* [YouTube video]. September 27, 2010. http://www.youtube.com/watch?v=_x4YezUX8lo&lr=1&uid=makWAtCIzgsRXZUNczyNEA
[64] City of Houston. Building Code Enforcement. http://www.houstonpermittingcenter.org/code-enforcement.html
[65] Massachusetts Department of Energy Resources. Installation Guide for Electric Vehicle Supply Equipment (EVSE). http://www.mass.gov/eea/docs/doer/alternative-fuels/ev-manual-mass-32011.pdf
[66] State of Oregon, Building Codes Division. Minor Label Program. http://www.bcd.oregon.gov/programs/minorlabel/minor_label_programs.html#2

Building Codes Division randomly selects for inspection one installation from every 10 labels a contractor uses.

The City of San Francisco's Department of Building Inspection issues same-day, over the counter permits for the necessary electrical work at a residence, and electricians registered with the Department of Building Inspection can obtain the permits instantly online.

Best Practices: Electrical Codes

The National Electrical Code (NEC), produced by the National Fire Protection Association, provides safety guidelines for electrical equipment installation. Local governments should adopt these guidelines, so they can require the highest safety standards for EV charging infrastructure. Table 4-1 contains a sample of relevant NEC sections. For a full list of applicable codes and standards, refer to the Advanced Energy's *Charging Installation Handbook for Contractors and Inspectors*.[67]

Table 4-1. National Electrical Code (NEC) Relevant to EVSE

Standard	Description
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 – Prevent Physical Damage
NEC 210.70(A)(2)	- Lighting Outlets Required – Dwelling Units – Additional Locations
NEC 625.1-625.5 NEC 626.28-625.30 UL UL 2251	- General (Scope, Definitions, Other Articles, Voltage, Listed/Labeled) - EVSE Locations - Standard for flexible cords and cables required by NEC 625 - Cord design and safety covers the plug, cord, receptacle, connectors and other items related to the charging cord set. Also verifies the cord's safety and ability to carry its rated load.

Source: Advanced Energy, http://www.advancedenergy.org/transportation/evse/Charging%20Handbook.pdf

[67] Advanced Energy. *Charging Station Installation Handbook for Electrical Contractors and Inspectors*. 2011. http://www.advancedenergy.org/transportation/evse/Charging%20Handbook.pdf

COMPREHENSIVE PLANNING, ZONING, AND BUILDING CODES RECOMMENDATIONS

Below are recommended changes to comprehensive plans, zoning, and building codes that would facilitate the installation and operation of EV charging stations.

Recommendation 1: Local governments should develop comprehensive plan guidance to guide EV infrastructure development.

a. Include in comprehensive plans identification of key areas for EVSE deployment and context for negotiating with developers on EV charging station installation commitments during the development approval process.

Recommendation 2: Local governments should amend zoning ordinance to support EV deployment.

a. Amend all zones except conservation areas to allow for EV charging as an accessory, conditional, or principal use.
b. Allow EV battery exchanges at gas stations within one mile of highways.

Recommendation 3: Local governments should establish design criteria to address ADA accessibility, safety, and theft deterrence.

a. For public and commercial charging stations, establish design standards to address ADA accessibility, space dimensions, tripping hazards, electrical hazards, and theft deterrence, including cost information (ADA compliance may be met by requiring attendant assistance).
b. Follow examples such as the *Advanced Energy Charging Installation Handbook.*

Recommendation 4: Local governments should establish guidelines for integrating EV infrastructure with public streets and publicly accessible spaces.

a. Work with communities, neighborhoods and business improvement districts to develop EV infrastructure design plans that blend in with the surrounding area.
b. Establish guidelines addressing preferred locations for EVSE installations on public streets—at either end of a row of spaces or near a power source—and working around trees and other infrastructure.
c. Synchronize charging time limits with current street parking time limits at each location if possible.
d. Allow charging station owners/managers the ability to control turnover, such as by raising the rate after two hours.
e. Follow the *Advanced Energy Charging Installation Handbook* .

Recommendation 5: Local governments, in collaboration with state and federal government, should standardize signage for EV charging stations.

a. Include in signage standards specifications for signage height, bollards, and lighting.
b. Include in signage standards requirement that signage notify users of security measures such as cameras and other deterrence devices and include instructions for dealing with nonretracting cords.
c. Include in signage standards requirement that signage contain information about the hourly and/or total cost of the charging service, if applicable.
d. Base standards on the Federal Housing Administration's *Manual for Uniform Traffic Control Devices*.
e. Use green paint to delineate EV charging spaces.

INSPECTIONS and PERMITTING RECOMMENDATIONS

The recommendations below focus on ways that local governments and utilities can streamline the permitting and inspections process for EVSE installations.

Recommendation 1: Local governments should streamline the permitting and inspection process for EVSE installations.

a. Develop streamlined inspection process with a two to three business day turnaround time for public, nonconstruction, and private (residential) charging installations.
b. Develop a streamlined process, waiving certain requirements (such as producing plans and drawings) for simple residential installations.
c. Update and enhance building codes and fast-track approval to encourage multiunit dwellings retrofitting.

Recommendation 2: Local governments, in cooperation with utilities, should develop a consistent set of permitting procedures for each EV charging scenario.

a. Develop a consistent set of permitting and inspection procedures and checklists for entities seeking permitting on the basis of three main EV charging scenarios:
    - *Level 1 (120V, 15 amps, single phase):* Residential and commercial charging (same process as with any other 120-volt outlet installations in residential and commercial facilities)
    - *Level 2 (208/240V, 40 amps, single phase):* Residential and commercial charging
    - *Level 3/DC fast charge (480V, 90 amps, 3-phase):* Commercial, parking garages and lots charging
b. Institute a one-time fee for each of the three main EV charging installation scenarios that combines all applicable fees for both the permit and inspection process.
c. Develop guidance and checklists for each of the charging scenarios to educate EVSE installers, homeowners, and businesses, and relevant government employees about the procedures involved in EVSE permitting and inspection.

Recommendation 3: Local governments, in cooperation with utilities, should amend electrical permit applications to include a field noting whether the facility will include EV charging.

a. Include on the permit application a field noting the voltage and amperage of the EVSE installation.
b. Provide location and all relevant EV charging information to the local electric utility to assist with grid planning efforts.

SECTION 5
ELECTRIC UTILITY POLICY

Increasing electric vehicle (EV) adoption poses two distinct electric utility policy issues. The first is notification of EV charging locations. Utilities are concerned that neighborhood "clustering" of EV charging could cause disruptions in the local power grid. To ensure that appropriate infrastructure is in place to accommodate the increased load and avoid service disruptions for their customers, utilities need to be notified in advance about the location of EV charging equipment. For DC fast charge stations, further advance notice is needed. Strategies to inform utilities about where EVs are being charged are critical to the infrastructure planning process.

Second, the regulatory status of EV charging stations—contained in provisions of electric utility policy—can help or hinder the ability of private companies and utilities to provide EV charging services. Across the region, the regulatory status of EV charging service providers is inconsistent and in some cases unclear. Clear state-level policies are needed to promote private investment in EV charging infrastructure for charging in the for-pay charging market.
Other issues impact utilities and utility policy: renewable and clean energy goals that reduce the estimated indirect emissions impact of EV use, the use of smart-grid-ready electric vehicle supply equipment (EVSE), regulations concerning second meters for EV charging, and the development and promotion of education and pilot programs.

At this point, utilities in the region are not major players in the EV charging market. Their involvement to date has been limited to monitoring the market and addressing the issues described above. While utilities reserve their ability to potentially provide EV charging services in the future, there are no immediate plans to do so.

This section begins with an analysis of the impacts that growing EV use could have on the electrical grid—depending on the size and timing of the increased charging load, on the extent of clustering of EV use, and on the type of charging used. Next, recent policy actions in the region are presented, followed by a discussion of the regulatory status of key policy issues and relevant program offerings in Maryland, Virginia, and the District of Columbia. Then an analysis of issues that will be of concern in the future is presented, and finally, the policy recommendations that emerged from this analysis are listed. The recommended policies include promoting exemption from regulation of EVSE service providers from electric utility regulation, notifying utilities of EVSE installations, and reducing upstream emissions from EV charging.

ELECTRIC GRID IMPACTS

With significant penetration of EVs still years away, EV charging load is not anticipated to have significant effects on generation and transmission infrastructure. Neighborhood-level clustering of EV charging, however, is a current concern for electric utilities, and infrastructure planning must be undertaken to prevent service disruption.

Generation and Transmission Infrastructure Impacts

The potential for EV charging to impact the electrical grid at the generation and transmission level depends highly on the size of the charging load and its timing relative to daily and seasonal electricity demand. On the one hand, adding large amounts of EV charging load to the grid at times of already high demand can amplify peak load and stress the electrical grid. As EV adoption increases significantly, unmanaged EV charging, particularly in the afternoon hours on the hottest summer days, could cause congestion that leads to brownouts or blackouts. However, increasingly stringent appliance efficiency standards and building codes will significantly reduce the likelihood of this occurring.

On the other hand, if EV charging is conducted at off-peak times, such as overnight, it could have the beneficial effect of evening out the load curve, called *valley filling*. This allows generating facilities to run more consistently, thereby providing more efficient and less costly electrical power.

While generation and transmission infrastructure impacts are not a significant current concern for utilities, this issue must be monitored to prevent future negative grid impacts. Other federal, state, and local policies related to appliance energy efficiency standards and building efficiency codes will help counter the effect of increasing EV loads. The EV Project, a partnership between the U.S. Department of Energy, ECOtality North America, and a number of corporate, nonprofit, and local government stakeholders, is helping fulfill this role in Washington, DC, and a number of states across the country.

Distribution Infrastructure Impacts

The immediate concern that most utilities have about the impact of EV charging is the clustering of vehicles at the distribution level. Preliminary data from auto manufacturers and state motor vehicle agencies demonstrate that EV adoption has not been evenly dispersed across a large area, but rather clustered in residential pockets. These clusters can significantly increase local electricity demand, overloading transformers and increasing the risk of local service disruptions. An EV's power demand is a function of the type of charging used. Level 1 charging, using a 120V AC charger, is not likely to significantly impact the distribution grid. However, multiple EVs charging at Level 2 (240V AC) have the potential to overload residential transformers.

Planning for distribution grid upgrades is essential to mitigating this risk, and information about the locations of EV charging stations will aid this effort.

DC Fast Charging Impacts

DC fast charging requires special attention from utilities. DC fast charging is not being used for residential EV charging because of its high voltage and amperage levels, but interest in the technology for public charging stations is growing. This type of charging equipment requires higher voltage, larger cables, and larger conduit, and thus has greater potential than Level 2 charging for impacting utility infrastructure. 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.

RECENT STATE POLICY ACTIONS

Maryland, Virginia, and the District of Columbia have all taken steps in recent years to resolve areas of uncertainty in their electric utility policy as it relates to EVs and EV charging. However, room for improvement remains, particularly when it comes to notifying utilities about EV charging station locations.

In accordance with legislation passed in the 2011 session of the Maryland General Assembly, Governor Martin O'Malley commissioned an Electric Vehicle Infrastructure Council, comprised of representatives of automobile manufacturers, EV charging manufacturers, utilities, electrical workers, state and local governments, and environment and energy experts. The Council is in the process of developing recommendations on infrastructure planning, policy changes to support EV charging, standards for streamlined permitting, and consumer outreach and awareness efforts. The Council issued an Interim Report in January 2012.[68] The report contains several policy recommendations that are relevant to utility policy and EV charging.

In 2010, Virginia Clean Cities released an initial EV plan titled Virginia Get Ready. The plan resulted from the work of over 100 stakeholders, including governments, universities, public utilities, civic entities, and businesses. It presents an analysis of the then-current state of the EV market and offers recommendations in a number of areas. Then, in 2011, the Virginia legislature passed several bills that helped define the status of EV charging station owners and operators in the state.[69] In addition, the Virginia State Corporation Commission (SCC) approved Dominion

[68] Electric Vehicle Infrastructure Council. *Interim Report*. January 1, 2012. http://www.msa.md.gov/megafile/msa/speccol/sc5300/sc5339/000113/014000/014354/unrestricted/20120165e.pdf

[69] Virginia General Assembly. Public Utilities—Electric Vehicle Charging Service; Excludes Certain Persons from Retail Sale of Electricity.; H.B. 2105, 2011Session. http://lis.virginia.gov/cgi-bin/legp604.exe?111+sum+hb2105

Virginia Power's EV charging pilot program in July 2011. The program became effective in October 2011.

The District of Columbia does not have a well-defined EV charging policy. The Public Service Commission (PSC) first implemented pilot EV rates in 1993 but discontinued them in 2006 due to low participation. The PSC currently has a case open to consider a broad range of EV policy questions, including EV chargers' regulatory status and whether special EV charging rates should be offered.[70] Additionally, a bill has been introduced in the Council of the District of Columbia that would exempt EV charging service companies and service providers from regulation as public utilities.[71]

KEY POLICY ISSUES AND CURRENT STATUS

Unless otherwise noted, the issues discussed below pertain to commercial EV charging stations, not residential charging. Table 5-1 contains a summary listing of the current laws and regulations in Maryland, Virginia, and the District of Columbia that address the issues raised in this subsection.

Regulation as a Public Utility

One could interpret some state public utility regulations governing the provision of electric service as applying to EV charging service providers because the charging service they provide is powered by electricity. If an EV charging station were deemed to be subject to public utility regulation, the state utility commission would have authority to set its rates and fees, requiring a formal administrative process for any changes. In addition, the commission could set other terms and conditions for the provision of charging service. The service that an EV charging station provides is not equivalent to that of a public utility and does not warrant the same high level of oversight and regulation. However, the lack of a clear state policy can impede the EV charging market in a given state if EV charging station owners or operators are faced with regulatory uncertainty. The jurisdiction regulatory status for Maryland, Virginia, and the District of Columbia are discussed below.

Maryland. In Maryland, a number of EV-related bills were proposed during the 2012 legislative session as a result of recommendations made by the Governor's Electric Vehicle Infrastructure Council. Legislation was enacted that exempts EV charging service providers from the

[70] District of Columbia Public Service Commission. Formal Case No. 1096, In the Matter of the Investigation into the Regulatory Treatment of Providers of Electric Vehicle Charging Stations and Related Services. http://www.dcpsc.org/edocket/docketsheets.asp?cbofctype=all&CaseNumber=FC1096&ItemNumber=&orderno=&PartyFiling=&FilingType=&yr_filing=&Keywords=&FromDate=&ToDate=&toggle_text=Full+Text&show_result=Y&hdn_orderNumber=&hdn_chk_whole_search=&hdn_AssesmentType=

[71] Council of the District of Columbia. Energy Innovation and Savings Amendment Act of 2012. http://dcclims1.dccouncil.us/lims/searchbylegislation.aspx.

definition of "electricity supplier" and "public service company" in the Public Utilities Article of the state code.[72],[73]

Virginia. Virginia's General Assembly passed legislation regarding EV charging service in 2011. The law exempts EV charging service providers from being regulated as public utilities.[74]

District of Columbia. In the District of Columbia, the PSC will consider the regulatory treatment of electric vehicle charging stations and related services in its ongoing EV case.[75] In April 2012, a bill was introduced to the Council of the District of Columbia that would exempt EV charging station service companies and service providers from regulation as public utilities.[76]

Resale of Electricity

Whether EV charging station owners/operators are deemed by the law to be reselling electricity or to be using electricity to provide a service will impact how EV charging stations are allowed to operate and charge for their services. If they were determined to be in the business of reselling electricity, EV charging stations would need to be licensed by the state public utility commission. The status of this issue in Maryland, Virginia, and the District of Columbia is discussed below.

Maryland. In Maryland, the recently passed legislation that exempts EV charging service providers from being regulated as utilities also exempts them from regulation as electricity suppliers. Thus, EV charging station owners and operators do not need to be licensed by the PSC in order to provide charging services.[77]

Virginia. Virginia's public utility laws explicitly deem EV charging service providers not to be engaged in the retail sale of electricity, provided that they purchase 100 percent of the electricity used from the incumbent utility within the given exclusive service territory and the electricity is used solely for transportation purposes.

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[72] Maryland General Assembly. Senate. Public Utilities – Electric Vehicle Users and Charging Stations – Exclusions. H.B. 1280, 2012 Session. http://mlis.state.md.us/2012rs/billfile/hb1280.htm

[73] Maryland Code §7–211. Public Utilities Article. http://mlis.state.md.us/asp/web_statutes.asp?gpu&7-211

[74] Virginia General Assembly. Public Utilities—Electric Vehicle Charging Service; Excludes Certain Persons from Retail Sale of Electricity.; H.B. 2105, 2011Session. http://lis.virginia.gov/cgi-bin/legp604.exe?111+sum+hb2105

[75] District of Columbia Public Service Commission. Formal Case No. 1096, In the Matter of the Investigation into the Regulatory Treatment of Providers of Electric Vehicle Charging Stations and Related Services. http://www.dcpsc.org/edocket/docketsheets.asp?cbofctype=all&CaseNumber=FC1096&ItemNumber=&orderno=&PartyFiling=&FilingType=&yr_filing=&Keywords=&FromDate=&ToDate=&toggle_text=Full+Text&show_result=Y&hdn_orderNumber=&hdn_chk_whole_search=&hdn_AssesmentType=

[76] Council of the District of Columbia. Energy Innovation and Savings Amendment Act of 2012. http://dcclims1.dccouncil.us/lims/searchbylegislation.aspx.

[77] Maryland General Assembly. Senate. Public Utilities – Electric Vehicle Users and Charging Stations – Exclusions. H.B. 1280, 2012 Session. http://mlis.state.md.us/2012rs/billfile/hb1280.htm

District of Columbia. Currently, only retail suppliers licensed by the PSC may sell electricity in the District of Columbia. This issue may be addressed by the ongoing EV case before the PSC.

Notification/Release of Records

Currently, EV manufacturers and dealers are utilities' main source of information on EV sales in the region. However, this information does not give a complete picture of where vehicles are being charged. Data about residential charging stations are particularly important because studies indicate that 80 percent to 95 percent of EV charging occurs at home. Because potential immediate grid impacts of EV charging are local, complete and accurate data about home charging are essential to distribution planning efforts.

Electric permitting and inspection documents are likely to catch most new stand-alone EV charging locations. However, all vehicles will be able to charge using 120-volt outlets, and some consumers may not install Level 2 charging equipment. Currently, many electric permits do not indicate whether the new installation is for EV charging or for some other purpose. Including a checkbox on each permit indicating whether or not EV charging equipment was installed, as well as fields for the voltage and amperage, would greatly assist utilities in infrastructure planning. The regulatory status of this issue in Maryland, Virginia, and the District of Columbia is discussed below.

Maryland. Maryland's 2012 legislature enacted legislation that allows the Motor Vehicle Administration to provide electric utilities with the address of each registered EV owner in the state. [78]

Virginia. Virginia does not have an official utility notification policy. However, Virginia Clean Cities and the Virginia Department of Mines, Minerals and Energy were awarded a grant for EV infrastructure planning through the Department of Energy (DOE). This issue will be addressed as part of this effort, known as the Richmond Electric Vehicle Initiative (REVi).

District of Columbia. The District of Columbia does not have an official utility notification policy.

Utility Programs on EV Tariffs and Education

Some states in the region have experimented with special EV charging rates, and others are considering developing programs. These programs allow utilities to collect valuable charging data from participants and assess the effectiveness of price signals in encouraging off-peak

[78] Maryland General Assembly. House of Delegates. H.B. 1279 Motor Vehicle Administration - Plug-In Vehicles - Disclosure of Personal Information. http://mlis.state.md.us/2012rs/billfile/HB1279.htm

charging. In addition, special EV tariffs offer EV owners opportunities to lower fuel costs. These programs need approval by state utility commissions.

Several utilities are developing education programs to provide their EV customers with information related to the development and deployment of EVs. Such programs may include website information, speakers bureaus, community outreach, and electronic or paper education materials that are available to EV owners, potential EV owners, and the general public. Utilities are in a unique position to help educate current and potential EV owners because of their existing customer relationships. Therefore, utilities can be helpful partners with EV manufacturers, charging station managers, trade associations, and governments in developing education and outreach programs. These programs may be targeted to specific customer segments, such as residential, commercial, industrial, government, or fleet customers. Program offerings in Maryland, Virginia, and the District of Columbia are outlined below.

Maryland. In Maryland, Pepco offers special EV rates for commercial customers under "Schedule EV." In addition, a law passed in 2011 requires the PSC to develop a pilot incentive program for residential, commercial, and government electric customers to charge EVs during off-peak hours. The program must be in place by June 30, 2013. [79]

Virginia. In Virginia, Dominion Virginia Power offers an EV Pilot Program that was approved by the SCC in July 2011 and became effective in October 2011. The program offers two rates for residential customers who own EVs. The Electric Vehicle Pricing Plan (Schedule EV) offers customers lower rates during off-peak hours, provided that a separate, dedicated EV meter is installed in the home. The Electric Vehicle + Home Pricing Plan (Schedule 1EV) offers time-of-use pricing for the entire home, including the vehicle, using a single whole-house meter. [80]

District of Columbia. The District of Columbia does not currently have a special rate for EVs. Pepco offered two experimental EV rates from 1993 until 2006, when they were eliminated due to low participation. The EV case now before the PSC will consider reinstituting an EV pilot rate. [81]

[79] Pepco. Maryland Electric Vehicle Service Schedule EV. http://www.pepco.com/_res/documents/MDRatesEV.pdf
[80] Dominion. Plug In Electric Vehicles. https://www.dom.com/about/environment/electric-vehicles.jsp
[81] District of Columbia Public Service Commission. Formal Case No. 1096, In the Matter of the Investigation into the Regulatory Treatment of Providers of Electric Vehicle Charging Stations and Related Services. http://www.dcpsc.org/edocket/docketsheets.asp?cbofctype=all&CaseNumber=FC1096&ItemNumber=&orderno=&PartyFiling=&FilingType=&yr_filing=&Keywords=&FromDate=&ToDate=&toggle_text=Full+Text&show_result=Y&hdn_orderNumber=&hdn_chk_whole_search=&hdn_AssesmentType=

Emissions Impacts

EVs can offer significant emissions reductions over conventional vehicles. They produce no tailpipe emissions, thereby reducing urban concentrations of carbon monoxide, volatile organic compounds, oxides of nitrogen, sulfur oxides, and particulate matter. They can also offer significant greenhouse gas reductions, depending on the electricity sources that are used to charge them.

The extent to which EV use reduces estimated upstream emissions—that is, total emissions from electricity production—is determined by the mix of energy sources used to power the local electrical grid and when EV owners recharge their vehicles. EVs charged in areas using a greater percentage of clean and/or renewable energy sources will have lower estimated upstream emissions impacts than EVs charged in areas depending heavily on conventional fossil fuel generation.

On the basis of the 2005 national average of fuel sources, EVs offer a 38 percent reduction in annual greenhouse gas emissions compared with conventional vehicles. A DOE emissions comparison module based on 2005 annualized electrical grid data shows that EVs produce a 44 percent reduction in greenhouse gas emissions when charged in the District of Columbia and Virginia and a 24 percent reduction when charged in Maryland.[82] The reduction estimates are higher when 2009 or 2011 data are used. As the proportion of clean and renewable fuels used to produce electricity in the region increases, the benefits of EV deployment increase as well.

Utilities across the region are making progress toward state renewable portfolio standard (RPS) goals, and many have implemented their own renewable and clean energy programs. State and local initiatives to increase installations of solar panels and other renewable energy technologies are also helping decrease the emissions intensity of electricity provided to the region. Continued government support for these initiatives is critical to increasing the environmental and health benefits of EV use over time.

[82] DOE EERE Alternative Fuels and Advanced Vehicles Data Center: Emissions from Hybrid and Plug-In Electric Vehicles. http://www.afdc.energy.gov/afdc/vehicles/electric_emissions.php.National and state electricity fuel source mixes are based on 2007 EPA eGrid data.

Table 5-1. Overview of State Laws and Regulations Related to EVSE

	Maryland	District of Columbia	Virginia
Regulation as a Public Utility	Legislation has been passed exempting electric vehicle charging station (EVCS) owners, EVCS service companies, and EVCS service providers from the definition of "electricity supplier" and "public service company" in the Public Utilities Article (H.B. 1280 and S.B. 997).	The DC Council is considering a bill that would exempt EVCS service providers from public utility regulation. (Energy Innovation and Savings Amendment Act of 2012).	The Virginia General Assembly passed legislation in 2011 that deems the provision of EV charging services to be a permitted utility activity, but it exempts EVCS service providers from being regulated as public utilities. (House Bill 2105, 2011, and Virginia Code 56-1.2 and 56-232.2)
Sale of Electricity for EV Charging	Only electric suppliers licensed by the PSC can sell electricity.	Only retail suppliers licensed by the PSC can sell electricity. The DC PSC is considering regulatory treatment of EVs and EVCS owners in Formal Case #1096.	Under the 2011 law, EV charging service providers are deemed not to be engaged in the resale of electricity, provided that they purchase 100 percent of the electricity used to provide EV charging services from the incumbent electric utility in the given service territory and that the electricity purchased is used solely for transportation. (House Bill 2105, 2011, and Virginia Code 56-1.2)
Release of Records	Legislation has been passed to allow the Motor Vehicle Administration to release street addresses to utilities to ensure public safety and reliability of the electric grid (H.B. 1279 and S.B. 998).	Has not been addressed.	This issue will be addressed as part of DOE's EV Readiness Grant awarded to the Greater Richmond Region.
Rates/Tariffs	Pepco offers an EV rate for commercial customers under Schedule EV. The PSC Rate Case 9261 established a working group to consider rate-based incentives and pilot programs.	No special rate for EV. PSC Case has been opened (Case #1096).	Dominion EV Rate Pilot Program was approved by the VA SCC in July 2011 and became effective in October 2011. Offers two rate options specifically designed for customers with EVs: (1) a whole-house time-of-use rate and (2) a separately metered EV-only rate. Each option is open to 750 participants. The pilot will be in effect for three years.

FUTURE EV ISSUES

Electric utilities and other stakeholders foresee a number of issues relevant to EVs and grid planning that are important to consider as EV infrastructure grows. These issues do not require policy change at this time but are most appropriately dealt with by the private sector. Local and state governments should monitor these issues, should the need for regulation arise in the future.

Preparing for DC Fast Charging

DC fast charging infrastructure requires special equipment and has a greater potential to impact utility transformers than do Level 1 and Level 2 charging stations. Currently, only two EV models available in the United States have DC fast charge capability and there are none of these chargers installed in the DC region. However, DC fast charging is seen as the "next frontier" in EV infrastructure. More vehicles are expected to have DC fast charge capabilities in the future, and some companies have expressed interest in installing DC fast chargers in the Washington region in coming months or years. So while DC fast charging infrastructure is not currently a pressing concern, it is an important issue for future planning. it is not currently a pressing concern.

Because of the increased risk of electric infrastructure impacts and the planning that is necessary for DC fast charging, utilities need advance notice of specific deployment plans for DC fast charging installations. For the foreseeable future, DC fast charge stations will not be installed in homes, so this issue applies solely to nonresidential public and private charging stations.
The Society of Automotive Engineers (SAE International) just finalized the North American DC fast charging standards. However, vehicles will not be equipped with the standardized charging receptacle until at least late 2013. Because the charging connection standard will impact what charging equipment is appropriate, local governments and fleet owners should consider waiting for the introduction of vehicles equipped with the new standard receptacle before making large investments in DC fast charging infrastructure.

Cost to Charge EVs at Public Charging Stations

A range of public charging options is available in the region, including pay services and free charging. At this early stage of the market, providing this variety of options is important to test various charging rates and structures. Providing free services is an important component of the market and should be preserved as a charging option.

Deployment of "Smart" EVSE

There has been considerable interest in linking EVs with smart grids to better manage electrical loads. However, some charging stations being sold in the market today are not capable of two-way communication with the grid and thus are not smart-grid-ready. While EVs may one day play a significant role in smart-grid development, it is too early in the marketing of both

technologies to regulate how they might be connected. Thus, there should not be any restrictions on non-smart-grid-ready EVSE technology.

Use of a Second Meter or Multiple Meters for EV Electric Consumption Billing

Many commercial and multiunit residential buildings use multiple electricity meters to measure consumption in various areas or uses. In addition, some EV tariffs and rate schedules may require a separate meter for EV charging equipment. Separate metering may allow EV drivers to take advantage of the most cost-effective rates. Preserving the current regulatory flexibility is important, since it allows for multiple technological solutions to metering and billing.

UTILITY POLICY RECOMMENDATIONS

Recommendation 1: State governments and regulatory bodies should promote a clear regulatory framework for EV charging service providers that exempts them from regulation as electric utilities or retail sellers of electricity.

a. Do not regulate nonutility EV charging service providers as public utilities or electricity suppliers.
b. Because EVSE providers are offering a service and not just electricity, do not consider that service to be a "sale for resale" or the "retail sale of electricity" subject to state/local electric provider regulations as long as EV charging service providers meet any existing conditions in state law that exempt the provision of EV charging services from treatment as a "sale for resale" or the "retail sale of electricity."

Recommendation 2: Local governments permitting agencies should notify utilities of EVSE installations.

a. Include a field on all new electrical permits noting whether the permit includes EV charging and if so, its voltage and amperage. If the field is checked on the permit, share the information with the local utility.
b. Notify utilities in advance about the locations of new Level 2 or DC fast charge charging stations.
c. Develop a statewide public charging station registry.

Recommendation 3: State and local governments, in cooperation with utilities, should reduce upstream emissions associated with EV charging.

a. Continue to support clean and renewable energy programs that reduce the emissions intensity of electricity production in the region and thereby decrease the estimated indirect upstream emissions associated with EV use.

Recommendation 4: Federal government entities, in cooperation with standards development organizations, should develop communications protocols for "smart" EVSE.

a. Encourage standards development organizations, working with federal government entities, to develop communications protocols for EVSE.
b. Encourage state and local governments not to prohibit the sale of EVSEs that are not smart-grid-ready, so as not to interfere with the market.

Recommendation 5: State governments and regulatory bodies, in cooperation with utilities, should allow a variety of metering and billing scenarios for EV charging.

a. Encourage regulatory flexibility to allow multiple technological solutions to metering and billing issues.

b. Do not prevent or prohibit the use of second meters, since in some instances they may provide the most cost-effective option.

Recommendation 6: State regulatory bodies and utilities should enable and promote utility EV pilot programs.

a. Encourage customers who have purchased an EV or are considering the purchase of an EV to participate in utility pilot programs.
b. Support state regulatory approval of such programs, including the establishment of EV-specific tariffs for residential, commercial, industrial, and governmental customers.

Recommendation 7: Utilities, in partnership with the EV industry and stakeholders, should promote EV education programs.

a. Encourage participation in or partnership with utility education programs.
b. Research the possibility of joint programs to expand and improve their outreach and impact.

SECTION 6
VEHICLE FLEETS

Government and commercial fleets offer a significant potential market for electric vehicles (EVs). Fleet purchases have a number of advantages:

- Fleet purchases reduce costs by taking advantage of economies of scale.
- Fleet purchases can help promote the adoption of new technology, as compressed natural gas (CNG) fleets did in the past. Since the 1990s, federal legislation has encouraged fleet purchasing of alternative fuel vehicles. Federal agencies are required to ensure that that 75% of their annual light-duty vehicle purchases use alternative fuels, including compressed natural gas, E85, M85, LPG, hydrogen, biodiesel, electric, hybrids, and fuel cell vehicles (See Figure 6-1).
- Fleets have advantages over passenger vehicles that allow them to overcome problems faced by household consumers.
- Fleets operate in a defined geographic area, often service fixed routes, and return to a central location in the evening, thereby addressing concerns about range and charging infrastructure locations faced by private EV owners. Postal delivery trucks, utility service trucks, and consumer sales vehicles have these fleet characteristics.

This section explores the advantages of EVs for fleet use, highlights the EV public fleets now in use in the metropolitan Washington region, and discusses the current and planned use of EVs in private fleets in the region. Finally, recommendations related to promoting EV fleets are presented—primarily focused on using financing and tax incentives to reduce the cost and utilization of EVs in fleets and promoting sharing of charging stations and cooperative purchasing.

BENEFITS OF EVS FOR FLEET USE

A 2012 survey of fleets in the metropolitan Washington region found that EVs are being adopted slowly. The Greater Washington Region Clean Cities Coalition's survey of 11 fleet managers found that most EVs currently in operation are used onsite, such as trucks used on landfills or campus landscaping equipment.[83] According to the Coalition, fleet managers cite the cost of EVs and infrastructure as obstacles to purchasing additional EVs.

[83] Greater Washington Regional Clean Cities Coalition. *Clean Cities 2011 Annual Report*. Spring 2012.

The Electrification Coalition prepared a report, *Fleet Electrification Roadmap (2010)*,[84] which presents six major advantages of EVs over internal combustion vehicles for commercial and government fleet use. One of the main advantages is the lower total cost of ownership (capital, operating, maintenance, and service costs). Fleets also may lend themselves to electrification due to characteristics such as route predictability, higher vehicle utilization rates, and more use of central parking and fueling facility.

The *Fleet Electrification Roadmap* also points out that EVs are flexible in their use of power generation because they can switch to a different fuel during a power supply shortage. Electricity can be generated from different sources such as natural gas, hydropower, wind, geothermal heat, and solar energy.

The Electrification Coalition looked at the characteristics of different fleets, such as service and utility vehicles and medium short haul vehicles. They concluded that fleet managers need efficient vehicles that can perform well under specified conditions. The report recommends tailoring the battery size for the task to get a vehicle that specifically fits the fleet's needs and is used efficiently. The analysis concludes that cost competiveness increased over time for hybrid electric and plug-in hybrid electric vehicles compared with conventional internal combustion vehicles when the battery is sized according to fleet operating conditions.

Figure 6-1. EPAct 92 AFV Acquisition Requirements

Under the Energy Policy Act of 1992 (EPAct 1992) certain federal, state, and alternative fuel provider fleets are subject to alternative fuel vehicle (AFV) acquisition requirements.

Under EPAct 92, local government fleets are not subject to these requirements; however, the District of Columbia is considered a state under EPAct and is required to follow the state mandates.

AFVs include flex-fuel vehicles , compressed natural gas or propane dedicated or bi-fuel

Figure 6-2. Available EV Products on GSA's Federal Vehicle Standards

Light-Duty Hybrid

- Sedans: Honda Insight, Toyota Prius, Ford Fusion, RP Automotive Hyundai Sonata
- SUV (4x2 and 4x4): Ford Escape, Chevrolet Tahoe
- Pickup (4x2 and 4x4): Chevrolet Silverado

Electric Vehicles

- Sedans: Chevrolet Volt, RP Automotive Nissan LEAF, RP Automotive Mitsubishi iMiev, Ford Focus Electric
- Cargo Vans/Trucks: Smith Electric Newton, Central Truck Zero, EVI, Boulder, eStar

EVSE (as of 1/12/2012)

- ClipperCreek, Coulomb Technologies, Eaton, Leviton, Merit Builders, Schneider Electric, Siemens

PUBLIC FLEETS

In 2010, the General Service Administration (GSA) initiated a Plug-in Electric Vehicle Pilot that will distribute 116 vehicles across nine cities, including the metropolitan

[84] Electrification Coalition. *Fleet Electrification Roadmap*. Noven
http://www.electrificationcoalition.org/sites/default/files/EC-F

Washington region. The program includes Chevy Volts, Nissan LEAFs, and Think City EVs. The 20 participating agencies are required to install one Level 2 charging station/connector per vehicle.

The GSA office in the Washington region received 37 Chevy Volts. The first two Volts were delivered in October 2011, and the remaining 35 were delivered between February and May 2012. Through this pilot program, Baltimore received five Think Citys in November 2011, with charging stations installed and operational by December 2011.

GSA's Federal Acquisition Service provides access to different types of alternative fuel vehicles, including compressed natural (CNG), ethanol (E85), and EVs. Through GSA Federal Vehicle Standards, GSA customers can acquire a variety of EVs and EVSE brands/models, installation services, and ancillary services. Figure 6-1 outlines the alternative fuel vehicle acquisition requirements of the EPAct 1992 that apply to fleets. Figure 6-2 lists the available EVs that are compliant with GSA's federal vehicle standards.

PRIVATE FLEETS

Some regional corporate leaders support electricity as a transportation solution. Frito-Lay currently operates EV trucks in the metropolitan Washington region. Enterprise Rent-A-Car is planning a large-scale EV rental rollout across several markets throughout the United States as part of their corporate commitment to sustainability. Enterprise also offers daily and weekly rentals of the Chevy Volt Extended-Range EV. Enterprise has introduced 500 Nissan LEAFs into the fleet, with an ongoing goal of incorporating new technology, such as the Toyota Prius Plug-In hybrids and Peugeot iOns, to be added in Enterprise Rent-A-Car's neighborhood locations, local business rental programs, and WeCar car sharing. Within the metropolitan Washington region, the Downtown DC Enterprise location offers hybrid and/or EV rentals. Enterprise is considering providing public charging at rental locations in the near future. In addition, Enterprise is installing Level 2 charging stations at a number of metropolitan Washington region area rental branches to support a growing fleet of EVs.

FLEETS RECOMMENDATIONS

Below are recommendations related to promoting increased use of public and private EV fleets.

Recommendation 1: The Regional EV Partnership should work to reduce the cost and increase the utilization of EVs in fleets.

a. Adopt measures to increase the use and acquisition of EVs in fleets by leveraging public and private funding. Offset fleet EV vehicle acquisition costs by using available grant funding of up to 20 percent to be competitive.
b. Use federal and state financing and tax incentives and implement other incentives to reduce parking fees, permitting fees, and registration fees, and expand HOV access.

c. Expand the tax credit for light, medium, and heavy duty vehicles for corporations, and encourage metropolitan Washington region dealers to extend the reduced pricing to public fleets.
d. Support the extension of existing federal tax credits for EV infrastructure through 2018.
e. Create clean renewable energy bonds for fleet vehicle infrastructure financing for fleets with more than 10 vehicles.
f. Support advanced battery and related research and development (R&D).
g. Encourage public and private fleet managers to consider the total value of EV ownership, such as lower fuel and maintenance costs as well as nonmonetary benefits.

Recommendation 2: The Regional EV Partnership should encourage sharing and alternate EV charging station arrangements.

a. Encourage fleets that operate in large geographic areas to develop working relationships with federal agencies/commercial interests having charging stations in strategic locations throughout the service area.
b. Encourage installation of Level 2, on-street public charging.
c. Encourage locating employer workplace charging such that fleet vehicles and other public EVs could utilize if available.
d. Encourage utility and private firms to consider installing EVSE networks with monthly subscription rates for unlimited charging.

Recommendation 3: Federal, state, and local governments should promote cooperative purchasing.

a. Utilize GSA, COG, or other cooperative procurement agreements and mechanisms to reduce acquisition costs and to advance adoption of EVs.
b. Offer incentives, such as tax credits, for fleet owners who convert fleet vehicles to electric.

Recommendation 4: Public fleet owners, businesses, and the EV industry should become more engaged in development of EV charging policy.

a. Engage in the regulatory treatment of EV charging stations—such as supporting model ordinances—as an effective way to influence EV charging policy.

SECTION 7
OUTREACH AND EDUCATION

A significant information gap exists among the driving public regarding the benefits of EVs compared with those of conventional vehicles. Education efforts by private and public entities (including nongovernmental organizations, electric utilities, plug-in electric vehicle [PEV] service providers, auto dealers, other businesses, and government) are needed to bridge the gap.[85] To set the stage for EV marketplace success in the National Capital Region, regional partners involved in the Task Force have identified key target audiences and information needs for those audiences.

This section first defines the various target audiences and their information needs related to EV adoption. Then public safety training needs and national and regional training resources for emergency responders, the EV service community, consumers, and the general public are discussed. Finally, recommendations are presented that are intended to bridge the information gap between EV and conventional vehicle technology by identifying and promoting relevant resources and encouraging continued collaboration and sharing of best practices among interested parties.

EV EDUCATION TARGET AUDIENCES

Consumers. Ultimately, marketplace success is determined by consumers. Messaging should reflect how easy it is to own an EV/PEV and how it can fit into the consumer's lifestyle. This could include information on what to consider prior to buying a EV, Level 1 charging at home, home safety and inspection, and information that will help alleviate range anxiety.

Property Owners and Managers. This target audience includes all types of property owners and managers such as multifamily, commercial, institutions, and homeowner/condominium associations. Property owners and managers need information on how to locate a charging station at their property. Property owners and managers with charging stations can assist in relieving consumers of range anxiety. Businesses that are interested in purchasing or leasing an EV may need information on EV fleet capabilities appropriate for their needs.

Service Industry. This target audience incorporates total vehicle service and includes charging station installers, charging station inspectors, car dealerships, repair shops, and first responders. If EVs are going to be successful in the marketplace, the service industry needs to understand how to accommodate EVs. Education and training are needed on installing and inspecting

[85] Center for Climate and Energy Solutions. *An Action Plan to Integrate Plug-in Electric Vehicles with the U.S. Electrical Grid.* March 2012. http://www.c2es.org/docUploads/PEV-action-plan.pdf

charging stations. Car dealerships need to be able to provide EV owners and potential buyers with accurate information, and mechanics need training on how to repair PEVs. First responders need to know how to respond to an emergency involving an EV.

Students. Educating the next generation on EV technology will assist in bridging the technology gap. The target audience includes elementary, middle, high school, and college students.

EV Owners/Enthusiasts. EV owners can be champions in their community just by sharing their experience as an owner. Public and private entities engaging consumers in PEV education may want to consider tapping into this resource and encouraging owners to participate in outreach events.

All target audiences need information on available incentives and on EV charging stations, including locations, etiquette, and payment mechanisms as well as charging station installation, inspection, and maintenance. Messaging should also recognize that driving less and alternative commuting are key to reducing greenhouse gas emissions and congestion.

PUBLIC SAFETY

Although as safe as conventional vehicles, high-voltage EVs pose a new set of concerns for first responders when approaching an accident scene. Knowing that firefighters and first responders are equipped with the necessary safety information for EVs is crucial to public acceptance. It is important that those connected with fire services and first responders are educated on how to safely work with the inherent differences of EVs. EV have wires, battery packs, and drive train components that can be up to 600V, which can lead to injuries to first responders if not handled properly.

It is important to develop an EV public safety program that is comprehensive, standardized, and consistent. Typical training sessions are eight hours and are geared to educate firefighters on how to act efficiently in emergencies involving electric and hybrid vehicles. Most safety training courses cover vehicle identification and configuration of hybrid electric, plug-in hybrid electric, and battery electric vehicles; overview of components and characteristics; safety features; and recommended extractions procedures for first responders.

National Safety Training Programs

In 2010, the National Fire Protection Association (NFPA) received a $4.4 million grant from the U.S. Department of Energy (DOE) to develop an Electric Vehicle Safety Program.[86] The NFPA

[86] National Fire Protection Association. *Electric Vehicle Safety Training.* http://www.evsafetytraining.org/about-us.aspx#

project supports DOE's aim to increase the number of EVs on the road. The training is offered to members of the fire service, law enforcement, and emergency medical services personnel. The NFPA safety program offers computer-based training courses, self-based study, and webinars that can be taken on a home computer or on a smart phone. The program has identified risks, procedures, and various scenarios ranging from water submersion to in-structure fires and power lines. Through the NFPA program, fire departments will also have access to safety information published by the auto manufacturers.

NFPA expects to train state and metro fire trainers and first responders to deliver course content and curricula. The distribution plan will consist of a train-the-trainer program, including a kit that will be distributed to 60,000 fire departments via the NFPA web portal. NFPA also offers a webinar course, which reviews the safety steps for installation of EV supply equipment.

In January 2012, the National Highway Traffic Safety Administration (NHTSA) released a report called *Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries*.[87] Prepared in cooperation with DOE and NFPA, the report identifies appropriate postcrash safety measures for vehicle owners and the general public, emergency responders, and towing/recovery operators and vehicle storage facilities. NHTSA also offers more targeted, user-friendly guidance for consumers,[88] the emergency response community,[89] and tow truck operators and storage facilities.[90]

Regional Safety Training Programs

The National Alternative Fuels Training Consortium (NAFTC) is a nationally recognized program offering a menu of training courses on advanced vehicle technology and products from biofuel, gaseous fuel, hydrogen, and EVs. Headquartered in West Virginia, the consortium operates through a network of National Training Centers and Associate Training Centers across the United States.

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[87] National Highway Traffic Safety Administration. *Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries.* January 2012. http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_ELECTRIC%20and%20HYBRID%20VEHICLES.pdf

[88] National Highway Traffic Safety Administration. *Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries.* January 2012. http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_Consumers.pdf

[89] National Highway Traffic Safety Administration. *Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries (Law Enforcement/Emergency Medical Services/Fire Department).* http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_Emergency%20Response.pdf

[90] National Highway Traffic Safety Administration. *Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries (Towing and Recovery Operators and Vehicle Storage Facilities).* http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_Tow.pdf

National Training Centers are postsecondary education and training organizations that provide instruction and a demonstrated commitment providing instruction in alternative fuels, alternative fuel vehicles, advanced technology vehicles, and related technologies. Associate Training Centers include high schools, technical centers, and other organizations that provide secondary education. There are three National and Associate Training Centers in the greater Washington–Baltimore area:

- Alexandria Campus–Northern Virginia Community College
- Electric Drive Transportation Association
- The Community College of Baltimore County

NAFTC also offers dedicated workshops and online courses. The first responder safety course for EVs is offered only online.

Additional Resources

For additional resources including safety guidance, as well as safety information from EV manufacturers, see NFPA's Electric Vehicle Safety Training resource page.

Original Equipment Manufacturer Training[91]

- Chevrolet Volt Emergency Response Guide
- Chevrolet Volt Emergency Responder Quick Reference Page Training Class Reference
- Chevrolet Volt Emergency Responder Quick Reference Guide
- General Motors High Strength Steel Reference Guide
- Chevrolet Malibu Eco Emergency Response Guide

[91] Electric Vehicle Safety Training. *Chevrolet.* http://www.evsafetytraining.org/Resources/Auto-Manufacturer-Resources/Chevrolet.aspx

OUTREACH AND EDUCATION RECOMMENDATIONS

Based on the target groups and needs identified, the following recommendations are intended to bridge the information gap between PEV and conventional vehicle technology:

Recommendation 1: The Regional EV Partnership should identify and promote EV education and outreach resources.

a. Identify the main resources that address the needs of target audiences and share them with regional partners on a continual basis to ensure that reliable and consistent information is being provided across the region. Update the list regularly to ensure that new resources are incorporated as they are developed.
b. Add more local resources as local governments develop policies and standards for EV charging stations and other regional partners move forward with their outreach efforts.
c. Include the resources in the outreach and education section of Appendix C.

Recommendation 2: The Regional EV Partnership should continue to engage regional EV partners to encourage collaboration, share experiences, and identify new best practices and resources.

a. Continue to convene to help facilitate implementation of the strategy, share resources, and collaborate on initiatives and events.

Recommendation 3: The Regional EV Partnership should promote awareness of the emerging EV industry training and curricula.

a. Encourage service industry representatives to participate in EV courses that are offered by community colleges and training centers in the region.
b. Encourage high school automotive programs to participate in available training.
c. Make high school instructors aware of other available curricula, resources, and case studies such as the following:
    - The Advanced Electric Drive Toolkit, which features videos and PowerPoint presentations on EV history, orientation, and technologies
    - The National Sustainable Energy Association Curricular Units and Educational Materials
    - The National Renewable Energy Laboratory Model Car Competition for Students
    - Local competitions are organized by the Electric Vehicle Association of Greater Washington DC
    - Maryland Science Center Energy Efficient Car Exhibit
    - The Baltimore-Washington Electric Vehicle Initiative (BEVI) EV intern placement program
    - The Kansas school “SHS Chevy Volt Project”

- GM Electric vehicle school lesson plans, teachers guides, and games
- A year-long EVChallenge for high school students in North Carolina
- The Chevy Volt as a teaching aid video
- Chevrolet Invites Students Nationwide to an “Electric” Education

SECTION 8
SUMMARY OF RECOMMENDATIONS

Achieving electric vehicle (EV) readiness in the metropolitan Washington region will require a coordinated approach among local governments, utilities, players in the EV industry, and nonprofit groups. This report contains recommendations for these stakeholders to promote a consistent set of practices across the region that will remove barriers to EV adoption and infrastructure planning. The recommendations are summarized by topic below and presented in Table 8-1.

EV AND EVSE DEPLOYMENT PLANNING

The region needs guidelines and regulations that ensure that the built environment can easily accommodate future EV charging infrastructure. Special consideration should be given to the multifamily residential sector, workplace charging, and tourism sector. Governments and companies can consider providing incentives to EV owners and charging station hosts to further promote EV deployment.

LOCAL GOVERNMENT POLICY

Local governments should ensure that their comprehensive plans address EV infrastructure development to elevate awareness of the issue among relevant departments and to provide context for negotiations with developers to secure vehicle charging station commitments. Design guidelines, zoning, and building codes should address issues such as ADA accessibility, safety, integration with public streets, and signage.

Local governments can reduce barriers to EV adoption by streamlining permitting and inspection procedures for EV charging installation. This would involve adopting a consistent set of permitting procedures for each EVSE type, developing guidance for installers, and instituting one-time fees.

UTILITY PLANNING AND POLICY

The region needs a consistent regulatory framework for EV charging service providers. State governments should clarify the regulatory status of EV charging service providers, exempting them from public utility laws and electricity resale provisions, and should allow utilities to establish EV rate pilot programs. Electric utilities should be notified of EVSE installations so they can provide necessary grid upgrades and protect service reliability. Notification through the electrical permitting process is preferred. Utilities may also play an important role in EV education programs.

FLEETS

Financing and tax incentives can be used to reduce the cost and increase the utilization of EVs in vehicle fleets in the region. Coordinated efforts, including EV station sharing and cooperative purchasing, can keep down the cost of EV fleet deployment.

OUTREACH AND EDUCATION

Stakeholders should continue to collaborate, share experiences, and identify new best practices as they arise. There is a need to identify existing outreach and education resources, both nationally and in the region, that address the needs of key audiences. Stakeholders can also help promote emerging EV industry trainings and curricula offered in the region.

Table 8-1. Recommendations for the Regional EV Partnership

RECOMMENDATIONS FOR THE REGIONAL EV PARTNERSHIP
1. Promote EVSE siting in strategic locations and monitor EV use and EVSE installations.
2. Equip major new construction and redevelopment in the commercial, multifamily, and public sectors with a feasible level of inexpensive technology to reduce the cost of future EVSE installation.
3. Address multifamily residential EV charging challenges.
4. Facilitate workplace charging by identifying prime charging locations, connecting employers and property managers with EVSE installation resources, and building partnerships between businesses and EV industry players.
5. Develop tourist market opportunities by increasing the availability of EV rentals and developing charging infrastructure at hotels and tourist destinations.
6. Offer incentives to promote investment in publicly accessible EV infrastructure.
7. Develop comprehensive plan guidance to guide EV infrastructure development.
8. Amend all zones except conservation areas to allow for EV charging as an accessory, conditional, or principal use.
9. Establish design criteria to address ADA accessibility, safety, and theft deterrence.
10. Establish guidelines for integrating EV infrastructure with streets and publicly accessible spaces.
11. Standardize signage for EV charging stations.
12. Streamline the permitting process for EVSE installations.
13. Develop a consistent set of permitting procedures for each EV charging scenario.
14. Amend electrical permit applications to include a field noting whether the facility will include EV charging, and share this information with the local electric utility.
15. Promote a clear regulatory framework for EV charging service providers that exempts them from regulation as electric utilities or as retail sellers of electricity.
16. Reduce upstream emissions associated with EV charging.
17. Develop communications protocols for smart EV.
18. Allow a variety of metering and billing scenarios for EV charging.
19. Enable and promote utility EV rate pilot programs.
20. Reduce cost and increase utilization of EVs in fleets by leveraging public and private funding, innovative financing mechanisms, and tax incentives.
21. Encourage infrastructure sharing and alternate EVSE arrangements for fleets.
22. Promote cooperative purchasing of EVs for fleets.
23. Identify and promote EV education and outreach resources.
24. Continue to engage regional EV partners to encourage collaboration, share experiences, and identify new best practices and resources.
25. Promote awareness of the emerging EV industry with training and curricula.

APPENDIX A
ABOUT COG

For more than 50 years, the Metropolitan Washington Council of Governments, known as COG, has helped develop regional solutions to issues including the environment, affordable housing, growth and development, public health, child welfare, public safety, homeland security, and transportation. Founded in 1957, COG is comprised of elected officials from 21 local governments, members of the Maryland and Virginia state legislatures, and members of the U.S. Congress. COG and its 21 member jurisdictions seek to create a more accessible, sustainable, prosperous, and livable National Capital Region.

The organization's overall mission is expressed in our vision plan titled *Region Forward*, which is a comprehensive framework that resulted from the Greater Washington 2050 Initiative. Endorsed by each of COG's 21 local member jurisdictions, *Region Forward* creates a coordinated approach for identifying, tackling, and measuring regional issues that are likely to improve the accessibility, sustainability, prosperity, and livability of communities throughout the region.

In addition to the *Region Forward* vision, COG has used its far-reaching relationships to create regional reports on a number of issues. The 2008 *National Capital Region Climate Change Report* addresses short- and long-term goals to reduce greenhouse gas emissions, ultimately to 80 percent below 2005 levels by 2050. The COG Transportation Planning Board's (TPB's) *The Vision* from 1998 lays out eight broad goals and a host of objectives and strategies to guide the region's transportation investments. The *2006 COG Energy Strategic Plan* focuses on actions that COG and its members can take to help the region adjust to the rising demand for and tightening supply of global energy. The *Bicycle and Pedestrian Plan for the National Capital Region,* the *National Capital Region Freight Plan,* and the *Update of the Ground Access Element of the Washington–Baltimore Regional Airport System Plan,* all from 2010, show how the TPB is incorporating many transit modes and approaches into their comprehensive planning for the region.

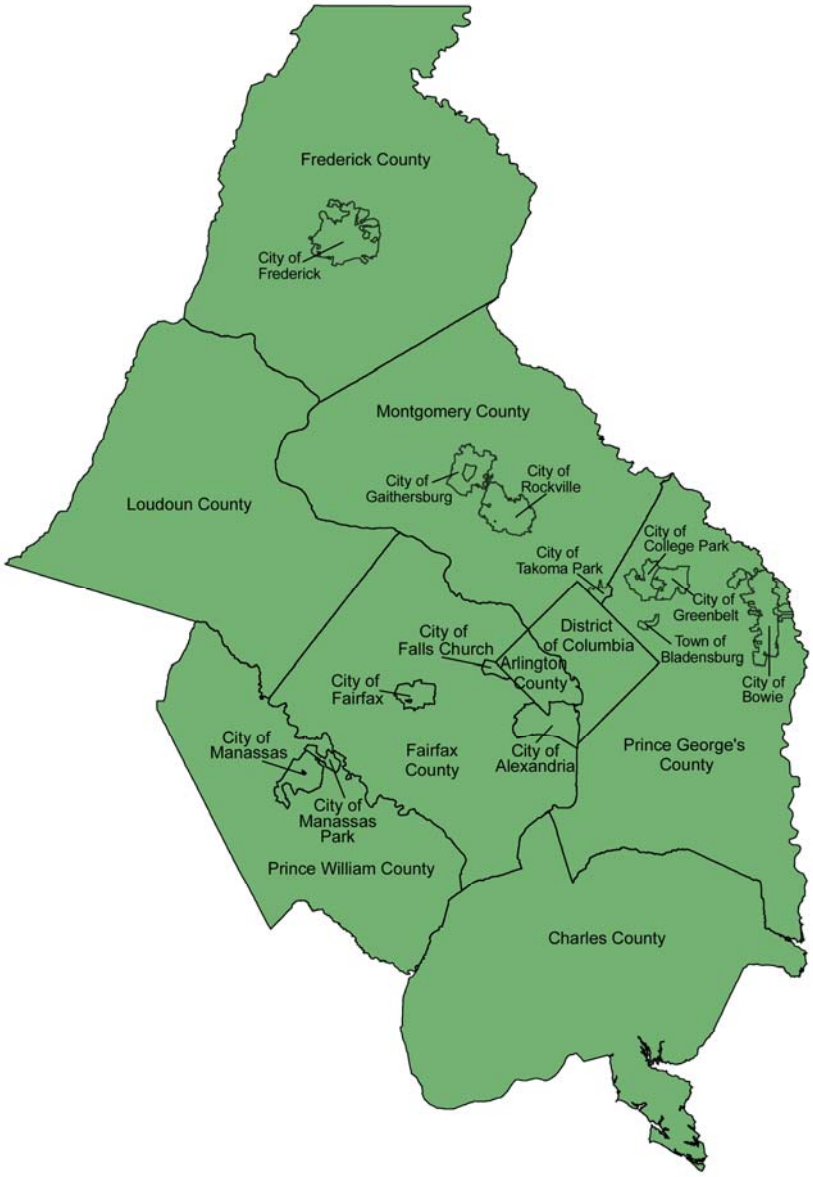
The COG TPB is the federally designated Metropolitan Planning Organization for the region and serves as the regional forum for transportation planning. With participation from the District of Columbia and state departments of transportation and the region's local governments, the TPB prepares intermediate and long-range transportation plans and programs. In addition to the reports mentioned above, the TPB prepares the annual Constrained Long Range Plan (CLRP), which identifies all regionally significant transportation projects and programs that are planned in the metropolitan Washington region between 2010 and 2040. Numerous technical committees

provide information that contributes to recommendations and actions in the CLRP. The Transportation Improvement Program (TIP) is a six-year financial program that describes the schedule for obligating federal funds to state and local projects. The program is updated each year to reflect priority projects in the CLRP. The TIP serves as a schedule of accountability to the Federal Highway and Federal Transit Administrations.

In April 2009, the COG Board created the Climate Energy and Environment Policy Committee (CEEPC) to be its principal policy adviser on climate change, energy, green building, alternative fuels, solid waste and recycling policy issues. CEEPC is responsible for managing implementation of the *2008 National Capital Region Climate Change Report* mentioned above. That includes developing a regional climate change strategy to meet regional greenhouse gas reduction goals adopted by the COG Board.

After COG's EV Forum in April 2011, CEEPC determined that a regional electric vehicle (EV) strategy is a top priority for the region. Elected local government leaders who participated in COG's EV Forum are very interested in working with the Greater Washington Region Clean Cities Coalition and with the stakeholders who attended the forum—original equipment manufacturers, electric vehicle supply equipment manufacturers, Pepco, and Virginia Dominion Power, in particular—to continue to promote greater EV readiness in the region.

Figure A-1. Map of COG Members in the Washington, DC Region



APPENDIX B
GLOSSARY OF TERMS AND ACRONYMS

alternating current (AC)—A type of electric power commonly found in households or businesses where the electric charge constantly and cyclically reverses directions.

alternative fuel—As defined by the Energy Policy Act (EPAct) of 1992, the following fuels are defined as alternative fuels: pure methanol, ethanol, and other alcohols; blends of 85 percent or more of alcohol with gasoline; natural gas and liquid fuels domestically produced from natural gas; liquefied petroleum gas (propane); coal-derived liquid fuels; hydrogen; electricity; pure biodiesel (B100); fuels, other than alcohol, derived from biological materials; and P-Series fuels.

alternative fuel vehicle (AFV)—A vehicle that runs on any form of alternative fuel, including electricity, solar energy, ethanol, or biodiesel.

amperage—The strength of an electrical current measured in amperes (amps).

automatic start/shutoff—An engine that automatically shuts off when the vehicle comes to a stop and restarts when the driver accelerates so energy isn't wasted during idling.

battery electric vehicle (BEV)—A battery-operated all-electric vehicle (electricity is stored in the batteries). BEVs generally have the highest all-electric range (e.g., 60–300 miles) and the largest battery capacity (e.g., 25–35 kWh) among EVs. Includes Nissan LEAF.

DC fast charging—A direct-current charging that uses a 480-volt connection to provide 50kW or more to EV batteries. It provides a full charge in less than 30 minutes, enabling charging along heavy traffic corridors and at public charging stations. The first generation of DC fast chargers primarily use the CHAdeMO connector, produced in Japan. However, in May 2012 the International Society of Automotive Engineers (SAE) designated a new plug design as the standard for American and European models. The new design, called DC Fast Charging with a Combined Charging System, offers a single port that is compatible with existing Level 1 and 2 plugs.

direct current (DC)—A type of electric power commonly found in batteries and solar cells where the electricity charge flows in one direction.

electric motor assist—Technology whereby the electric motor provides additional power to the engine during acceleration, passing, and hill climbing, and uses a smaller, more efficient energy conversion unit (engine).

electric motor drive—Technology whereby the electric motor alone provides the power for lower-speed driving.

electric vehicle (EV)—A vehicle comparable to the conventional gasoline-fueled vehicle, except that refueling is done through electricity and stored in a battery instead of a tank. Power is then transmitted to the wheels via an electric motor, rather than a traditional internal combustion engine.

electric vehicle supply equipment (EVSE)—Equipment used in charging electric vehicles.

extended-range electric vehicle (E-REV)—An electric vehicle with a relatively large battery (e.g., 16–27 kWh) capable of relatively long all-electric ranges (e.g., 40–60 miles) and with a back-up source of power such as gasoline or E85 ethanol. Includes Chevy Volt.

fuel cell electric vehicles (FCEV)—An electric vehicle that converts hydrogen stored onboard with oxygen from the air into electricity to power its electric motor.

heavy duty motor vehicles—A vehicle over 10,000 lbs. gross vehicle weight rating (GVWR).

hybrid vehicle (HV)—A vehicle that uses two or more power sources, usually with one fuel source such as gasoline and the other often a form of electricity stored in a battery.

instantaneous demand—The maximum electric demand at the instant of greatest load.

kilowatt (kW)—A unit of power measurement (1 watt = 1 joule/second; 1,000 watts = 1 kilowatt).

kilowatt-hour (kWh)—A unit of energy measurement equal to one kilowatt acting for one hour; kWh is frequently used as a unit of electrical consumption by which domestic energy use is measured.

Level 1 charging—Standard 120 volts AC (VAC) branch circuit, which is the lowest common voltage level found in both residential and commercial buildings. Typical voltage ratings can be from 110 to 120 volts AC. Typical amp ratings for these receptacles are 15 or 20 amps.

Level 2 charging—Typically described as the "primary" and "preferred" method for the EVSE for both private and publicly available facilities. Level 2 charging specifies a single-phase branch circuit with typical voltage ratings from 220 to 240 volts AC.

Level 3 charging—A charging type that is still in development but is expected to provide a faster AC charging option at public stations. It would operate at a higher voltage and current than Level 2 EVSE. Level 3 charging is expected to deliver a full charge in less than 30 minutes.

light duty motor vehicle—A passenger car or light duty truck at or under 8,500 lbs. GVWR.

li-ion (lithium ion)—A rechargeable battery technology that uses the mineral lithium as a catalyst against various other materials to store and then deliver electrical energy.

medium duty motor vehicle—A motor vehicle between 8,500 lbs. and 10,000 lbs. GVWR.

neighborhood electric vehicle (NEV)—A battery-charged EV with a given amount of speed of up to 25 mph in designated neighborhood areas; NEVs are great for small communities. Includes Columbia ParCar Mega, Dynasty IT, GEM E4, Miles ZX40S, Miles ZX40ST, and Zenn Standard.

nickel metal hydride (NiMH)—A rechargeable battery technology that uses the mineral nickel and a hydrogen-storing alloy to store and then deliver electrical energy.

plug-in hybrid electric vehicle (PHEV)—A hybrid vehicle that runs on an internal combustion engine with batteries that can be recharged by plugging into an external electric power source. They have larger batteries than traditional hybrid vehicles (e.g., 5–22 kWh), allowing for a longer all-electric range. Because they have hybrid engines, PHEVs effectively have an unlimited driving range.

private charging stations—Charging stations located on private property and available only to specified vehicle owners or specified vehicles.

public charging station—A station installed or operated by a public entity, whether publicly available or not.

publicly accessible charging stations—A charging station that is available to the wider public (which could be located on public or private property or operated by a public or private firm).

regenerative braking—Technology whereby energy normally lost during coasting and braking is converted into electricity and stored in the battery.

voltage (V)—A measure of electric potential, which is the condition that causes electric energy to flow; measured in volts.

zero emissions vehicle (ZEV)—A vehicle that produces no tailpipe emissions, no evaporative emissions, and no emissions from gasoline refining or sales, according to California's Air Resource Board, which also produced the standards for the super ultra low emissions vehicle and the partial zero emissions vehicle.

APPENDIX C
RESOURCES

Works Cited in this Report

Advanced Energy. Charging Station Installation Handbook for Electrical Contractors and Inspectors. 2011. http://www.advancedenergy.org/transportation/evse/Charging%20Handbook.pdf

Berkowitz, Justin and Csaba Csere. "The CAFE Numbers Game: Making Sense of the New Fuel-Economy Regulations." Car and Driver, November 2011. http://www.caranddriver.com/features/the-cafe-numbers-game-making-sense-of-the-new-fuel-economy-regulations-feature

Blanco, Sebastian. "GM sells 2,831 Chevy Volts in August, Nissan sells 685 Leafs." Autoblog Green, September 4 2012. http://green.autoblog.com/2012/09/04/gm-sells-2831-chevy-volts-in-august-nissan-sells-685-leafs/

Bloomberg Energy Finance. Electric Vehicle Batter Prices down 14% year on year. http://www.bnef.com/PressReleases/view/210

California Department of General Services. DSA—2011 California Access Compliance Reference Manual Policies. Rev. January 1, 2011. http://www.documents.dgs.ca.gov/dsa/pubs/policies_rev_01-01-11.pdf

Center for Automotive Research. Deployment Rollout Estimate of Electric Vehicles, 2011-2015. http://www.cargroup.org/assets/files/deployment.pdf

Center for Climate and Energy Solutions. An Action Plan to Integrate Plug-in Electric Vehicles with the U.S. Electrical Grid. March 2012. http://www.c2es.org/docUploads/PEV-action-plan.pdf

CHAdeMO Connector (Photo: http://evworld.com/news.cfm?newsid=26062)

Chevrolet Volt. http://www.chevrolet.com/volt-electric-car/ (Photo: http://www.chevrolet.com/volt-electric-car/)

City of Houston. Building Code Enforcement. http://www.houstonpermittingcenter.org/code-enforcement.html

City of Raleigh. Electric Vehicle Charging Station Installation. http://www.raleighnc.gov/search/content/CityMgrDevServices/Articles/HowToElectricVehicleCharging.html

City of Raleigh. How-To Charge Your Electric Car at Home [YouTube video]. September 27, 2010. http://www.youtube.com/watch?v=_x4YezUX8lo&lr=1&uid=makWAtCIzgsRXZUNczyNEA

City of Raleigh. Installing Public Charging Stations [YouTube video]. November 30, 2010. http://www.youtube.com/watch?v=jvPLvsg9y2o

City of Vancouver. Electric Vehicle Infrastructure Requirements for Multi-Family Buildings. http://vancouver.ca/sustainability/EVcharging.htm

COG Department of Transportation Planning. Presentation of Some Initial Findings by Robert E. Griffiths, Technical Services Director to the National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, January 28, 2009. http://www.mwcog.org/committee/committee/archives.asp?COMMITTEE_ID=15

COG Transportation Planning Board. What Would It Take? Transportation and Climate Change in the National Capital Region. May 18, 2010. http://www.mwcog.org/uploads/committee-documents/kV5YX1pe20100617100959.pdf

Combined Charging System (Photo: http://www.digitaltrends.com/cars/is-a-universal-ev-charger-on-the-way/)

Coulomb Technologies. San Francisco MDU Program: "Multicharge SF" [PowerPoint presentation]. February 2012. http://www.mwcog.org/uploads/committee-documents/bl1eWlpc20120229071705.pdf

Council of the District of Columbia. Energy Innovation and Savings Amendment Act of 2012. http://dcclims1.dccouncil.us/lims/searchbylegislation.aspx.

District of Columbia Department of Transportation. Park and Charge Pilot. http://ddot.dc.gov/DC/DDOT/Services/Parking+Services/View+All/Park+and+Charge+Pilot

District of Columbia Public Service Commission. Formal Case No. 1096, In the Matter of the Investigation into the Regulatory Treatment of Providers of Electric Vehicle Charging Stations and Related Services. http://www.dcpsc.org/edocket/docketsheets.asp?cbofctype=all&CaseNumber=FC1096&ItemNumber=&orderno=&PartyFiling=&FilingType=&yr_filing=&Keywords=&FromDate=&ToDate=&toggle_text=Full+Text&show_result=Y&hdn_orderNumber=&hdn_chk_whole_search=&hdn_AssesmentType=

DOE EERE Alternative Fuels and Advanced Vehicles Data Center: Emissions from Hybrid and Plug-In Electric Vehicles. http://www.afdc.energy.gov/afdc/vehicles/electric_emissions.php.

Dominion. Plug In Electric Vehicles. https://www.dom.com/about/environment/electric-vehicles.jsp

ECOtality. Long-Range EV Charging Infrastructure Plan for Greater San Diego. October 2010. http://www.theevproject.com/downloads/documents/Long%20Range%20EV%20Charging%20Infrastructure%20Plan%20for%20the%20Greater%20San%20Diego%20Area%20Ver%204.1.pdf

Edmunds.com. Upcoming Revenge of the Electric Car? The Potential for Higher EV/PHEV Sales. http://www.edmunds.com/industry-center/commentary/upcoming-revenge-of-the-electric-car.html

Electric Transportation Engineering Corporation. Electric Vehicle Infrastructure Deployment Guidelines for the Greater San Diego Area. May 2010. Available at http://www.theevproject.com/downloads/documents/Electric%20Vehicle%20Charging%20Infrastructure%20Deployment%20Guidelines%20for%20the%20Greater%20San%20Diego%20Area%20Ver%203.2.pdf

Electric Vehicle Charging Micro-Climate™ Plan for the Greater Houston Area. Available at http://www.greenhoustontx.gov/ev/pdf/micorclimateplan.pdf

Electric Vehicle Safety Training. Chevrolet. http://www.evsafetytraining.org/Resources/Auto-Manufacturer-Resources/Chevrolet.aspx

Electrification Coalition. Fleet Electrification Roadmap. November 2010. http://www.electrificationcoalition.org/sites/default/files/EC-Fleet-Roadmap-screen.pdf

EV Project. http://www.theevproject.com/index.php

Federal Highway Administration. MAP-21 fact sheet: Congestion Mitigation and Air Quality Improvement Program (CMAQ). http://www.fhwa.dot.gov/map21/cmaq.cfm

Government of the District of Columbia. Climate of Opportunity: A Climate Action Plan for the District of Columbia [draft for public discussion]. September 2010. http://rrc.dc.gov/green/lib/green/pdfs/ClimateOfOpportunity_web.pdf

Honda Prius Plug In. http://www.toyota.com/prius-plug-in/ (Photo: http://www.toyota.com/prius-plug-in/photo-gallery.html)

Idaho National Laboratory. American Recovery and Reinvestment Act (ARRA) – Light-Duty Electric Drive Vehicle and Charging Infrastructure Testing. See Infrastructure Summary Reports. http://avt.inl.gov/evproject.shtml

J1772 Connector (Photo: http://www.ittcannon.com/NewProduct.aspx?id=3802)

Kane County Electric Vehicle Infrastructure Task Force. Draft Electric Vehicle Infrastructure Ordinance. November 29, 2011. Available at http://ncrportal.mwcog.org/sites/surveys/EVP/Model%20Ordinances/Nov%20Electric%20Vehicle%20Insfrastructure.pdf

Kaplan, Noel H., Fairfax County Dept. of Planning and Zoning. Fairfax County's Comprehensive Plan and Potential Application in Support of Electric Vehicles [presentation to the COG EV Planning and Processes Work Group]. November 29, 2011. https://ncrportal.mwcog.org/sites/surveys/EVP/Comprehensive%20Planning/Comprehensive%20Plan_Kaplan%20Ffx%20(2).pdf

Loveday, Eric. "Renault-Nissan CEO still committed to $5.6 billion electric vehicle investment." Autoblog Green. June 20 2011. http://green.autoblog.com/2011/06/20/renault-nissan-ceo-5-6-billion-electric-vehicles/

Maryland Code §7–211. Public Utilities Article. http://mlis.state.md.us/asp/web_statutes.asp?gpu&7-211

Maryland Electric Vehicle Infrastructure Council. Interim Report. January 1, 2012. http://www.msa.md.gov/megafile/msa/speccol/sc5300/sc5339/000113/014000/014354/unrestricted/20120165e.pdf

Maryland General Assembly. House of Delegates. H.B. 1279 Motor Vehicle Administration - Plug-In Vehicles - Disclosure of Personal Information. http://mlis.state.md.us/2012rs/billfile/HB1279.htm

Maryland General Assembly. Senate. Public Utilities – Electric Vehicle Users and Charging Stations – Exclusions. H.B. 1280, 2012 Session. http://mlis.state.md.us/2012rs/billfile/hb1280.htm

Maryland Public Service Commission. Case No. 9261. IN THE MATTER OF THE INVESTIGATION INTO THE REGULATORY TREATMENT OF PROVIDERS OF ELECTRIC VEHICLE CHARGING STATIONS AND RELATED SERVICES. http://webapp.psc.state.md.us/Intranet/casenum/CaseAction_new.cfm?CaseNumber=9261

Maryland Senate Bill 997, 2012. Public Utilities—Electric Vehicle Users and Charging Stations—Exclusions. http://mlis.state.md.us/2012rs/billfile/sb0997.htm

Maryland Senate Bill 998, 2012. Motor Vehicle Administration - Plug-In Vehicles - Disclosure of Personal Information. http://mlis.state.md.us/2012rs/billfile/sb0998.htm

Massachusetts Department of Energy Resources. Installation Guide for Electric Vehicle Supply Equipment (EVSE). http://www.mass.gov/eea/docs/doer/alternative-fuels/ev-manual-mass-32011.pdf

Metropolitan Council of Governments. Region Forward: Sustainability Targets. http://www.regionforward.org/sustainability-targets

Mitre Corporation. Electric Vehicle Charging Infrastructure Recommendations to Fairfax County. 2011. Available at http://www.mitre.org/work/tech_papers/2011/11_2916/

Mitsubishi i. http://i.mitsubishicars.com/ (Photo: http://evworld.com/news.cfm?newsid=19244)

Mitsubishi Motors. Frequently Asked Questions – Battery & Charging. http://i.mitsubishicars.com/faq/battery

National Fire Protection Association. Electric Vehicle Safety Training. http://www.evsafetytraining.org/about-us.aspx#

National Highway Traffic Safety Administration. Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries. January 2012. http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_ELECTRIC%20and%20HYBRID%20VEHICLES.pdf

National Highway Traffic Safety Administration. Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries. January 2012. http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_Consumers.pdf

National Highway Traffic Safety Administration. Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries (Law Enforcement/Emergency Medical Services/Fire Department). http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_Emergency%20Response.pdf

National Highway Traffic Safety Administration. Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries (Towing and Recovery Operators and Vehicle Storage Facilities). http://www.evsafetytraining.org/Resources/~/media/Files/PDFs/NHTSA%20Interim_Guidance_Tow.pdf

National Highway Traffic Safety Administration. Obama Administration Finalizes Historic 54.5 mpg Fuel Efficiency Standards. http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/Obama+Administration+Finalizes+Historic+54.5+mpg+Fuel+Efficiency+Standards

National Highway Traffic Safety Administration. Obama Administration Finalizes Historic 54.5 mpg Fuel Efficiency Standards. http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/Obama+Administration+Finalizes+Historic+54.5+mpg+Fuel+Efficiency+Standards

Nissan LEAF. http://www.nissanusa.com/leaf-electric-car/ (Photo: http://www.nissanusa.com/leaf-electric-car/specs-features/index#/leaf-electric-car/specs-features/index)

Oregon Building Codes Division. Minor Label Program. http://www.bcd.oregon.gov/programs/minorlabel/minor_label_programs.html#2

Pepco. Maryland Electric Vehicle Service Schedule EV. http://www.pepco.com/_res/documents/MDRatesEV.pdf

Pike Research. EV Charging Growing More Complex. August 4, 2010, by John Gartner. http://www.pikeresearch.com/blog/articles/ev-charging-growing-more-complex

Plug In America. GM Voltec EVSE. http://www.pluginamerica.org/accessories/gm-voltec-evse

Puget Sound Regional Council. Electric Vehicle Infrastructures: A Guide for Local Governments in Washington State. Appendices. http://psrc.org/assets/4326/EVI_full_appendices.pdf

Reeves, Benjamin. "Why GM Actually Is Getting Its Money's Worth From The Chevy Volt: http://www.ibtimes.com/articles/382612/20120910/general-motors-gm-chevy-volt-cost-losses.htm

Snohomish County Planning and Development Services. Snohomish County Electric Vehicle Infrastructure Requirements. Available at http://www.mwcog.org/uploads/committee-documents/kV1eWlpe20120228145939.pdf

Sustainable DC. http://sustainable.dc.gov/node/135652

Sustainable Transportation Strategies. EV Charging for Persons with Disabilities. February 2012. https://ncrportal.mwcog.org/sites/surveys/EVP/ADA%20Compliance/ProjGetReady%20-%20EV-Charging-ADA-Version-1.0s.pdf

U.S. Department of Energy Alternative Fuels & Advanced Vehicles Data Center. Hybrid Electric Vehicles. http://www.afdc.energy.gov/afdc/vehicles/electric_basics_hev.html

U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Vehicle Technologies Program Multi-Year Program Plan (2011-2015). http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf

U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Vehicle Technologies Program Multi-Year Program Plan (2011-2015). http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf

U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Federal Tax Credits for Electric Vehicles. http://www.fueleconomy.gov/feg/taxevb.shtml

U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Federal Tax Credits for Plug-In Hybrids http://www.fueleconomy.gov/feg/taxphevb.shtml

U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. Electric Vehicles: Compare Side-by-Side. http://www.fueleconomy.gov/feg/evsbs.shtml

U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. 2011–12 Electric Vehicles. http://www.fueleconomy.gov/feg/evsbs.shtml

U.S. Department of Energy's Vehicle Technologies Program. Clean Cities Webinar—Charging Infrastructure Process Infrastructure Micro Climate Process and Data Collection. Available at http://www1.eere.energy.gov/cleancities/toolbox/pdfs/ev_charging_infrastructure.pdf

U.S. Department of Transportation Federal Highway Administration. Our Nation's Highways: 2008. http://www.fhwa.dot.gov/policyinformation/pubs/pl08021/fig4_5.cfm

U.S. Department of Transportation, Federal Highway Administration. Summary of Travel Trends: 2009 National Household Travel Survey. June 2011. Available at http://nhts.ornl.gov/2009/pub/stt.pdf

U.S. Energy Information Administration. Frequently Asked Questions. http://www.eia.gov/tools/faqs/faq.cfm?id=93&t=4

Union of Concerned Scientists. State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States. Rev. April 12, 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html.

Virginia Code. §56-1.2. Persons not designated as public utility, public service corporation, etc. http://leg1.state.va.us/cgi-bin/legp504.exe?000+cod+56-1.2

Virginia General Assembly. Public Utilities—Electric Vehicle Charging Service; Excludes Certain Persons from Retail Sale of Electricity.; H.B. 2105, 2011Session. http://lis.virginia.gov/cgi-bin/legp604.exe?111+sum+hb2105

Washington Department of Commerce & Puget Sound Regional Council. Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State. July 2010. http://www.commerce.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=8851&MId=863&wversion=Staging

Washington State Department of Commerce, Electric Vehicle Infrastructure, A Guide for Local Governments in Washington State, July 2010, pp.25-31. http://psrc.org/assets/4325/EVI_full_report.pdf

Other Sources Consulted

Austin Energy. *Charge on the Road with Plug-In EVerywhere.* 2012. http://www.austinenergy.com/about%20us/environmental%20initiatives/Plug-In%20Partners/chargeOnTheRoad.htm

City of Houston. *Electric Vehicle Charging Long Range Plan for the Greater Houston Area.* http://www.greenhoustontx.gov/ev/pdf/longrangeevplan.pdf

ECOtality North America. *EV Project: Accessibility at Public EV Charging Locations* [Prepared for the U.S. Department of Energy]. October 10, 2011. http://www.theevproject.com/downloads/documents/EV%20Project%20-%20Accessibility%20at%20Public%20EV%20Charging%20Locations%20(97).pdf

eVgo. *NRG Launches Nation's First Privately Funded, Comprehensive Electric Vehicle Charging Ecosystem* [press release]. November 18, 2010. https://www.evgonetwork.com/News_and_Events/News_Archive/NRG_Launches_Nations_First_Privately_Funded_Comprehensive_Electric_Vehicle_Charging_Ecosystem/

Mecklenburg County, NC Code Enforcement. *Fourteen Years of Change: Key Initiatives 1996–2010.* May 25, 2010, rev. September 2010. Available at http://charmeck.org/mecklenburg/county/CodeEnforcement/AboutUs/Documents/BDC14yrsof%20change.pdf

Public Utilities Commission of the State of California. *Alternative-Fueled Vehicle Information.* http://www.cpuc.ca.gov/PUC/hottopics/1Energy/090814_ev.htm

Public Utilities Commission of the State of California. Rulemaking 09-08-009, Proposed Decision of Commissioner Ryan. May 21, 2010. http://docs.cpuc.ca.gov/efile/PD/118345.pdf

Public Utilities Commission of the State of California. Rulemaking 09-08-009, Proposed Decision of Commissioner Peevey. http://docs.cpuc.ca.gov/efile/PD/132120.pdf

Public Utilities Commission of the State of California. Rulemaking 09-08-009, Administrative Law Judge's Ruling—Phase 3. http://docs.cpuc.ca.gov/efile/RULINGS/158505.pdf

Public Utilities Commission of the State of California. Rulemaking 09-08-009, Joint IOU Assessment Report for PEV Notification. http://docs.cpuc.ca.gov/efile/REPORT/156710.pdf

The EV Project. *EV Project EVSE and Vehicle Usage Report*. http://www.theevproject.com/documents.php

U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center. *Alternative and Advanced Vehicles*. http://www.afdc.energy.gov/afdc/vehicles/index.html

U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center. *All Electric Vehicle Basics.* http://www.afdc.energy.gov/afdc/vehicles/electric_basics_ev.html

U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center. *Hybrid Electric Vehicle Basics.* http://www.afdc.energy.gov/afdc/vehicles/electric_basics_hev.html

U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center. *Light Duty Vehicle Search.* http://www.afdc.energy.gov/afdc/vehicles/search/light/autos/compare?c[]=10420&c[]=10303&c[]=10304&c[]=10357&c[]=10371&c[]=10375&c[]=10378&c[]=10386&c[]=10389&commit=Side-by-Side+Comparison

U.S. Department of Justice. *2010 ADA Standards for Accessible Design.* September 15, 2010. http://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards_prt.pdf

Virginia Clean Cities. *Virginia Get Ready: Initial Electric Vehicle Plan*. October 13, 2010. http://www.virginiaev.org/wp-content/uploads/2010/11/EV-VGR-FINAL-October-13-2010.pdf

EV CHARGING STATION INVENTORY

The following sites offer information on available EVSE:

AFDC—http://www.afdc.energy.gov/afdc/locator/stations/?fuels=ELEC

Clean Technica—http://alternative-fuel.cleantechnica.com/d/a/Electric

Coulomb ChargePoint America—http://chargepointamerica.com/charging-find-stations.php

ECOtality BLINK—http://blinknetwork.com/locator.html

Go Electric Drive—
http://www.goelectricdrive.com/Charging/ChargingStationLocator.aspx#.TwN65Qa1ezY.email

Google Maps— http://maps.google.com/

Plug share—http://www.plugshare.com/

SemaConnect's SemaCharge—http://www.semacharge.com/publicstations.php

OUTREACH AND EDUCATION

National Resources

- www.goelectricdrive.com is sponsored by the Electric Drive Transportation Association. Also, see their Facebook Page, Twitter Feed, and YouTube Page.
- www.plugincars.com features an Online User's Guide for Plug-in Hybrids and Electric Cars. Also, see their Facebook Page or Twitter Feed.
- DOE Alternative Fuel Data Center includes
    - Hybrid and plug-in basics, benefits, maintenance comparison, and charging at home
    - The National Alternative Fuel Station Locator, which includes EV charging station locations, the ability to map your route and identify stations along the way and a feature in which you can submit information to get your station added to the map.
- Environmental Protection Agency Electric Vehicles Brochure
- The EV Project FAQs
- Clean Cities Publications, which include PEV handbooks for consumers, electrical contractors, fleet managers, and public charging station hosts.

Regional Resources

- Baltimore-Washington Electric Vehicle Initiative
- Electric Vehicle Association of Greater Washington DC
- Maryland Science Center Energy Efficient Car Exhibit
- Dominion Helping You Get Plug-In Ready brochure or web link
- Pepco Electric Vehicle Charging Information and How to Prepare (for ownership)
- BGE Plug-In Electric Vehicle Guide and Tips
- Greater Washington Region Clean Cities Coalition About Electric Vehicles and Electric Vehicle Facts
- Virginia Clean Cities Online Educational Resource
- Local events for National Alternative Fuel Vehicle Day, October 18, 2012
- Georgetown Climate Center Transportation and Climate Initiative Electric Vehicle Support Pledge
- Center for Climate and Energy Solutions (C2ES) education strategies for electric vehicles— in development

APPENDIX D

REGIONAL CHARGING STATION INVENTORY

Station Name	Address	City	State	ZIP	Phone	Access	Level 1 Charger	Level 2 Charger
Fashion Centre at Pentagon City	1100 S Hayes St	Arlington	VA	22202	888-758-4389	Public	0	4
Views at Clarendon	1210 N Highland St	Arlington	VA	22201		Planned	0	2
Arlington County	1400 N Uhle St	Arlington	VA	22201	888-758-4389	Private	0	1
1400 Joyce St	1400 S Joyce St	Arlington	VA	22202	888-758-4389	Public	1	1
220Living	220 20th St S	Arlington	VA	22202	888-758-4389	Public	1	1
Arlington Courthouse Plaza	2200 Clarendon Blvd	Arlington	VA	22201	888-758-4389	Public	1	1
Crystal City Plaza	2200 Crystal Dr	Arlington	VA	22202	888-758-4389	Public	1	1
Crystal City Shops	2231 Crystal Dr	Arlington	VA	22202	888-758-4389	Public	2	3
The Concord	2600 Crystal Dr	Arlington	VA	22202	800-663-5633	Public	0	2
Potomac Overlook Regional Park	2845 N Marcey Rd	Arlington	VA	22207	800-663-5633 703-528-5406	Public	1	1
Virginia Tech Research Center	900 N Glebe Rd	Arlington	VA	22203	888-758-4389	Public	2	2
National Airport garage B east side	2400 S Smith Blvd	Arlington	VA	22202	888-758-4389	Public	4	4
Potomac Yard North	2733 South Crystal Drive	Arlington	VA	22202		Public	6	6
Potomac Yard South	2777 South Crystal Drive	Arlington	VA	22202		Planned	1	1
Potomac Yard South	2777 South Crystal Drive	Arlington	VA	22202		Public	6	6
Skyline Shopping Center	5203 Leesburg Pk	Falls Church	VA	22041	888-758-4389	Public	0	2
Brown's Fairfax Nissan	11000 Main St	Fairfax	VA	22030	703-591-8009	Public	0	1
Nissan of Chantilly	14840 Stonecroft Center C	Chantilly	VA	20151	703-889-3700	Public	0	1
Passport Nissan - Alexandria	150 S Pickett St	Alexandria	VA	22304	703-823-9000	Public	0	1
Wolf Trap	1551 Trap Rd	Alexandria	VA	22314	888-758-4389	Public	2	2
The Barns at Wolf Trap	1645 Trap Rd	Alexandria	VA	22314	888-758-4389	Public	1	1
Carr Properties	1701 Duke St	Alexandria	VA	22314	888-758-4389	Planned	1	1
Carr Properties	1800 Diagonal Rd	Alexandria	VA	22314	888-758-4389	Public	1	1
Center for Innovative Technology Headquarters	2214 Rock Hill Rd	Herndon	VA	20170	888-758-4389 703-742-6971	Public	1	1
Walgreens	225 Maple Ave E	Vienna	VA	22180	800-663-5633	Public	0	1
Stone's Cove Kitbar	2403 Centreville Rd	Herndon	VA	20171	703-434-3615	Public	0	1
Halstead Square	2750 Gallows Rd	Vienna	VA	22180	800-663-5633	Private	0	1
Walgreens	3050 Nutley St	Fairfax	VA	22031	800-663-5633	Public	0	1

MOM's Market	424 Elden St	Herndon	VA	20171	888-758-4389	Public	2	2
Walgreens	6717 Richmond Hwy	Alexandria	VA	22306	800-663-5633	Public	0	1
Walgreens	7629 Richmond Hwy	Alexandria	VA	22306	800-663-5633	Public	0	1
Gosnell Properties	8130 Boone Blvd	Vienna	VA	22182	888-758-4389	Public	2	2
Gosnell Properties - Lower Parking Garage	8130 Boone Blvd	Vienna	VA	22182	888-758-4389	Public	1	1
Rosenthal Nissan Mazda	8525 Leesburg Pike	Vienna	VA	22182	703-442-8700	Public	0	1
Smart Center Tysons Corner	8601 Leesburg Pike	Vienna	VA	22182	888-758-4389	Public	1	2
MOM's Market	Post Dr	Herndon	VA	20170	888-758-4389	Public	2	2
Flint Hill	3201 Jermantown Rd	Fairfax	VA	22030	703-964-0432	Private	0	1
Koons Nissan	1051 E Broad St	Falls Church	VA	22044	703-241-1000	Public	0	1
Scott Jenkins Memorial Park - Loudoun County	39464 E Colonial Hwy	Hamilton	VA	20158	888-758-4389	Public	5	5
Brown's Sterling Nissan	45155 Towlern Pl	Sterling	VA	20166	703-948-1100	Public	0	1
Metropolitan Washington Airports Authority	Cargo Dr	Sterling	VA	20166	888-758-4389	Public	4	4
Atlantic Corporate Park	45600 Woodland Rd	Sterling	VA	20166	703-964-0431	Private	0	1
City of Manassas - Public Works	8500 Public Works Dr	Manassas	VA	20110	888-758-4389	Public	0	1
Sheehy Nissan of Manassas	9010 Liberia Ave	Manassas	VA	20110	703-361-5161	Public	0	1
City of Manassas - City Hall	9027 Center St	Manassas	VA	20110	888-758-4389	Public	2	2
City of Manassas - Manassas Museum	9101 Prince William St	Manassas	VA	20110	888-758-4389	Public	2	2
City of Manassas - Virginia Railroad Express Garage	9102 Prince William St	Manassas	VA	20110	888-758-4389	Public	2	2
Kohl's	13651 Foulger Sq	Woodbridge	VA	22192	888-758-4389	Public	1	1
Walgreens	6400 Hoadly Rd	Manassas	VA	20112	888-758-4389	Public	0	1
IBEW Local Union 26 - Joint Apprenticeship and Training Committee	7016 Infantry Ridge Rd	Manassas	VA	20109	888-758-4389	Public	2	2
Cowles Nisson	14777 Jefferson Davis Hwy	Woodbridge	VA	22191	703-497-3000	Public	0	1
MedImmune Ventures	1 MedImmune Way	Gaithersburg	MD	20878	888-758-4389	Public	2	2
MedImmune Ventures	1 MedImmune Way	Gaithersburg	MD	20878	888-758-4389	Public	3	3
MedImmune Ventures - Visitor's Parking Lot	1 Medimmune Way	Gaithersburg	MD	20878	888-758-4389	Public	1	1
MedImmune Ventures - Employee Parking Lot	101 Orchard Ridge Dr	Gaithersburg	MD	20878	888-758-4389	Public	1	1
Charles County Hilton	10385 O'Donnell Pl	Waldorf	MD	20601	800-663-5633	Public	0	2
SunTrust Bank	10415 Old Georgetown Rd	Bethesda	MD	20814	800-663-5633	Public	0	3
The Tower Companies - The Tower Building	1101 Wootton Pkwy	Rockville	MD	20852	800-663-5633	Private	0	1

Kohl's	12024 Cherry Hill Rd	Silver Spring	MD	20904	888-758-4389	Public	1	1
The Tower Companies - The Blairs Shopping Center	1220 East West Hwy	Silver Spring	MD	20910	800-663-5633	Public	0	2
Crain Memorial Welcome Center - Charles County	12480 Crain Hwy	Newburg	MD	20664	888-758-4389	Planned	1	1
Linganore Winecellars	13601 Glissans Mill Rd	Mount Airy	MD	21771		Planned	0	1
The Tower Companies - The Blairs	1401 Blair Mill Rd	Silver Spring	MD	20910	800-663-5633	Public	0	1
Darcars Nissan	15911 Indianola Dr	Rockville	MD	20855	301-309-2200	Public	0	1
Criswell Nissan	19574 Amaranth Dr	Germantown	MD	20874	301-670-3900	Public	0	1
The Tower Companies - Headquarters	2000 Tower Oaks Blvd	Rockville	MD	20852	800-663-5633	Private	0	1
Walgreens	25 High St	Waldorf	MD	20602	800-663-5633	Public	0	1
Olde Towne Youth Center - Gaithersburg	301 Teachers Way	Gaithersburg	MD	20877	301-258-6374	Public	1	0
Herb Gordon Nissan	3131 Automobile Blvd	Silver Spring	MD	20904	301-890-8200	Public	0	1
Charles County Public Library - Potomac Branch	3225 Ruth B Swann Dr	Indian Head	MD	20640	888-758-4389	Public	1	1
University of Maryland-College Park - Lot U4	4116-4138 Mowatt Ln	College Park	MD	20740	888-758-4389	Public	1	1
Indian Head Town Hall	4195 Indian Head Hwy	Indian Head	MD	20640	888-758-4389	Public	1	1
Joint Apprenticeship and Training Committee - IBEW Local Union 26	4371 Parliament Pl	Lanham-Seabrook	MD	20706	888-758-4389	Public	3	3
The Prime Street Grille	4680 Crain Hwy	White Plains	MD	20695	888-758-4389	Public	2	2
Charles County Public Library - PD Brown Memorial Branch	50 Village St	Waldorf	MD	20602	888-758-4389	Public	1	1
Passport Nissan Marlow Heights	5000 Auth Way	Marlow Heights	MD	20746	301-423-8400	Public	0	1
Walgreens	6300 Crain Hwy	La Plata	MD	21646	800-663-5633	Public	0	1
Frederick Nissan	7418 Grove Rd	Frederick	MD	21704	301-662-0111	Public	0	1
Chevy Chase Nissan	7701 Wisconsin Ave	Bethesda	MD	20814	301-656-9200	Public	0	1
Mona Electric Group	7915 Malcolm Rd	Clinton	MD	20735	888-758-4389	Public	1	1
Frederick Community College	7932 Opossumtown Pike	Frederick	MD	21702	800-663-5633	Public	0	2
Hawkins Electric	8001 Sheriff Rd	Landover	MD	20785	888-758-4389	Planned	1	1
King Farm	805 King Farm Blvd	Rockville	MD	20850	800-663-5633	Planned	0	2
University of Maryland - Shady Grove	9630 Gudelsky Dr	Rockville	MD	20850	888-758-4389	Public	0	1
MOM's Organic Market - College Park	9827 Rhode Island Ave	College Park	MD	20740	301-220-1100 888-758-4389	Public	2	2

University of Maryland-College Park - Union Lane	Library Ln	College Park	MD	20740	888-758-4389	Public	2	2
University of Maryland-College Park - Lot EE	Paint Branch Dr	College Park	MD	20740	888-758-4389	Public	1	1
University of Maryland - College Park - Regents Dr	Regents Dr	College Park	MD	20740	888-758-4389	Public	2	2
University of Maryland-College Park - Stadium Garage	Stadium Dr	College Park	MD	20740	888-758-4389	Public	1	1
Bethesda Row Garage	4950 Elm St	Bethesda	MD	0	305-521-0200	Public	1	0
Town Square	200 E Middle Lane	Rockville	MD	0	240-403-1141	Public	1	0
Indian Head Naval Base BVSE Bldg 525	4145 Lloyd Road	Indian Head	MD	20640		Public	0	1
Sheehy Nissan of Waldorf	2950 Crain Hwy	Waldorf	MD	20601	301-843-5300	Public	0	2
Bowie Nissan	2200 Crain Highway	Bowie	MD	20716	301-218-3100	Public	0	3
FedEx Field	1600 FedEx Way	Landover	MD	20785		Planned	4	4
Darcars Nissan of College Park	9330 Baltimore Ave	College Park	MD	20740	301-459-6800	Public	0	1
NIH Fishers Lane Conference Center	5635 Fishers Lane	Rockville	MD	0		Public	0	2
Lenkin Co	1050 K St NW	Washington	DC	20001	888-758-4389	Public	2	2
Manulife Building	1100 New York Ave NW	Washington	DC	20004	202-289-6820	Public	1	1
Lenkin Co	1133 Connecticut Ave NW	Washington	DC	20036	888-758-4389	Public	2	2
Carr Properties	1255 23rd St NW	Washington	DC	20037	888-758-4389	Public	1	1
Lenkin Co	1300 19th St NW	Washington	DC	20036	888-758-4389	Planned	2	2
CoStar Group	1331 L St NW	Washington	DC	20005	888-758-4389	Public	0	1
Carr Properties	1455 Pennsylvania Ave NW	Washington	DC	20004	888-758-4389	Public	1	1
Carr Properties	1575 I St NW	Washington	DC	20005	888-758-4389	Public	1	1
The Tower Companies	1707 L St NW	Washington	DC	20036	888-758-4389	Public	1	1
The Tower Companies	1828 L St NW	Washington	DC	20036	888-758-4389	Public	1	1
Manulife Building	1850 M St NW	Washington	DC	20036	877-308-7714	Public	1	1
The Tower Companies - Millennium Building	1909 K St NW	Washington	DC	20006	888-758-4389	Public	2	2
District Department of Transportation - Franklin D Reeves Center	2000 14th St NW	Washington	DC	20009	888-758-4389	Public	2	2
Washington Real Estate Investment Trust (WRIT)	2000 M St	Washington	DC	20036	800-663-5633	Public	0	2
Control Data Learning Center	2101 L St NW	Washington	DC	20037	888-758-4389	Public	1	1
Lenkin Company	2201 Wisconsin Ave NW	Washington	DC	21401	800-663-5633	Public	0	2

Carr Properties	2233 Wisconsin Ave NW	Washington	DC	20007	888-758-4389	Public	1	1
Car Charging Group Inc - Union Station Garage L1	300 Massachusetts Ave NE	Washington	DC	20002	888-758-4389	Public	1	1
Car Charging Group Inc - Union Station Garage L2	300 Massachusetts Ave NE	Washington	DC	20002	888-758-4389	Public	1	1
Washington Harbour Shopping Plaza	3000 K St NW	Washington	DC	20007	888-758-4389	Public	2	2
M Street Garage	3307 M St	Washington	DC	20007	800-663-5633	Public	0	1
Lexington/Market Square Parking Garage	401 9th St NW	Washington	DC	20004	800-663-5633	Public	0	1
Days Inn	4400 Connecticut Ave NW	Washington	DC	20008	800-663-5633	Planned	0	2
American University - Katzen Arts Center	4400 Massachusetts Ave NW	Washington	DC	20016	888-758-4389	Public	1	1
Donohoe Re Services	550 C St SW	Washington	DC	20024	888-758-4389	Public	0	2
Manulife Building	555 12th St NW	Washington	DC	20004	202-624-0841	Public	1	1
Columbia Square Underground Parking Garage	555 13th St NW	Washington	DC	20005	888-758-4389	Public	2	2
Hogan Lovells	555 13th St NW	Washington	DC	20005	888-758-4389	Private	1	1
National Public Radio	635 Massachusetts Ave NW	Washington	DC	20001	888-758-4389	Private	3	3
Victor Building Parking Garage	750 9th St NW	Washington	DC	20001	202-638-0253	Public	1	1
George Washington University	801 22nd St NW	Washington	DC	20050	888-758-4389	Public	1	1
Carr Properties	901 K St NW	Washington	DC	20001	888-758-4389	Public	1	1
Equity Residential	425 Massachusetts Ave NW	Washington	DC	20001		Private	1	1
Florida Power & Light	801 Pennsylvania Ave NW	Washington	DC	20004	202-347-7082	Private	0	1
Blue Plains Wastewater Treatment Plant	5000 Overlook Ave. SW	Washington	DC	20032		Private	0	2
Main & O Pumping Stations	125 O St SE	Washington	DC	20003		Private	1	0
Firstfield Shopping Center	505 Quince Orchard Rd	Gaithersburg	MD	20878	703-442-4331	Public	0	2

Note: Includes stations published on AFDC, Plugshare, and other sources as of late April/early May 2012. Does not include single family home installations.

Metropolitan Washington
COUNCIL OF GOVERNMENTS

October 2012