BUSINESS

STRATEGIC PLANNING TO IMPLEMENT PUBLICLY AVAILABLE EV CHARGING STATIONS: A GUIDE FOR BUSINESSES AND POLICYMAKERS

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

National Association of State Energy Officials

Clean Cities
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STRATEGIC PLANNING TO IMPLEMENT PUBLICLY AVAILABLE EV CHARGING STATIONS: A GUIDE FOR BUSINESSES AND POLICYMAKERS

by

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NOTICE

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UNLOCKING PRIVATE SECTOR FINANCING FOR ALTERNATIVE FUEL VEHICLES AND FUELING INFRASTRUCTURE

NASEO and C2ES, with funding from the U.S. Department of Energy's Clean Cities Program, began a two-year project in 2013 to develop innovative finance mechanisms aimed at accelerating the deployment of alternative fuel vehicles (AFVs) and fueling infrastructure. C2ES has assembled an advisory group of experts on AFVs, infrastructure, and finance from the public and private sectors to help guide its work. The project aims to:

- Identify barriers that hinder private sector investment;
- Develop and evaluate innovative financing concepts for vehicle purchase and fueling infrastructure in order to make AFVs more accessible to consumers and fleet operators; and
- Stimulate private-sector investment in AFVs and the associated infrastructure deployment, building upon and complementing investments previously made by the public sector.

C2ES researched financial barriers, prepared case studies, and developed strategies to deploy innovative financing concepts that states can consider piloting:

Alternative Fuel Vehicle & Fueling Infrastructure Deployment Barriers

Barriers to deployment of electric, natural gas, and hydrogen fuel cell vehicles and fueling infrastructure

Potential role of private sector financial solutions

Case Studies on Natural Gas Vehicle Fleets and Electric Vehicle Charging

Applying the energy service company model to advance deployment of fleet natural gas vehicles and fueling infrastructure

The role of clean energy banks in increasing private investment in electric vehicle charging infrastructure

Strategic Planning Guides

Electric vehicle charging and natural gas vehicle fleets

Key factors that affect financial performance

Business model application to a particular market

Implementation guidance for policymakers and businesses

The project specifically emphasizes two fuels that offer significant opportunities for growth—electricity and natural gas. Biofuels are not considered because the deployment of biofuel-powered vehicles is already being facilitated by many government and private sector stakeholders. Vehicles powered by hydrogen are included, but they are not a major focus because hydrogen fuel cell vehicles are not yet widely available.

This project is a part of C2ES's AFV Finance Initiative. More information is available at www.c2es.org/initiatives/alternative-fuel-vehicle-finance.

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EXECUTIVE SUMMARY

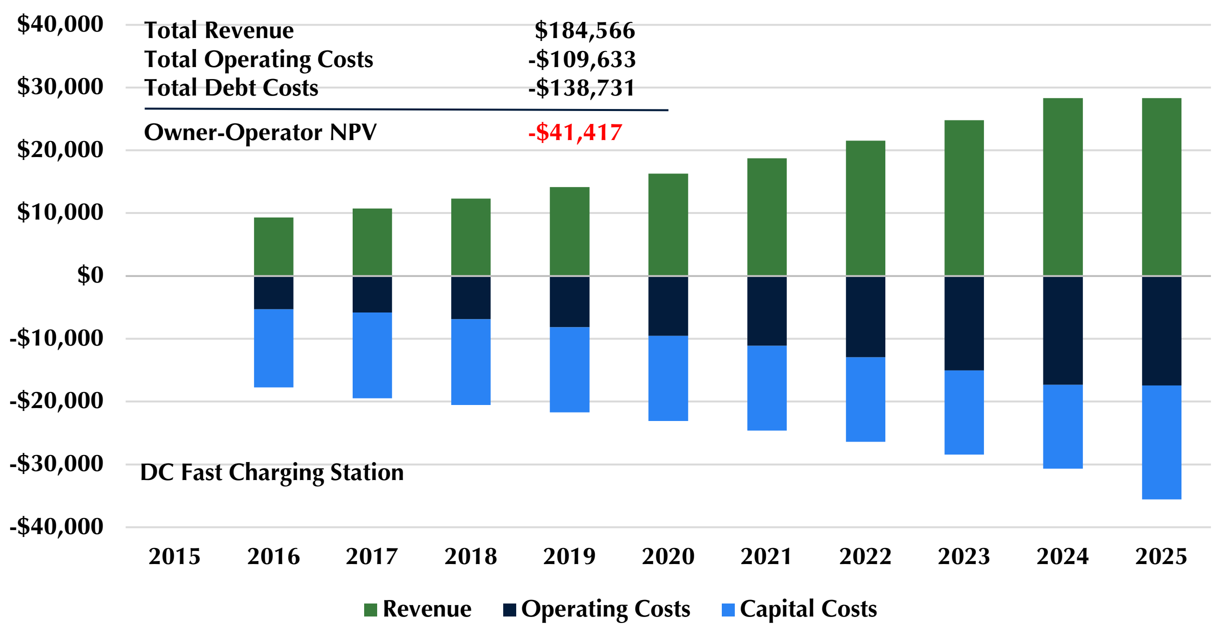
The electric vehicle (EV) market has grown rapidly since the introduction of mass-market EVs in late 2010. More than 300,000 commercial EVs have been sold in the United States between December 2010 and May 2015. However, several barriers persist that prevent the widespread adoption of EV technology. A lack of publicly available charging infrastructure, notably, creates consumer “range anxiety” and may prohibit travel between and within cities and popular destinations. According to the Department of Energy, expanding publicly available charging infrastructure is critical to developing consumer confidence in EV technology and to growing the EV market.

This guide answers questions that private investors and state and local agencies, such as state energy offices, may have in deciding whether and to what extent they should invest in publicly available charging infrastructure. The guide demonstrates that with continued public support in the near term, new business models could gradually make publicly available charging projects profitable for private businesses without additional government interventions.

BACKGROUND

As of May 2015, there were nearly 900 public (direct current or DC) fast charging locations and almost 9,000 lower-powered (Level 2) public charging locations with more than 20,000 charging ports in the United States. The size of the nation’s charging network may not accurately represent the viability of the private sector’s ability to fund the public charging market since federal and state governments funded a large share of the publicly available infrastructure initially deployed to serve the nascent EV market. Private investment in public charging stations is typically not profitable under current market conditions, as the revenues earned from offering public charging services do not offset the costs of purchasing, installing, and operating the stations within a typically attractive payback period of five years.

FIGURE ES-1: Public Fast Charging Stations Unlikely to Payback under Current Market Conditions



This figure illustrates the business challenge facing charging service providers presently. Over the expected life of the charging equipment, the direct revenue for the provision of charging services is less than the cost of owning and operating the charging station.

While the direct revenue from a charging station does not cover the full cost of offering the service, as illustrated in **Figure ES-1**, EV charging stations provide greater value than the direct revenue streams earned from paying customers. Not shown in the chart above are *indirect revenues*, the revenues that the use or presence of charging stations generate for automakers, nearby retailers, or other businesses. These companies may profit from the increased EV sales as a result of more public charging infrastructure, for instance, or from the increased time customers may spend shopping while charging their EVs. Capturing some of this indirect revenue through innovative financial arrangements can enable businesses to grow their own profits while encouraging the development of public charging networks.

Although sharing additional revenue from businesses that host charging stations with the charging station owner-operators may improve the financial performance of private charging station investments, it may not be enough to make public charging stations profitable. As a result, state and municipal public policy interventions are necessary in the near term. Interventions such as grants, loans, and EV purchase incentives could reduce capital costs and the costs of funds, as well as increase both direct and indirect revenues. Public financial incentives could recognize the public benefits that EVs can offer, such as reduced greenhouse gas and tailpipe emissions and the fostering of clean energy development. Some combination of these public interventions is likely necessary for public charging infrastructure to be deployed at a scale conducive to supporting a mass EV market.

KEY STRATEGIC QUESTIONS TO ASSESS THE FINANCIAL VIABLILITY OF EV CHARGING

This guide provides pertinent facts to inform the detailed financial analyses necessary for private investors and state and local agencies to develop public charging projects. The guide is structured to be high-level, presenting findings on innovative financing strategies for public EV charging deployment developed through two years of research and analysis. The guide consists of four sections, each aiming to answer a key question defined below:

1. What are the key market factors that could affect an EV charging project's financial viability?
2. How do upfront costs and uncertainty about station utilization affect project viability and investor decisions?
3. Are there business models that can improve the financial viability of publicly available charging projects?
4. Can the federal, state, and local government sectors improve the financial viability of publicly available charging stations in the near term, resulting in more private investment in the medium term?

1. What are the key market factors that could affect an EV charging project's financial viability?

Three market factors influence the financial viability of a charging project:

- Consumers' willingness to pay;
- The amount and type of charging infrastructure necessary to accommodate the local EV market; and
- Market opportunities where EV charging gaps may exist.

Consumers' willingness to pay for publicly available charging is a critical factor in an investor's assessment of a public charging project's financial viability. Although public charging serves a critical need for a growing EV market, EV drivers use public charging less than charging at home or the workplace. The financial viability of a charging project could depend upon stations receiving regular use and the amount that station operators can earn from customers. The largest components of a charging service provider's operating profit margin are the service prices assessed to consumers and the cost of electricity that operators pay. Larger price differentials create larger direct revenue streams per customer, but may reduce customer satisfaction and compel drivers to avoid public charging, which would reduce an operator's net revenue over time.

Investors must also assess the need for new charging installations to identify market opportunities. Locations that have insufficient public charging access, or that may not be compatible with all EVs (e.g., a station that only supports one of the three types of connectors in use today), may provide promising investment opportunities, for example. DC fast charging locations are mostly located near dense all-electric vehicle populations, but gaps in this type of infrastructure may inhibit all-electric vehicle drivers from accessing desirable locations, such as popular tourist destinations. Similarly, existing Level 2 charging stations may not adequately serve neighborhoods with higher EV populations, which creates a market opportunity for charging station investment. Since many trips are local, adding Level 2 charging stations would allow EV drivers to "top off," travel further than they would otherwise, and/or reduce any anxiety they may have about reaching their destination.

2. How do upfront costs and uncertainty about station utilization affect project viability and investor decisions?

Expanding the publicly available charging station network may require greater regulatory certainty from state utility commissions. In many states, it is unclear under what conditions a charging service provider could be subject to the same regulatory treatment as electric utilities, which would create a heavy burden on public charging projects that could discourage third-party investments.

Regulatory certainty may help enable charging service providers to expand public charging infrastructure, but investors still need to make public charging projects profitable by reducing costs and maximizing direct revenue streams. Two factors influence the profitability of public charging projects:

- **High upfront costs**, particularly for DC fast charging stations, create an impediment to investing in publicly available charging projects. Equipment purchase, siting, and installation costs require significant revenues for the owner-operator to achieve profitability.
- **Inadequate charging station utilization** does not sufficiently meet investors' needed direct revenues from public charging stations. An average EV driver presently uses public charging for less than 5 percent of total charging needs. The nascent EV market is not large enough, in most instances, to produce a sufficient direct revenue stream that would earn investor payback. The uncertain demand for public EV charging stations could require investors to assume high-interest debt, which would compound the difficulty of achieving payback with low revenue streams.

As a result of these two factors, business models that rely solely on direct revenue from the provision of charging services is unlikely to pay back an investment under current market conditions within an investors' preferred period of five years. Charging project developers will need to augment the direct revenue from EV charging station use with other revenue streams or sources of capital to achieve profitability.

3. Are there business models that can improve the financial viability of publicly available charging projects?

There are four ways to improve the financial prospects of a public charging project: increasing revenue, decreasing capital costs, decreasing operating costs, and decreasing the cost of funds. Using these strategies, this guide considers two alternate business models that may improve the financial viability of public charging projects:

- The **sales boost business model** assumes that an automaker that benefits from expanded access to EV charging subsidizes the deployment of a charging network. The guide assumes that an automaker would only invest a small fraction of the value it receives from a charging station into a new infrastructure project. In this model, the automaker transfers funds directly to the charging network owner-operator at the outset of the project, thereby lowering the project's upfront costs.
- The **revenue sharing business model** assumes that a group of businesses located in, for example, a popular tourism or shopping destination contribute to a funding pool that provides an annual subsidy to a charging network owner-operator. The charging network enables travel to and within the destination region. By offering customers EV charging services while they shop, retailers can increase customer dwell time (the time spent shopping), thereby increasing revenue. In this model, the group of businesses annually share a percentage of their increased revenues with the charging service provider, thereby increasing the owner-operator's revenue.

The guide presents the results of the application of each business model to a hypothetical charging project in the states of Washington and New York to assess two different EV markets. The results show both business models greatly improve the financial viability of public charging projects. However, neither model increases revenues sufficiently to make the projects viable within a short enough payback period to make the projects attractive to investors.

4. Can the public sector improve the financial viability of publicly available charging stations in the near term and promote more private investment in the medium term?

The public sector could provide several interventions to improve the financial viability of public charging station investments. This guide presents the results of financial analyses for the sales boost and revenue sharing business models in the states of New York and Washington using three interventions that could benefit the financial performance of each business model. These interventions are:

- **Grants**: Public grants can significantly lower the upfront cost of a charging project and allow an owner-operator to achieve payback for the sales boost and revenue sharing business models.
- **Low-Interest Loans**: The state governments' access to low-cost capital in New York and Washington can greatly improve owner-operators' financial performance with the sales boost and revenue sharing business models.
- **EV Purchase Incentives**: Vehicle incentives can grow the EV market, resulting in increased charging station utilization. With greater charging station use, projects that implement the revenue sharing business model can become profitable.

This guide's analysis demonstrates that a combination of these incentives can make charging projects profitable within a payback period that is attractive to private investors in two representative states, New York and Washington. These near-term policies will enable projects that implement the sales boost and revenue sharing business models to become profitable within five years, assuming that the policies help to grow the EV market. With a larger EV market, projects that begin in five years would require no further public incentives to be profitable. Consequently, action in the near term can induce a virtuous cycle that accelerates private investment and contributes toward the development of a robust public EV charging network.

I. INTRODUCTION

Although U.S. consumers purchased more than 300,000 electric vehicles (EVs) from late 2010 to February 2015, EVs still make up less than 1 percent of total light-duty vehicle sales. According to the U.S. Department of Energy's Clean Cities program, the deployment of publicly available charging stations is a key driver for the increased growth of EV sales.[1] This infrastructure enables travel to more locations, provides charging for drivers without convenient access to home charging, and increases consumer confidence that the technology is here to stay.

This guide answers questions private investors and state and local agencies, such as state energy offices, may have in deciding whether and to what extent they should invest in publicly available charging infrastructure. Although this guide focuses on public charging, much of the information may be applicable or relevant to addressing charging infrastructure challenges in other key locations, including workplaces and multi-unit dwellings. See **Box 1** for information about the scope of this guide, the project for which it was produced, and the methodology followed to complete it.

Box 1: About this Guide for Businesses and Policymakers

This guide provides a strategic framework and decision-relevant information for private businesses and policymakers interested in improving the financial viability of EV charging projects from the perspective of the private investor. The guide is the final phase of a multi-year project, a collaboration between the Center for Climate and Energy Solutions (C2ES) and the National Association of State Energy Officials (NASEO), on innovative finance mechanisms to accelerate the deployment of alternative fuel vehicles (AFVs) and fueling infrastructure. The goal of the project is to identify ways to increase private investment in AFVs and fueling infrastructure, with a focus on publicly available EV charging and the use of natural gas in vehicle fleets. The use of natural gas vehicles in fleets is covered in another guide.

The project focuses on publicly available EV charging for three reasons:

- Publicly available charging stations are necessary for some EV drivers to meet their travel needs.
- The business case for private investment in publicly available charging infrastructure is challenging due to the high upfront costs of equipment and installation, inadequate near-term demand for station use, and the low price consumers are willing to pay for these charging services.
- Public EV charging can provide many public benefits, including increased travel for EV drivers, fostering clean energy deployment, reduced emissions, and improved local economic development.

This guide highlights the findings from two years of research and analysis on barriers to private investment, business models that capture additional revenue sources for EV charging services, public interventions that lower the cost of deploying EV charging, and the financial performance of EV charging projects.

ASSESSING THE FINANCIAL VIABILITY OF EV CHARGING: KEY STRATEGIC QUESTIONS

This guide focuses on presenting findings from research and analysis conducted over two years on innovative financing strategies for public EV charging deployment. The guide consists of four sections, each aiming to answer a key question defined below:

- What are the key market factors that could affect an EV charging project's financial viability?
- How do upfront costs and uncertainty about station utilization affect project viability and investor decisions?

- Are there business models that can improve the financial viability of publicly available charging projects?
- Can the federal, state, and local government sectors improve the financial viability of publicly available charging stations in the near term resulting in more private investment in the medium term?

Further descriptions of the findings presented in this guide, including the results from example financial analyses, are included as appendices.

UNDERSTANDING THE AMOUNT OF PUBLICLY AVAILABLE CHARGING INFRASTRUCTURE NEEDED FOR EV DRIVERS

Although most EV charging occurs at home, followed by charging at work, drivers still rely on publicly available charging to complete trips beyond the immediate areas surrounding their home or workplace. In addition, drivers of plug-in hybrid electric vehicles may use public charging to increase the share of miles traveled powered by the vehicle's batteries. Even though public charging equipment may only be used infrequently, the presence and visibility of public charging increases the confidence of consumers in EV technology, according to the U.S. Department of Energy (DOE) Clean Cities program.[2]

FIGURE 1: EV Charging Levels

Low – AC 120V "AC" LEVEL 1	Medium – AC 240V "AC" LEVEL 2	High – DC Fast Charge "DC" LEVEL 2
• Uses standard outlet • Power requirements similar to a toaster • Up to 1.4 kilowatts • Adapter comes with the car • Accommodates average daily driving needs • Can use existing power outlets resulting in no cost installation • Charging rate: 3-5 miles per hour	• Requires high-voltage circuit • Power requirements similar to an electric clothes dryer • Up to 19.2 kilowatts • Equipment & installation costs vary widely (~$6,500 in public and ~$2,000 at home) • Charging rate: 12-75 miles per hour	• Often requires very high voltage circuit & 3-phase power • Power requirements are up to max power for 15 homes • Up to 90 kilowatts • Currently, three systems used (CHAdeMO, SAE Combo, Tesla) • Can have very high equipment & installation costs (up to $90,000) • Equipment costs vary widely • Charging rate: 100-300 miles per hour

This guide only considers publicly available Level 2 and DC fast charging stations. Level 2 stations are assumed to provide charging to EV drivers near their home and around popular destinations. DC fast charging stations are assumed to provide charging to those without access to home charging and/or along major travel routes to enable EV drivers to reach their destination.

Source: Nigro, Nick, and Matt Frades. 2015. Business Models for Financially Sustainable EV Charging Networks. Arlington, Virginia: Center for Climate and Energy Solutions. http://www.c2es.org/publications/business-models-financially-sustainable-ev-charging-networks. SAE. 2011. SAE Charging Configurations and Ratings Terminology. Accessed September 21, 2014. http://www.sae.org/smartgrid/chargingspeeds.pdf.

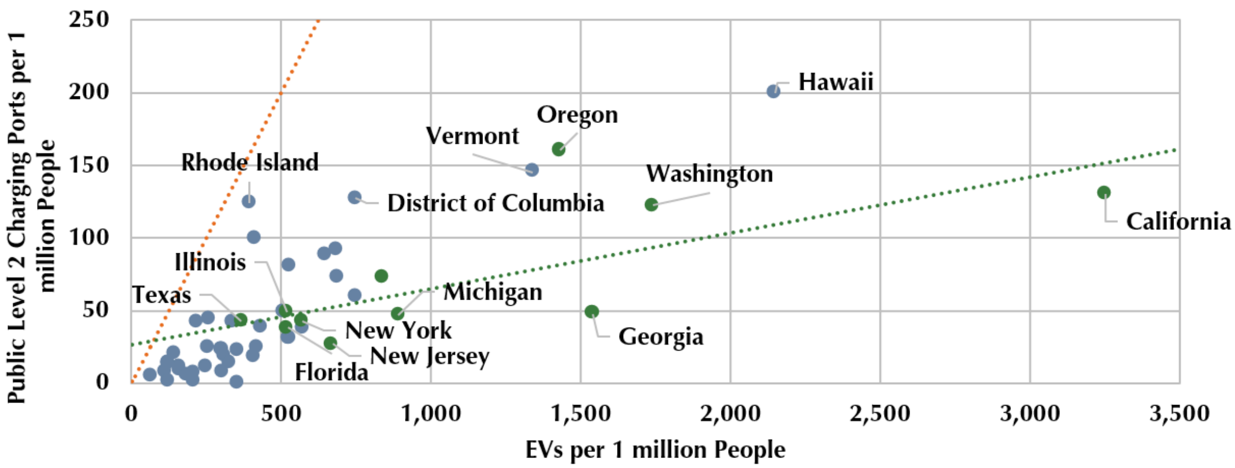
The extent and type of public charging infrastructure needed to accommodate EV drivers now and into the future will evolve with more information and advancements in EV technology. Three kinds of EV charging stations are used today as defined by the Society of Automotive Engineers (SAE): alternating current (AC) Level 1, AC Level 2, and direct current (DC) Level 2. This guide primarily considers AC Level 2 and DC Level 2 because these provide the quickest charge and consequently are the types commonly used for publicly available charging infrastructure. Throughout this guide, AC Level 2 is referred to as Level 2 and DC Level 2 is referred to as DC fast charging. Although Level 2 charging is typically offered at a power level of 3.3 kilowatts (kW) or 6.6 kW, the SAE J1772 standard allows for equipment to provide power as high as 19.2 kW. Level 2 charging stations are often sited at retail outlets, public parking lots, or other locations where drivers may park their vehicles for several hours. DC fast charging can recharge a vehicle at up to 90 kW, though stations typically only go up to 50 kW.[3] These stations enable drivers to travel longer distances by recharging in less than 30 minutes. See **Figure 1** for an overview of EV charging levels. If EV range increases to nearly 200 miles in the next generation of vehicles as anticipated,[4] drivers, particularly single car households, could become more dependent on public charging, especially DC fast charging. This could mark a departure from what some studies have suggested regarding the amount of public EV charging infrastructure that would be needed to accommodate EV drivers. For example, the National Research Council's 2013 report, *Transitions to Alternative Vehicles and Fuels,* assumed one public Level 2 charging port would be needed for 2.5 EVs.[5] The same report estimated that one DC fast charging station would be needed for every 1,000 all-electric vehicles. Importantly, this study assumed all-electric vehicles would travel 100 miles or less on a charge well into the future, which would lead to low expectations regarding DC fast charging use for long range travel.

Figure 2 and **Figure 3** illustrate the current relationship between EV market size and public charging infrastructure. All states have fewer Level 2 charging ports and more DC fast charging stations relative to vehicle deployment than the National Research Council study estimated would be needed to provide adequate public charging.

Although the amount of public charging needed to accommodate EVs will continue to shift with advances in technology and changes in driver behavior, the 10 largest EV markets offer insight into a suitable balance of public charging and EVs in a regional market. The ratio of public charging to EV deployment in these 10 markets is similar for each charging type, with Oregon being a notable exception (see **Figure 2** and **Figure 3**). The largest markets have an average of 18 EVs on the road per Level 2 charging port (a station can have multiple ports) and 210 all-electric vehicles per DC fast charging station.

In addition, a state's policy environment could help explain the number of EVs and charging stations in a region. For example, Georgia has a $5,000 tax credit for all-electric vehicles and has one of the most active EV markets as a result. The state does not have any notable charging infrastructure incentives, which may explain the relatively low ratio of DC fast charging stations and all-electric vehicles compared to other states with large EV markets. Conversely, the ratio of DC fast charging stations and all-electric vehicles in Oregon is very high compared to other states with large EV markets. The Oregon state government has supported the deployment of many DC fast charging stations through federal grants but does not offer an EV purchase incentive, as of May 2015.

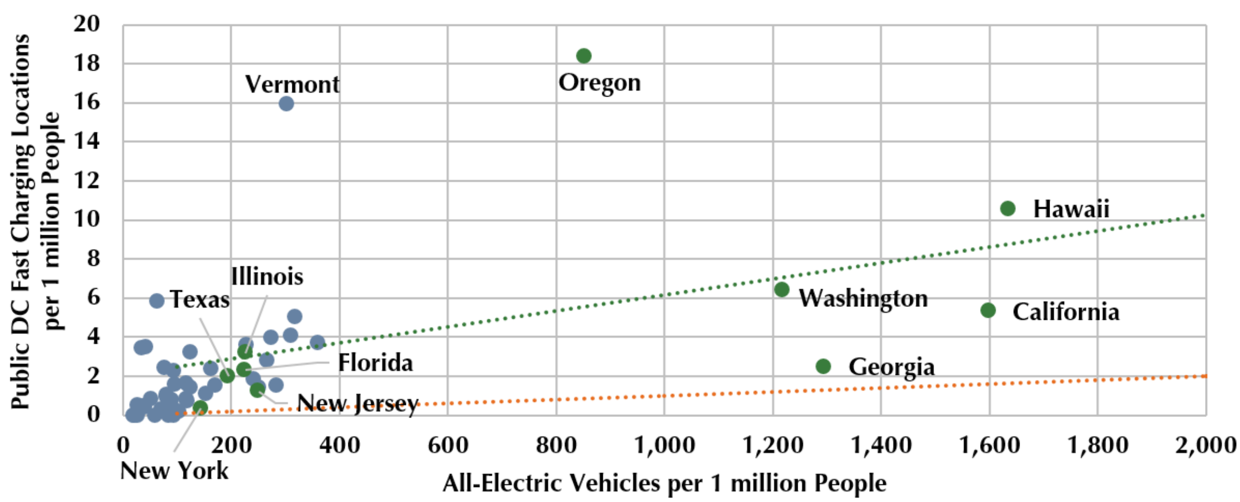
FIGURE 2: Public Level 2 Charging Ports and EVs per 1 million People as of December 2014



This figure shows the connection between publicly available Level 2 charging and EV deployment, both normalized for population. The 10 largest EV markets are shaded in green. The dotted orange line shows the expected ratio of EVs and public Level 2 charging from a 2013 study by the National Research Council (2.5 EVs for every one public Level 2 charging station). All states fall to the right of the orange line, indicating they have less Level 2 public charging than the study estimated would be necessary to service the public charging needs of EV drivers. The dotted green line shows the trend from the 10 largest EV markets.

Source: National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, Accessed March 17, 2015. DOE. 2014. Alternative Fuels Data Center. http://www.afdc.energy.gov.

FIGURE 3: Public DC Fast Charging Locations and All-Electric Vehicles per One Million People as of December 2014



This figure shows the connection between publicly available DC fast charging and all-electric vehicle deployment, both normalized for population. The 10 largest all-electric vehicle markets are shaded in green. The dotted orange line shows the expected ratio of all-electric vehicles and public DC fast charging from a 2013 study by the National Research Council (1,000 all-electric vehicles for every one public DC fast charging station). All states fall to the left of the orange line, indicating they have more public charging than the study estimated would be necessary to accommodate regional EV drivers. The dotted green line shows the trend from the 10 largest all-electric vehicle markets.

Source: C2ES analysis. National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, Accessed March 17, 2015. DOE. 2014. Alternative Fuels Data Center. http://www.afdc.energy.gov.

THE NEED FOR MORE PRIVATE INVESTMENT IN PUBLICLY AVAILABLE EV CHARGING

At the outset of the EV mass market in late 2010, state and federal governments played a central role in funding EV charging infrastructure. The U.S. federal government made significant investments in charging deployment through the EV Project and ChargePoint America.[6] These projects led to the installation of thousands of charging stations, many of which were publicly available. Some states used these federal funds and their own state funds to install public charging infrastructure along corridors and other key locations. For example, the West Coast Electric Highway encompasses 1,350 miles of Interstate 5 from the U.S. border with Canada, through Washington, Oregon, and California, to the U.S. border with Mexico. DC fast charging stations are to be located every 25 to 50 miles once the initiative is completed.[7]

The public benefits offered by EV charging make a compelling case for public support of EV charging services. Benefits of increased use of publicly available charging may include:

- Reducing transportation greenhouse gas and other tailpipe emissions;[8]
- Fostering clean energy deployment;
- Promoting local economic development (e.g., from retail sales at charging station host sites);
- Expanding travel access to a growing segment of the nation's EV drivers; and
- Creating consumer confidence and expanding the EV market.

While federal, state, and local investments in charging infrastructure were critical to providing public charging to early EV adopters, private investments will play an important role in accelerating EV market growth. Given ever tightening state and city budgets, new, large-scale public investments are unlikely to occur in the near future. As a result, publicly led initiatives to fund charging infrastructure will likely have to rely on public-private partnerships or other methods that would encourage the private sector to take on a greater share of the financing for publicly available charging projects. Leveraging public investments to improve the business case for private charging infrastructure investments in the short term can help encourage more financially sustainable privately-funded charging projects in the future.

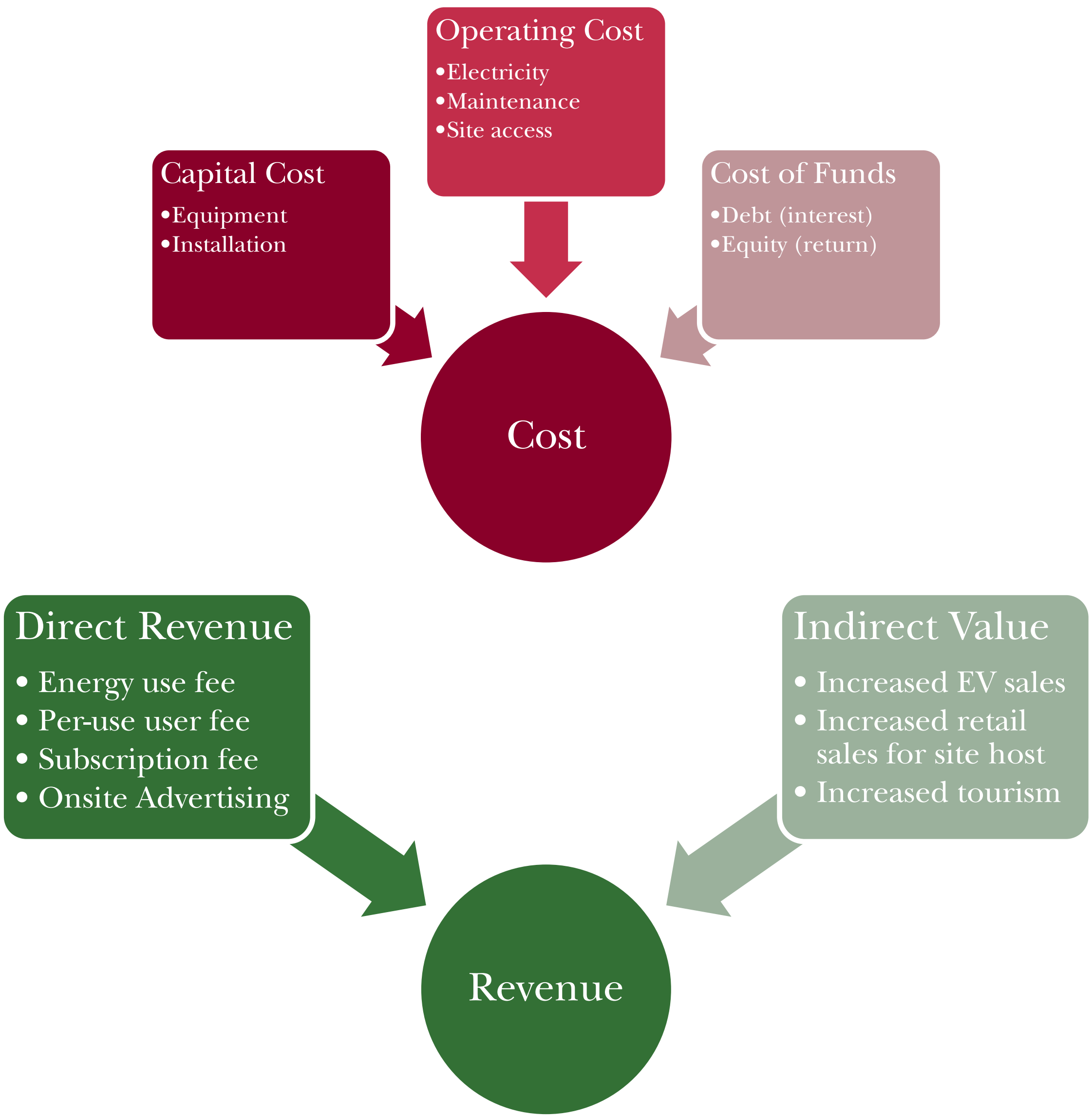
This guide draws upon data and analysis from Washington state that was used in a 2015 C2ES report called Business Models for Financially Sustainable EV Charging Networks. The Washington State Legislature's Joint Transportation Committee commissioned the study to develop new business models that will foster private sector commercialization of publicly available EV charging services and expand the role of private sector investment in EV charging throughout the state. More information is available at http://www.c2es.org/publications/business-models-financially-sustainable-ev-charging-networks.

UNDERSTANDING THE BASIC EV CHARGING BUSINESS MODEL

There are serious challenges to constructing a profitable EV charging business model from both a cost and revenue perspective. For an EV charging project to move forward, the charging station owner-operator (the entity responsible for funding and operating a charging station investment) must expect to receive direct and indirect revenues sufficiently greater than the total project cost to generate a profit. In addition, the project investors must receive a return on their investment that is equal to or greater than alternative investment opportunities. Time is a key component in this decision because many project investors require a payback of five years or less to consider an investment opportunity.[9] Taking all of these criteria into account, the financial performance of many projects could be improved through a combination of increased revenue, decreased capital cost, decreased operating cost, or decreased cost of funds.

As **Figure 1** illustrates, the purchase, installation, and operation of a Level 2 or DC fast charging public station is significantly more expensive than a Level 1 charging station when a power outlet is readily available. Of these three, DC fast charging is the most expensive, often more than 10 times the cost of a Level 2 charging station. In addition to this high cost, public charging station investors also face uncertainty related to the utilization of charging equipment and the price consumers are willing to pay for charging services. A summary of the key cost and revenue components of EV charging options is presented in **Figure 4**.

FIGURE 4: Private Sector Cost and Revenue Components of Providing EV Charging Services



These figures show private sector sources of costs and potential revenue for providing publicly available EV charging services. While most, if not all, of the costs must be paid by the owner-operator of the charging equipment, some of the indirect revenues could be earned by businesses other than the charging station's owner-operator.

For a private company to invest in a charging station or network of stations, the total revenue (including direct and indirect) received by the owner-operator must be greater than the total cost of the station or network over the life of the project. In practice, for most investors, the net revenues must not only be positive, but also provide a greater rate of return than alternative investments. Many private investors also require that their positive return on investment occur within five years. The formula below describes the basic requirement for the profitable operation of an EV charging network.

$$Total\ revenue\ (direct\ \&\ indirect)\ [R] + profit\ (p) > Total\ costs\ (capital\ costs\ [C] + operating\ costs [O] + costs\ of\ funds\ [F]$$

Where:

- *Capital costs* are the costs of equipment and installation.
- *Operating costs* are the ongoing costs to maintain and run the station(s), including potential network access fees and/or payment processing costs.
- *Costs of funds* are the costs of paying interest on debt and investor returns on equity.
- *Direct revenue* is attributable to direct use of a charging station (e.g., per-use fee).
- *Indirect revenue* is realized through sales of products other than the charging service, but could be attributed to the charging station(s).
- *Profit* is the return on investment necessary to induce a private company to spend money on the project.

Considering current and near term EV market conditions, the business case for private investment in publicly available charging infrastructure is very challenging. Three main factors drive the profitability of a charging project: the high upfront costs of equipment and installation, the inadequate near-term utilization for station use, and the low price consumers are willing to pay for these charging services. The challenge can become even greater if a charging provider is not allowed to sell electricity from these charging units (see **Box 2**). In that case, the charging provider could charge a user by the minute or per session to collect direct revenue, as illustrated in **Figure 4**.

Box 2: Regulations on Charging Service Operators Vary by Electric Utility Territory

Some charging providers may depend on the ability to sell charging services directly to EV drivers on a per-kilowatt hour basis. Charging providers wishing to implement this direct revenue model are subject to the regulatory oversight of state public utility commissions, municipal electric utilities, public utility districts, or other regulatory bodies. For investor-owned utility territories regulated by public utility commissions, 15 states have considered the provision of charging services to be distinct from the resale of electricity, and therefore, not subject to the regulations of an electric utility. This topic is discussed further in *Question 2. How do Upfront Costs and Uncertainty about Station Utilization Affect Project Viability and Investor Decisions?*

Where charging providers are allowed to impose a fee based on the electricity consumed (which may be in addition to or instead of parking fees), a reasonable approximation for consumers' willingness to pay is the price of gasoline on an energy equivalent basis.[10] As such, the price of gasoline could be considered an upper bound to the fee that can be imposed on EV consumers, which is an assumption that is used throughout the guide. See **Box 3** for a description of the approach used in this guide as an example of how to analyze the financial performance of EV charging projects.

Box 3: Quantifying the Financial Performance of EV Charging Projects

C2ES and Cadmus Group developed the EV Charging Financial Analysis Tool, available at the C2ES website,[11] to evaluate the financial viability of EV charging infrastructure investments that involve multiple partners from the private and public sectors. The tool uses the discounted cash flow analysis method to determine the expected financial returns for EV charging infrastructure investments over the expected lifetime of the charging equipment based on inputs provided by the user. The tool also provides financial viability metrics from the perspective of both private and public sectors, as well as sensitivity analyses for key inputs and assumptions. Appendix B contains more information on the EV Charging Financial Analysis Tool.

A key output that the tool provides is the net present value (NPV) of a charging station project. This output can be presented to the user as the NPV that accrues to the owner-operator, private sector partners, the public sector, or the project as a whole. The tool also calculates the time required for the project to generate net positive value to a project partner, also referred to as the "discounted payback period," or simply as the "payback period."

A list of assumptions and sources of information presented in this guide are provided in Appendix C.

II. ASSESSING THE FINANCIAL VIABILITY OF EV CHARGING: KEY STRATEGIC QUESTIONS

EVs offer many public benefits, but the supporting infrastructure for EVs is not completely in place to realize those benefits. This guide addresses the fundamental issue of financial viability of publicly available charging, given the uncertainties about EV demand, the limited nature of public funding, and the newness of the technology. The guide outlines the key strategic questions that any policymaker or company should ask and answer while considering options for increasing both the number of public EV charging stations and the level of private sector investment in this infrastructure.

QUESTION 1. WHAT ARE THE KEY MARKET FACTORS THAT COULD AFFECT AN EV CHARGING PROJECT'S FINANCIAL VIABILITY?

The three key market factors that affect the financial viability of a charging project are:

- Consumers' willingness to pay for publicly available charging;
- The amount and type of charging infrastructure necessary to accommodate the local EV market; and
- Market opportunities where charging gaps may exist.

The price EV drivers are willing to pay for publicly available charging services can be a key factor in a charging project's financial viability. Publicly available charging may often compete with convenient and relatively inexpensive home charging (see **Figure 1**). Data from the EV Project collected by Idaho National Laboratory indicates that all-electric and plug-in hybrid electric vehicle drivers charge mostly at home, followed by the workplace. EV drivers charge less than 5 percent of the time in public and use public infrastructure to provide less than 5 percent of the energy used to power their vehicles.[12, 13]

Nevertheless, both public Level 2 and DC fast charging stations can help accommodate daily driving needs, increase the percentage of miles driven using electricity for plug-in hybrids, enable travel beyond the immediate area around a home, and alleviate range anxiety. The value of these benefits should enhance consumers' willingness to pay for public charging, but estimating the value that consumers are willing to pay can be challenging. For example, the DC fast charging stations along the West Coast Electric Highway introduced pricing structures for charging services in April 2014 to a network that was previously free for public use. Consumers immediately responded by reducing charging use at many previously high-use stations. This response suggests that some EV drivers did not require DC fast charging to reach their destinations and changed their charging patterns to avoid paying for public charging. In contrast, however, several previously lower-use stations experienced a slight increase in usage after pricing structures were introduced, which may indicate that public charging is necessary for some EV drivers to complete their trips (see **Figure 5**).

FIGURE 5: Consumers are Willing to Pay for DC Fast Charging

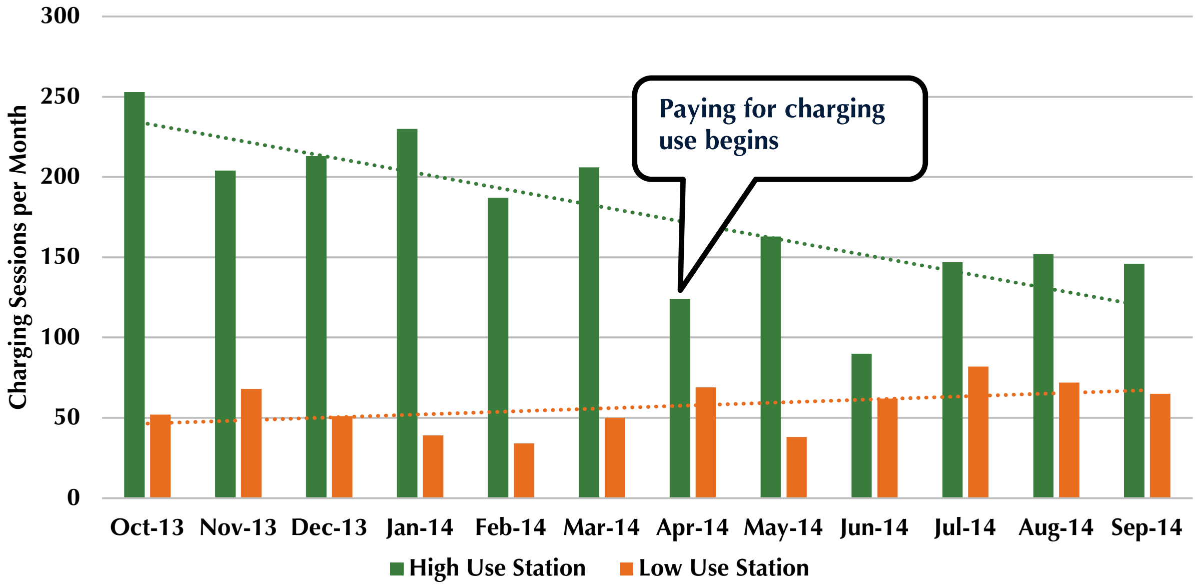


Figure 5 highlights usage at two DC fast charging stations for the six months before and after pricing was introduced to illustrate consumers' willingness to pay for public charging use. In April 2014, stations on the West Coast Electric Highway began charging for station use at DC fast charging sites. Utilization at some stations decreased, while utilization at other stations increased, but notably the imposition of a price did not eliminate consumer demand for public charging. This example indicates that consumers may be willing to pay for station use if it is necessary to complete a trip.

Source: Washington Department of Transportation, 2014

Charging services providers use varying fee structures that allow access to their charging units, typically including one or more of the following options: an energy-based fee (per kilowatt-hour), a monthly subscription fee, a per-session access fee, a time-based fee, or an approach that combines two or more options. For simplicity of illustration, analyses done for this guide use the energy-based fee as the direct revenue source for a charging station owner-operator. Assuming that owner-operators can structure payments by the amount of electricity provided, the difference between the retail cost of electricity and the cost of the charging service to the customer on a kilowatt-hour basis makes up the largest component of a service provider's revenue.

Because DC fast charging provides an EV with a quick recharging capability, much as gasoline does for an internal combustion engine, the price of gasoline can be considered a reasonable approximation of a consumer's willingness to pay for DC fast charging (on an energy equivalent basis).[14] With this analogy and approximation in mind, it is possible to evaluate the potential price level that an operator could charge, and where in the United States a DC fast-charging station with a gasoline energy equivalent pricing structure would be most profitable. Using the latest available data (electricity costs in January 2015 and gasoline costs in February 2015), EVs cost almost $0.05 per mile less to operate than comparable gasoline vehicles across all 50 states and the District of Columbia.[15] The vast majority of states (40 out of 51, including the District of Columbia) have a differential of at least $0.04 per mile, but there is wide variation among the states. In Alabama, for example, the price differential is more than $0.06 per mile, which is more than 300 percent higher than Hawaii's price differential of $0.015 per mile, implying that consumers may be willing to pay more for public EV charging in Alabama than in Hawaii (see **Figure 6**).

FIGURE 6: Electricity-Gasoline Differential for DC Fast Charging

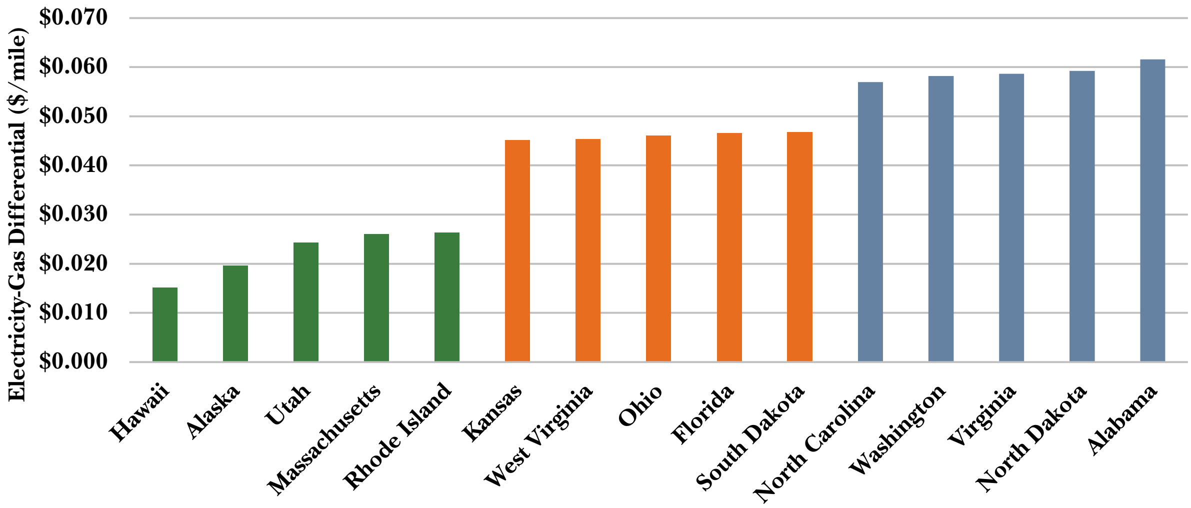


Figure 6 illustrates the difference between the price of gasoline (serving as a proxy for the potential charging price of DC fast charging) and the cost of electricity per kilowatt-hour in 15 states. The states represented are those five states each with the largest (blue), middle (orange), and smallest (green) differentials. Calculations for this figure assume the price of DC fast charging is the same as the price of gasoline on an energy-equivalent basis, an EV can travel 3.5 miles per kilowatt-hour, and a gasoline vehicle gets 30 miles per gallon.

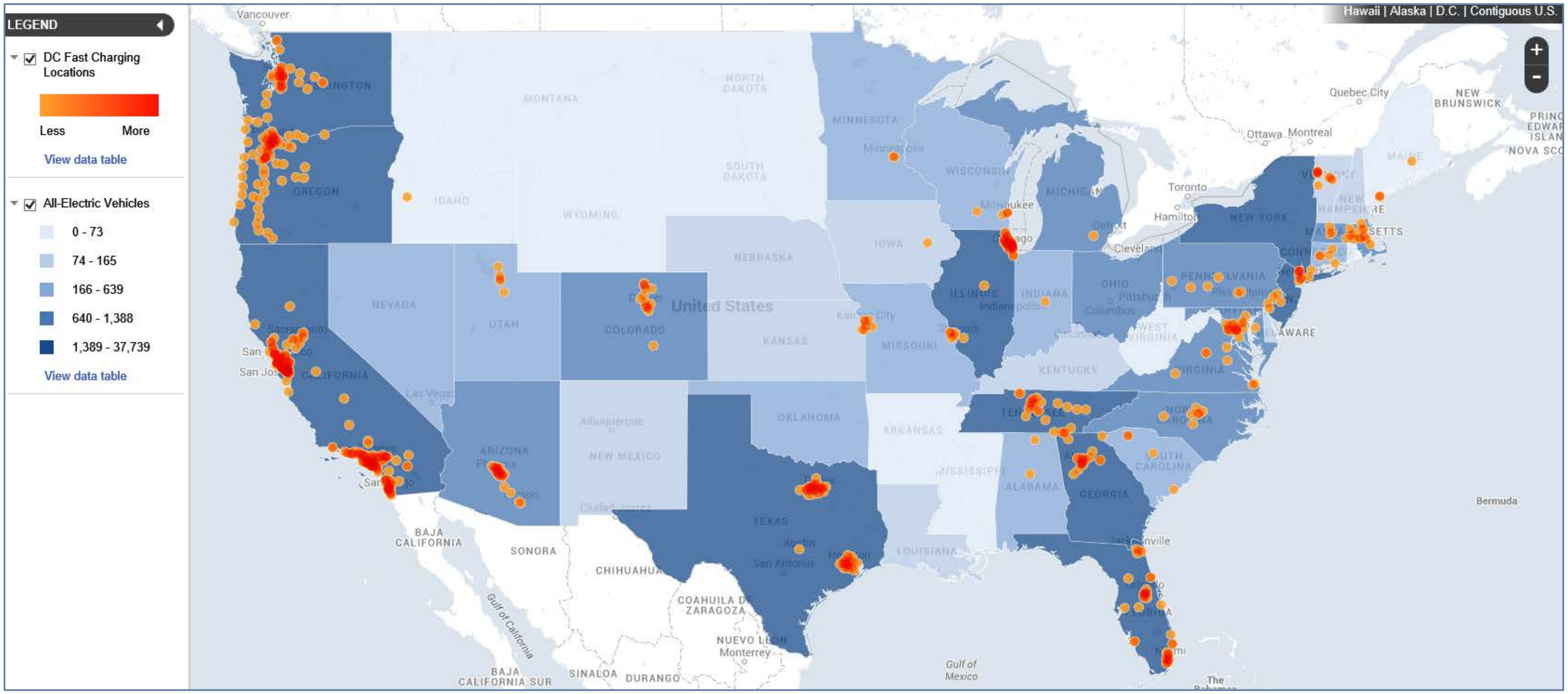
Source: AAA. 2015. State Prices. February 15. Accessed February 15, 2015. http://fuelgaugereport.aaa.com/todays-gas-prices. U.S. Energy Information Administration. 2015. Table 5.6.A. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector. May 26. Accessed June 18, 2015. http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a.

An expanded DC fast charging network can enable access to many locations in the United States that are currently inaccessible to all-electric vehicle drivers. Most all-electric vehicles available in 2015 can travel less than 100 miles before needing to recharge, so these drivers are very dependent on DC fast charging access to quickly and conveniently reach destinations outside the immediate area around their homes (see **Box 4**). Through selective siting that considers existing travel patterns, DC fast charging station installations can extend all-electric vehicle driving range while creating potential new opportunities that benefit local businesses. Enabling travel to and within popular destinations, for example, could be a valuable business opportunity for charging service providers. Local businesses may also benefit from EV drivers' increased access to popular tourist destinations because of the overall increase in visitors to the region. Charging service providers looking to fill charging gaps that enable travel to new locations should consider the capacity of existing EV charging infrastructure and the value to local businesses of enabling travel to these destinations. See **Figure 7** for an overview of the DC fast charging network in the United States.

Box 4: EV Range and Charging Needs

The Nissan LEAF, the popular all-electric EV, can travel 84 miles per charge, averaging almost four miles per kilowatt-hour of energy.[16] In this guide, an EV can be expected to travel 3.5 miles with each kilowatt-hour of energy delivered to its batteries, equivalent to charging the vehicle at one kilowatt for an hour. Charging a vehicle at 30 kilowatts for 30 minutes provides about 50 miles of range. Thus, the higher the power the charging station provides to the vehicle, the faster the vehicle's batteries can recharge.

FIGURE 7: DC Fast Charging Locations and All-Electric Vehicles



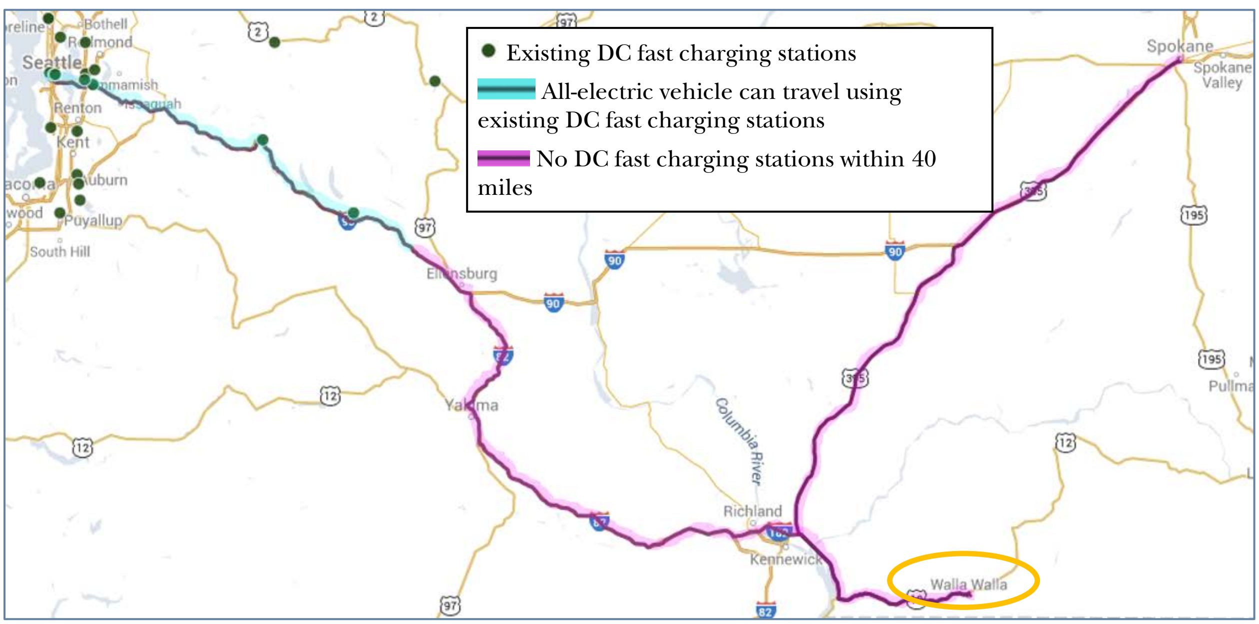
DC fast charging locations are heavily concentrated where all-electric vehicles are located. Tesla Superchargers are not shown.

Source: C2ES. 2015(a). DC Fast Charging and All-Electric Vehicles. February. Accessed June 18, 2015. http://bit.ly/1xuwIIc.

For example, Washington has more than 12,000 EVs on its roads—all-electric vehicles outsell plug-in hybrid electric vehicles by 130 percent,[17] yet all-electric vehicle drivers cannot reach many parts of the state with existing public charging infrastructure. Charging gaps prevent drivers from traveling to distant locations and within some regional destinations. In the state's more populated areas, Spokane and Seattle, all-electric vehicle drivers can easily travel within each city, but not between the two cities, because there are no DC fast charging stations for more than half the 280 miles along Interstate 90, which connect Seattle and Spokane.[18] Another charging gap separates these two cities and the popular Walla Walla region (see **Figure 8**). Like the gap between Seattle and Spokane, reaching the Walla Walla Region in an all-electric vehicle from either city is not possible with the existing DC fast charging infrastructure.

Filling these charging gaps may depend upon on the anticipated demand for DC fast charging infrastructure, its expected effect on EV sales, and the impact on local businesses. Addressing the Walla Walla charging gap could be a worthwhile investment for two reasons. First, the region is an energy sector employment center—employees at workplaces such as the Columbia Generation Station, the Hanford Site, and the Pacific Northwest National Laboratory may be interested in purchasing an EV and could frequent DC fast charging stations that connect large commercial and residential areas, such as Seattle or Spokane. Second, the Walla Walla region is a popular tourism destination, with more than 300 wineries, and could be a destination for EV travelers. Opening the region to all-electric vehicles would enable more EV drivers to visit the Walla Walla region and contribute to the local economy.

FIGURE 8: Travel from either Seattle or Spokane to Walla Walla is not possible with publicly available DC Fast Charging



Source: Nigro and Frades, 2014.

DC fast charging gaps could also exist if the charging connectors at existing stations do not support multiple standards. The charging units installed along the West Coast Electric Highway only supported the CHAdeMO connector standard, which has been adopted by Nissan, Mitsubishi, and Kia.[19] In contrast, nearly all American- and European-manufactured vehicles along with Hyundai have adopted the SAE Combo standard, and as such cannot connect to the CHAdeMO-supported stations along the West Coast Electric Highway.[20] Tesla, another EV manufacturer, has installed its own DC fast charging units in travel corridors across the United States, but only Tesla drivers can use the company's proprietary connectors. Though DC fast charging stations may be installed in certain locations, they may not be compatible for many drivers' needs, leaving charging gaps that would restrict all-electric drivers' travel range.

Recently, several automakers have announced plans to address charging gaps and standardization issues. BMW and Volkswagen will install 100 DC fast charging stations along East and West Coast travel corridors, and Nissan will install nearly 1,000 fast charging stations in select markets and travel corridors throughout the United States. Equipment installed for both projects are expected to be compatible with the CHAdeMO and SAE Combo connectors.[21, 22] These projects will create new opportunities to expand all-electric vehicles' travel range and will demonstrate the uses of dual-compatibility DC fast charging stations.

Market opportunities also exist for Level 2 and DC fast charging projects that enable all-electric vehicle travel to and within popular destinations. Frequently visited destinations, such as tourist destinations, can attract EV drivers and encourage new business. Level 2 and DC fast charging stations have been deployed along tourist travel corridors in north central Washington and along the Pacific Coast in Oregon.[23,24] Charging stations along these corridors function similarly to marketing or advertising campaigns that attract new visitors (EV drivers) to local businesses. The EV Rally of the Rockies event in Colorado, held in October, 2014, promoted EV tourism. The event consisted of EV drivers completing a tour of the region, which drew attention to EV technology and the towns along the route that hosted EV charging stations.[25] Private investors interested in EV tourism charging projects should consider existing charging access and the popularity of EVs in the region.

Market opportunities also exist for Level 2 charging in urban areas. Level 2 charging projects may be particularly attractive in urban areas if sited where drivers are expected to spend longer than an hour away from their vehicles. Most Level 2 stations are sited in major metropolitan areas (see **Figure 9**). Assessing whether there are sufficient stations to accommodate the number of EVs in the area is an important component of a charging gap analysis.

Even though many charging stations exist in these metropolitan regions, there may not be enough to adequately service the existing and projected EV market. Even comparatively dense publicly available charging infrastructure might be insufficient, which could lead to EV drivers experiencing reduced charging access or long wait times. For example, eight ZIP codes in the Seattle, Washington area have more than 50 registered EVs and no publicly available Level 2 charging locations (see **Figure 10**). These areas may be ideal for investments in Level 2 charging stations.

FIGURE 9: Level 2 Charging Locations and EVs

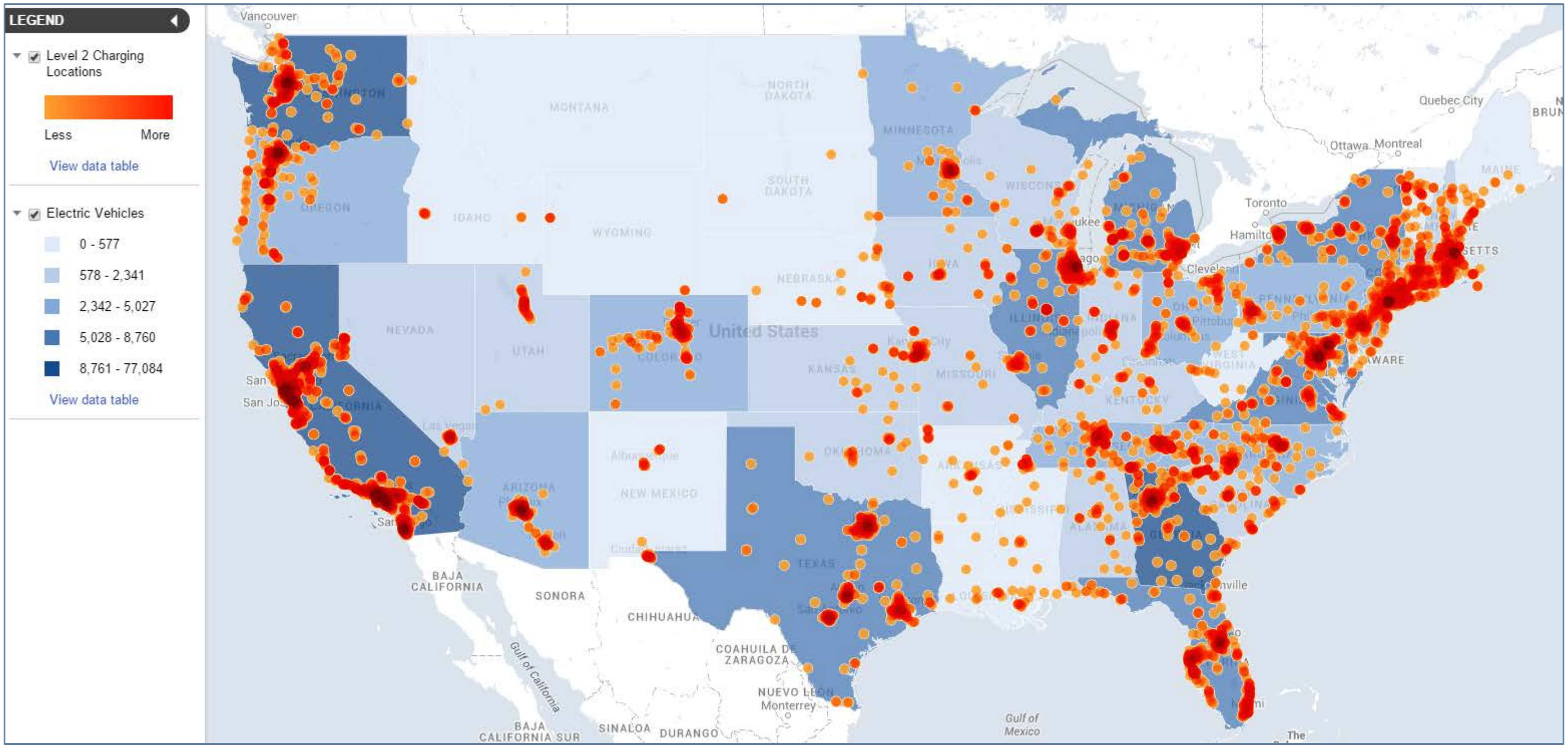


Figure 9 suggests that the concentration of Level 2 charging locations is generally located in major cities.

Source: C2ES. 2015(b). Level 2 Charging Locations and Electric Vehicles. February. Accessed June 18, 2015. http://bit.ly/1A3P9mW.

FIGURE 10: ZIP Codes around Seattle with More than 50 EVs and No Public Level 2 Charging Stations

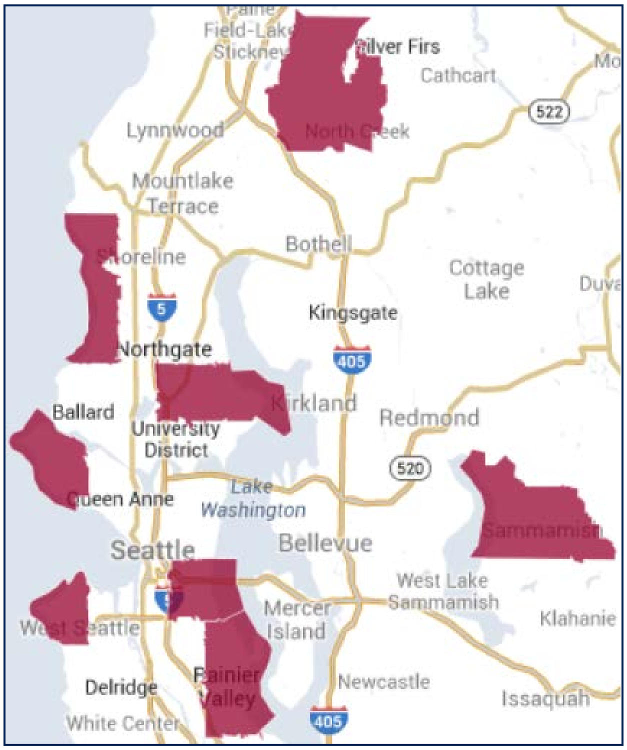


Figure 10 shows ZIP codes with 50 or more EVs registered as of June 2014 and no Level 2 charging stations.

Source: Nigro and Frades, 2014.

Summary: Key Market Factors

Several key factors determine whether EV charging stations are financially viable. First, consumers' willingness to pay for publicly available charging must be considered. Although EV drivers use public charging less than charging at home or the workplace, public charging serves a critical need for a growing EV market. The largest components of the operating profit margin of providing charging services are the charging fee level and the cost that charging providers must pay for electricity. A larger price differential will yield a larger direct revenue stream for a station owner-operator, but may reduce the frequency of use or consumer satisfaction leading to reduced net revenue over time.

Second, investors must carefully site charging locations in a way that complements the existing DC fast charging and Level 2 charging networks to ensure that each station attains sufficient utilization. DC fast charging locations are mostly located near dense all-electric vehicle populations, but installing these charging stations along travel corridors could enable all-electric vehicle drivers to expand their travel ranges and potentially access tourist destinations. Installed Level 2 charging stations may not adequately serve neighborhoods with higher EV populations, which creates a market opportunity for charging station investment. Since many trips are local, adding Level 2 charging stations would allow EV drivers to "top off," travel further than they would otherwise, and/or reduce any anxiety they may have about reaching their destination.

QUESTION 2. HOW DO UPFRONT COSTS AND UNCERTAINTY ABOUT STATION UTILIZATION AFFECT PROJECT VIABILITY AND INVESTOR DECISIONS?

Private sector investment in new charging projects is held back primarily because both DC fast charging and Level 2 projects are not profitable if they generate revenue solely from the sale of charging services. These projects are unlikely to generate a profit because of the high upfront costs of equipment and installation and the inadequate near-term demand for station use (referred to as charging station utilization).

The upfront costs for publicly available Level 2 stations are higher compared to residential charging stations due to the requirements of providing publicly available charging services. Fully charging a Nissan LEAF with at a Level 2 station can take between 3.5 to 7 hours, which could be done at home or in public. As a result, public Level 2 stations may often compete with home charging. While residential Level 2 charging stations can cost as little $500 for the equipment and installation,[26] public Level 2 stations are typically more expensive because they:

- Can require trenching, extensive wiring, or pavement replacement to deliver power to the charging station's parking spot;
- Must comply with regulations to serve the general public (e.g., Americans with Disabilities Act compliance);
- Often provide access to a charging network for consumer convenience purposes; and

- Must be designed and manufactured to withstand significant wear and tear from weather and other reasons.

These four factors increase the upfront costs of the equipment and installation above a home charging station. In addition, installation costs vary, depending upon the ready availability of electricity or the number of stations at a single location.

According to the EV Project, a federally-funded initiative that led to the installation of thousands of public charging stations, commercial Level 2 installations cost $4,000 on average,[27] excluding the cost of equipment, which can cost about $2,500.[28] Costs can be much lower, however, as in Arizona and Tennessee, where the installation costs were between $2,000 and $2,500. Installation costs for Level 2 stations in the EV Project were largely driven by siting choices (e.g., access to available power) with multiple charging stations at one site resulting in lower costs per station.[29]

The cost of installing DC fast charging equipment typically outweighs the actual equipment cost. In addition to the factors that increase the upfront costs of public Level 2 stations, DC fast charging stations can provide power at a significantly higher level, enabling a Nissan LEAF to charge to 80 percent capacity in less than 30 minutes. As a result, these stations can be sited at locations that expand travel for EV drivers but do not typically compete with home charging.

The equipment cost for a 50-kilowatt DC fast charging station, as of December 2014, was about $35,000.[30] BMW also sells a DC fast charging station that provides power at up to 24 kilowatts for less than $7,000, though the company subsidizes the cost of this equipment by an unknown amount.[31] In addition to the equipment cost, the cost of installing a DC fast charging station includes:

- The cost of labor;
- The cost of electric-panel upgrades;
- Host-site identification, analysis, and screening;
- Negotiation, legal review, permitting, and execution of lease; and
- Electric utility interconnection fee.

While the costs of each component above can vary, these combined installation costs often outweigh the cost of the station. For example, the cost of installing DC fast charging stations along the West Coast Electric Highway in 2012 only covered about half of the total stations costs (see **Table 1**). More recently, in 2014, the charging service provider NRG eVgo asserted that non-equipment costs account for nearly three quarters of the cost of installing a DC fast charging station.[32]

Installation costs can vary depending on the site location. Siting stations near commercial centers can lower costs because often they have access to "three-phase" power on site, a method of electricity transmission required for most DC fast charging stations. To reduce costs on the EV Project, for example, some installers sited equipment at sites that did not require an electric-panel upgrade; installation costs at these sites were about 60 percent lower than similar charging sites on the West Coast Electric Highway in Washington state (see **Table 2**). One tradeoff with this approach, however, is that sites that prioritize low costs due to easily accessible electric service may not optimize consumer convenience, which could result in lower utilization. Planners of the West Coast Electric Highway in Washington state prioritized consumer convenience over pre-existing electric infrastructure to fulfill the project's objective, which was to enable EV travel along Interstate 5. Some sites along the highway did not provide the type of pre-existing electric infrastructure that would have reduced costs.

The availability of electricity infrastructure, however, is not the only element that can affect upfront costs. Florida's municipally-owned utility, the Orlando Utilities Commission, installed five DC fast charging stations at a cost of 82 to 89 percent lower than the Washington project. In addition to carefully selecting sites with pre-existing electricity infrastructure, the utility lowered installation costs through its extensive relevant experience as the electrical grid operator and avoidance of an interconnection fee since it was performing the installation work itself.[33] See **Table 2** for an overview of a DC fast charging project installation costs.

TABLE 1: EV Charging Installation Costs for West Coast Electric Highway

COMPONENT	COST (2012)
DC Fast Charging Equipment	$58,000 per unit
Level 2 Charging Station Co-Located with DC Fast Charging Station	$2,500 per unit
Equipment Installation (Labor and Electric-Panel Upgrade)	$26,000 per location
Host-Site Identification, Analysis, and Screening	$5,000 per location
Negotiation, Legal Review, and Execution of Lease	$6,000 per location
Utility Interconnection	$12,500 to $25,000 per location
Total	**$109,500 to $122,000**

The table below shows the equipment and installation costs of the West Coast Electric Highway project in Washington from 2012.

Source: Washington State Department of Transportation, 2014(a).

TABLE 2: DC Fast Charging Equipment Installation Costs Can Vary

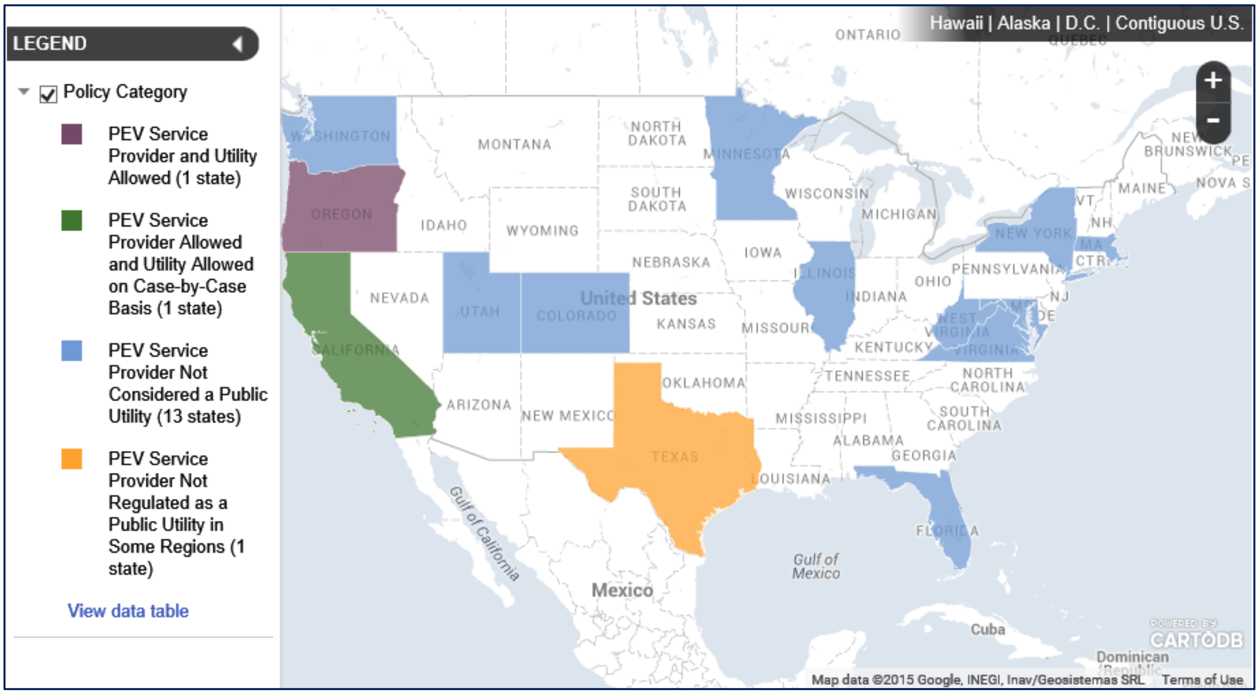
PROJECT DESCRIPTION	DC FAST CHARGING INSTALLATION COST PER STATION
Washington West Coast Electric Highway	$49,000 to $61,500
EV Project (average)	$20,848
EV Project (median)	$20,188
EV Project (highest)	More than $45,000
Orlando Utilities Commission	$6,939 to $8,928

This table shows a range of installation costs for three DC fast charging projects. The cost of installing DC fast charging stations for the EV Project may be misleading because project partners may have covered some of the costs due to budget requirements. For the Orlando Utilities Commission, no utility interconnection charge was necessary and sites were selected that could mostly accommodate the power needs of the charging equipment without additional power infrastructure.

Source: Idaho National Laboratory and Washington State Department of Transportation, Orlando Utilities Commission, 2014.

Private investment in charging is held back by uncertainty about state-level regulation of charging service providers, restrictions on revenue options, and potential competition from ratepayer-funded electric utilities. Public utility commissions in 35 states have not provided regulatory certainty to investor-owned electric utilities and third parties (i.e., privately owned charging service providers) on the provision of charging services. Third parties interested in providing charging services must know if selling these charging services would make them subject to regulation as utilities, which could potentially make it cost prohibitive for them to provide these services (see **Box 5** for considerations for electricity territories outside the control of state public utility commissions). However, no public utility commission has yet stated that third parties would be subject to these regulations unless that third party acts like an electric utility (e.g., procures electricity on a wholesale market). Third party investors have expressed unwillingness to invest in public charging infrastructure without regulatory certainty.[34] Restrictions on the resale of electricity prohibit charging service providers from earning direct revenue for the amount of electricity sold (see **Figure 4**), e.g. receiving payment for kilowatt-hours of electricity provided. Charging service providers that cannot receive payment for the amount of electricity sold must earn direct revenue through alternative methods or capture some of a charging station's indirect value.

FIGURE 11: Who Can Own and Operate a Charging Station



This figure summarizes the regulatory environment for owning and operating electric vehicle charging stations for investor-owned electric utilities and third party charging service providers in territories operated by investor-owned utilities.

Source: C2ES. 2015(c). DC Fast Charging and All-Electric Vehicles. March. Accessed June 18, 2015. http://www.c2es.org/initiatives/pev/maps/who-can-own-operate-a-charging-station.

Box 5: Considerations for Municipal Utilities, Public Utility Districts, and Rural Cooperatives

Electricity customers in territories controlled by municipal utilities, public utility districts, and rural cooperatives are not regulated by state public utility commissions. The regulatory hurdles mentioned in this guide may exist in these territories, but can be overcome without state government intervention. In addition, these territories can take their own action to promote the deployment EV charging infrastructure. For example, the Illinois Rural Electric Cooperative offers EV drivers a discounted electricity rate during off-peak usage periods.[35]

As of May 2015, through legislative or regulatory action, 15 states have stated that third-party charging service providers would not be treated as an electric utility, and only Oregon has expressly stated that investor-owned electric utilities are allowed to own and operate public EV charging equipment. In addition, California's Public Utility Commission ruled in December 2014 that its three investor-owned utilities could propose to offer public charging services that the commission would consider on a case-by-case basis.36 The inclusion of electric utilities in the marketplace could rapidly expand the publicly available EV charging infrastructure (see **Table 3**). The entrance of large electric utilities into this market would also likely alter third party charging service providers' investment strategies. In California, for example, utilities have proposed sizeable investments in public charging infrastructure, which if approved, could reduce charging service providers' investments in a top charging market. **Figure 11** identifies which states have clarified who can own and operate a charging station and **Table 3** summarizes proposals by investor-owned utilities to install public charging stations.

One key challenge to enabling utility investments in charging infrastructure is the assessment of cost and benefits to electricity ratepayers. A technical reference manual created by the Vermont Energy Investment Corporation, developed as part of this project, was designed to help state policymakers, regulators, and utilities better understand how to characterize the use of ratepayer funds and measure costs and benefits of transportation efficiency measures.[37]

Infrequent use and uncertain future utilization of publicly available charging stations can discourage private investment. For the EV Project, about half of DC fast charging stations were used less than once per day between September 2012 and January 2014. During the same period, Level 2 stations on the Blink Network that charged a fee were used far less frequently than those that did not charge a fee—less than 10 percent of Level 2 stations that charged a fee were used daily between September 2012 and January 2014, while 20 percent of free Level 2 stations were used daily during the same period (see **Figure 12**).

TABLE 3: Publicly Available Charging Project Proposals by Investor-Owned Utilities

INVESTOR-OWNED UTILITY	INVESTMENT SIZE ($)	CHARGING STATION COUNT	UTILITY ROLE	USE TARGET	STATE(S)
Georgia Power	$12 million	250	Owner-Operator	Public, Residential, Workplaces	Georgia
Indiana Power & Light	$16 million	200	Transfer Ownership	Public	Indiana
Kansas City Power & Light	$20 million	1,001	Owner-Operator	Public	Missouri, Kansas
Pacific Gas & Electric	$654 million	25,000	Owner-operator	Multi-Unit Dwellings, Public, Workplaces	California
Southern California Edison	$355 million	30,000	Make Ready	Fleets, Multi-Unit Dwellings, Public, Workplaces	California

Source: C2ES analysis completed in April 2015.

FIGURE 12: Charging Use for the EV Project

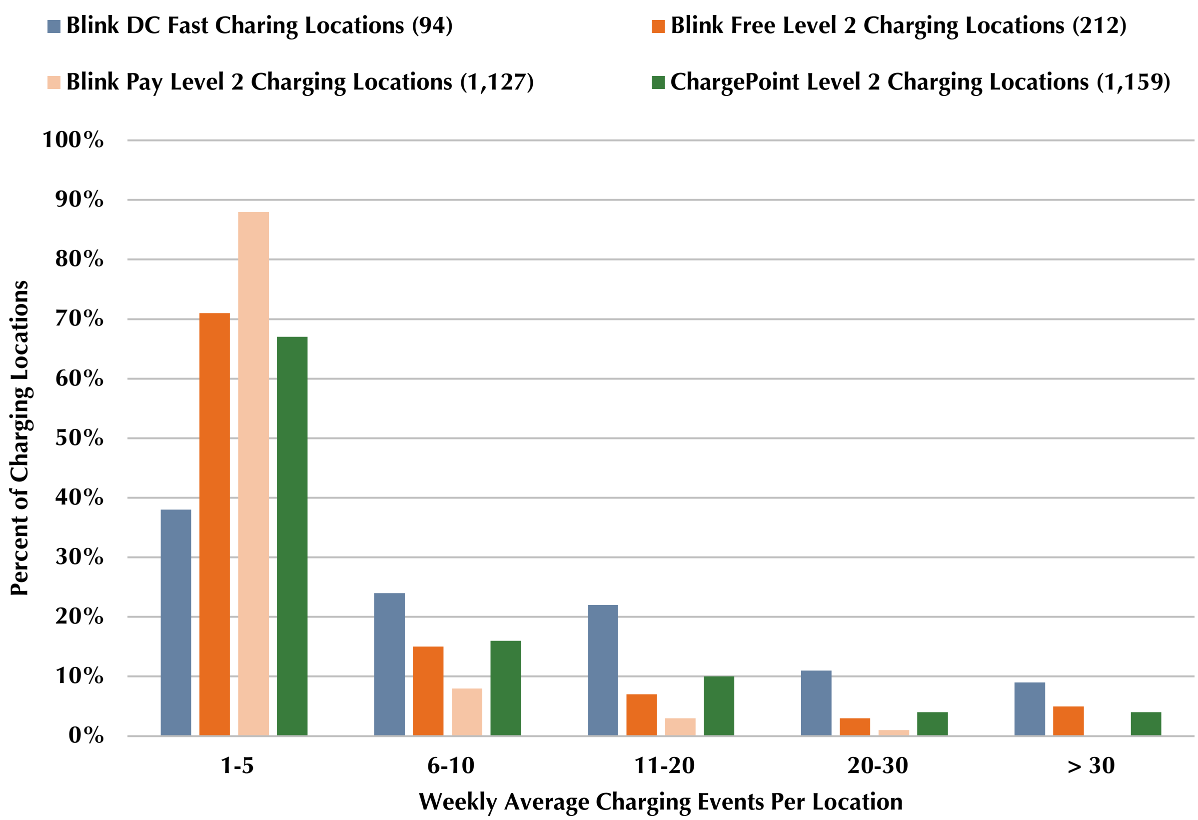


Figure 12 illustrates the average number of times per week charging stations were used from September 2012 to January 2014. The majority of DC fast charging stations were used more than seven times per week while the majority of Level 2 stations were used less than three times per week. In the Blink Network, Level 2 stations that charged a fee were used less frequently than those made available for free. The number of locations measured is shown in parentheses.

Source: Idaho National Laboratory, adapted from http://avt.inel.gov/pdf/EVProj/INLSmartPEVInfraDemosTRBJan15.pdf

A robust charging network may consist of stations that are used at different frequencies, including many stations used less than once per day. The West Coast Electric Highway in Washington consists of 12 DC fast charging sites that enable EV drivers to travel along Interstate 5 and other major roadways in the western half of the state. Along the route, the average utilization for DC fast charging stations was 66 times per month for the six months after fees were instituted in April 2014.[38] Some stations along the route were used frequently, however, with four stations averaging 127 charging sessions during the same period. Following the introduction of pricing, use at the most popular stations declined, but overall network use increased, including the share of stations used more than once per day (see **Figure 13**).

FIGURE 13: DC Fast Charging Station Use on West Coast Electric Highway from October 2013 to September 2014

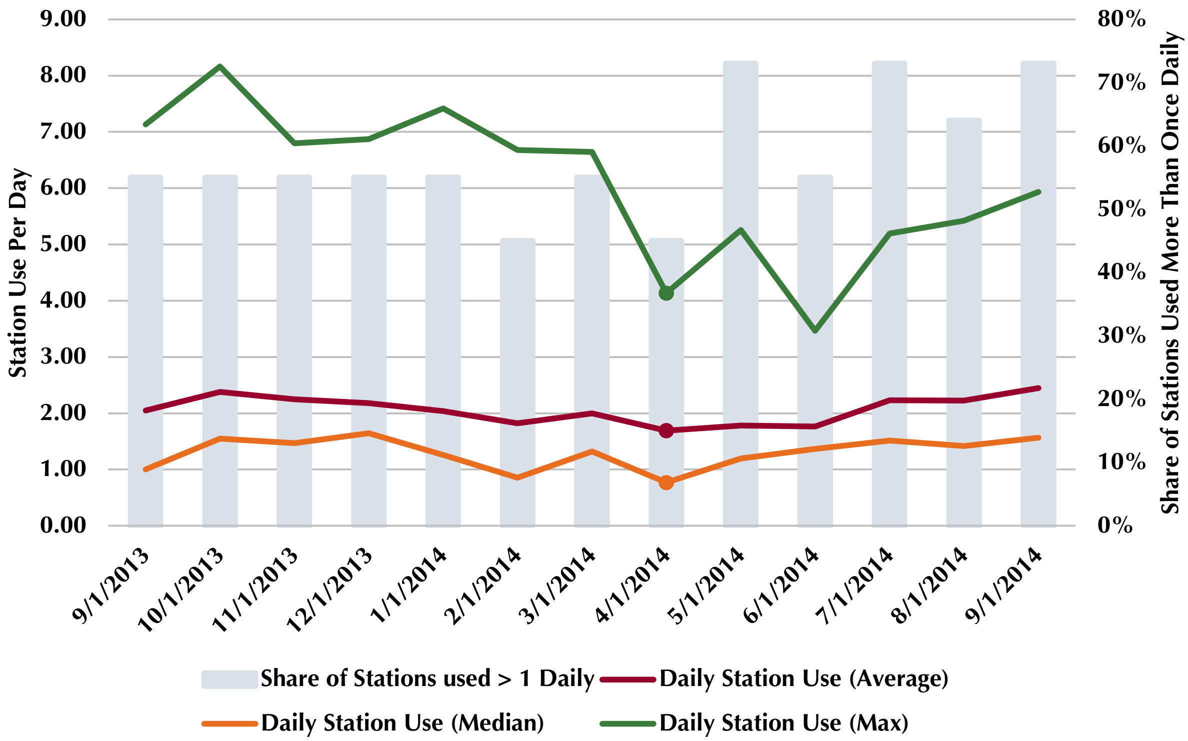
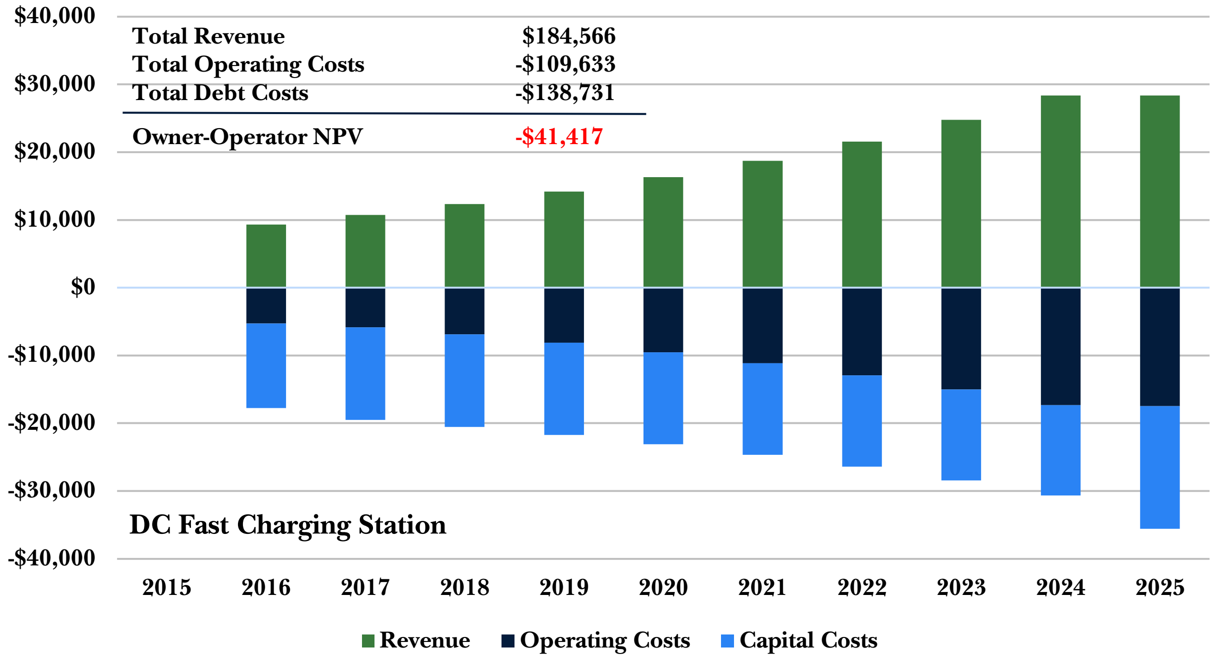


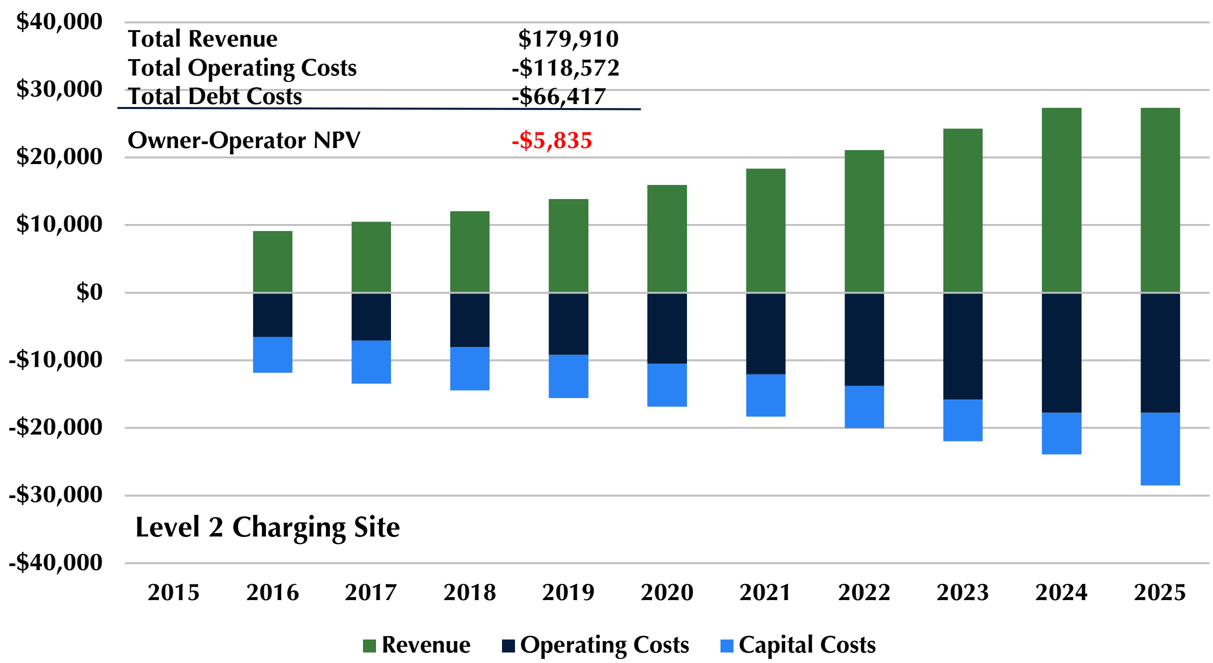
Figure 13 highlights the daily station use for the 11 DC fast charging stations in Washington state that constitute the West Coast Electric Highway. The graph shows the six months before and after pricing was introduced at the stations (April 2014).

Source: Washington Department of Transportation, 2014.

Given the relatively high upfront costs and uncertain utilization, the financial viability of DC fast charging and Level 2 charging projects for owner-operators is challenging, especially when revenue is generated solely from the sale of charging services. Two hypothetical charging projects based in New York help illustrate this problem. A charging project that consists of a single DC fast charging station would result in a net loss of $41,417 for the station owner-operator over 10 years. For this project, DC fast charging would cost EV drivers $0.52 per kilowatt-hour (the energy equivalent of the gasoline price) and the station would be used more than three times a day during the first year, with utilization growing 15 percent annually. A project with five Level 2 charging stations would result in a net loss of $5,835 for the station owner-operator over the same 10-year period. For this project, Level 2 charging would cost EV drivers $0.46 per kilowatt-hour (three times the retail electricity price), and the stations were used about once per day during the first year, with utilization growing 15 percent annually. **Figure 14** shows the discounted cash flows for both projects. Assumptions for this analysis are available in Appendix C.

FIGURE 14: Example NPV Analysis for Charging in New York State





The charts in Figure 14 illustrate the challenge of paying back large initial capital cost investments in charging stations. Capital costs of the Level 2 charging site are smaller than for a DC fast charging station. Although in both cases annual revenues exceed operating costs, the revenues are small compared to initial capital costs. A loan was taken at the project outset to cover all initial capital costs, and all revenue and operating cost cash flows are received at the end of each year. These charts present the net present value (NPV) of each project by considering the time value of money, discounted to the present day, and are not simply a sum of revenue, operating costs, and capital costs (including debts).

Source: C2ES analysis

Differences in electricity prices in local markets have a significant effect on the profitability of charging projects. The following example illustrates the impact of electricity prices on a hypothetical owner-operator of a single DC fast charging station that only received revenue from the sale of charging services. The price for DC fast charging was assumed to be the energy equivalent of the price of gasoline. A direct revenue DC fast charging project in the state with the highest net present value (NPV) was 36 percent higher than a project in the state with the lowest NPV, a difference of more than $11,000. For this analysis, only electricity pricing and local gas prices were changed to provide an apples-to-apples comparison. All other assumptions, such as electricity demand charges and utilization rate, were held constant. **Table 4** provides a summary of the analysis results for a single DC fast charging station in 10 states.

TABLE 4: Effects of Electricity Pricing on a Direct Revenue Model for a Single DC Fast Charging Station

STATE	AVERAGE ELECTRICITY PRICE IN 2012 (CENTS/KWH)[39]	DC FAST CHARGING NPV OVER 10 YEARS	DIFFERENCE WITH NPV IN WASHINGTON
California	13.50	-$39,116	$8,877
Colorado	9.39	-$33,555	$3,316
Georgia	9.37	-$33,527	$3,288
Maryland	11.30	-$36,139	$5,900
Massachusetts	13.80	-$39,522	$9,283
New York	15.20	-$41,417	$11,178
Oregon	8.21	-$31,958	$1,719
Washington	6.94	-$30,239	-

For the purposes of this demonstration, all other assumptions including electricity demand charges were held constant. Although projects in all states do not achieve profitability, the state where the direct DC fast charging project had the lowest NPV (New York) is 27 percent below the state where the project had the highest NPV (Washington).

Source: C2ES analysis

Significant upfront or annual subsidies are needed for a charging station owner-operator to achieve payback in five years or less. Generally, in order for private sector developers to invest in a project, they need to expect the project to be profitable and to achieve net profitability in a short period—many private investors are only interested in projects that can achieve payback in five years or less. For an investment of a single DC fast charging station in New York to achieve payback in five years, an owner-operator would require an upfront subsidy of more than $64,000 (69 percent of the total capital investment) or an annual subsidy of $12,200. For an investment of five Level 2 charging stations in New York to achieve payback in five years, an owner-operator would require an upfront subsidy of more than $44,412 (40 percent of the total capital investment) or an annual subsidy of $3,400. Refer to Appendix C for all assumptions used in this analysis.

TABLE 5: Initial Capital Cost Subsidies Needed for Projects to Achieve Payback within Five Years (Revenues Held Constant)

PROJECT TYPE	TOTAL CAPITAL INVESTMENT	INITIAL CAPITAL INVESTMENT SUBSIDY NEEDED
Single DC Fast Charging Station in New York	$92,932	$64,123 (69% of capital costs subsidized)
5 Level 2 Charging Stations in New York	$44,412	$17,765 (40% of capital costs subsidized)

TABLE 6: Additional Annual Revenue Needed for Projects to Achieve Payback within Five Years (Capital Cost Unsubsidized)

PROJECT TYPE	ANNUAL REVENUE	ADDITIONAL ANNUAL REVENUE NEEDED
Single DC Fast Charging Station in New York	$21,516 - $40,538	$12,200 (between 57% and 30% greater revenue needed)
5 Level 2 Charging Stations in New York	$12,520 - $30,760	$3,400 (between 27% and 11% greater revenue needed)

Summary: Barriers to Private Investment in Charging Projects

Current regulations in many states may treat charging service providers like electric utilities, a regulatory burden that can discourage private investments by third parties. Before private investment can expand the publicly available charging station network across the United States, states must provide regulatory certainty to both third party charging service providers and electric utilities.

Stable market conditions may create an opportunity to expand public charging infrastructure, but investors still need to make public charging projects profitable by reducing costs and maximizing direct revenue streams. The profitability of these projects hinges on two factors:

- **High upfront costs**, particularly for DC fast charging stations, create an impediment to investing in publicly available charging projects. Equipment purchase, siting, and installation costs require significant revenues for the owner-operator to achieve profitability.
- **Inadequate charging station utilization** reduces direct revenues for owner-operators of public charging stations. EVs, on average, use public charging for less than 5 percent of total charging needs presently. The nascent EV market does not currently have enough EVs on the roads to provide the direct revenue stream necessary to earn investor payback. In addition, the uncertainty over demand could require investors to assume high-interest debt, which makes achieving quick payback on a project more difficult.

Private investors typically expect an investment to payback in five years or less. The direct revenue business model is unlikely to earn back an investment within that timeframe under current market conditions. Developers of charging projects will need to supplement the direct revenue from EV charging station use with other revenue or sources of capital to achieve profitability.

QUESTION 3. ARE THERE BUSINESS MODELS THAT CAN IMPROVE THE FINANCIAL VIABILITY OF PUBLICLY AVAILABLE CHARGING PROJECTS?

For an owner-operator of a charging station or network of stations, the financial performance of a publicly available charging project could be improved through a combination of:

- Increased revenue;
- Decreased capital cost;
- Decreased operating cost; and/or
- Decreased cost of funds.

Considering these factors, this section defines two business models that could potentially improve the financial performance of a charging station by allowing owner-operators to capture some of the indirect value of providing charging services. One model decreases upfront capital costs (referred to as the sales boost business model) and the other increases revenue for the owner-operator (referred to as the revenue sharing business model). These models were chosen following research conducted for this project over the 2013 to 2014 period. In particular, a workshop put on jointly by the Harvard Business School, C2ES, and NASEO for the AFV Finance Advisory Group provided insight into what kinds of private partnerships might be most appropriate for this approach, given previous experience and current market conditions.[40]

Findings are based on the application of each business model to a hypothetical charging project in the states of Washington and New York to assess two different EV markets. Washington has very low electricity prices and a high ratio of all-electric vehicles to plug-in hybrid electric vehicles, while New York has higher than average electricity prices and a low ratio of all-electric vehicles to plug-in hybrid electric vehicles. Both states have incentives in place to encourage EV charging deployment and EV adoption. The hypothetical charging projects consist of 10 DC fast charging stations (8 corridor-based stations and 2 locally-based stations) and 50 Level 2 charging stations that enable EV travel to and within a popular regional destination.

All analyses were performed using the EV Charging Financial Analysis Tool described in **Box 3**. Each model is first described, and the results of both models are then compared. The financial analysis estimated the performance of charging station projects from three distinct perspectives:

- **Charging station project owner-operator.**
- **Project funding partner (an automaker or retailer in this case).** For the analyses presented in this section, the project funding partner always achieves a payback on its investment because the partner is assumed to provide an investment that is less than the anticipated revenues gained from the charging service.
- **Total project performance, the sum of all of the entities' perspectives combined into a single entity.** The total project performance perspective enables analysis of the project as a whole to compare with individual entities' financial performance. This is a useful function because a project may perform well as a whole, but does not perform well for particular entities. In such cases, each entity could adjust its role to make the business model financially sustainable. A project may also financially benefit particular entities but does not generate net value as a whole, in which case the business model could be adjusted to pursue additional revenue sources.

See Appendix C for all model assumptions.

Sales Boost Business Model

Adding new publicly available EV charging can increase the sales of EVs in a local market. Charging projects' financial performance from the owner-operator's perspective can be improved by sharing a portion of the revenue from these additional EV sales with the charging station owner-operator (see **Box 6**).

Box 6: Sales Boost Business Model Example: Automaker Invests in a Charging Network

Summary: An automaker that benefits from expanded access to EV charging infrastructure contributes funding that subsidizes the deployment of a DC fast charging network for interregional EV travel. Charging stations could be owned and managed by the site hosts or by a third-party charging service provider.

Form of funding: The automaker directly transfers funds upfront to the charging station owner-operator.

Target market for charging services: The primary target market of this business model is all-electric drivers taking interregional trips that are longer than the expected range of their vehicles, although plug-in hybrid drivers that seek charging services at convenient locations along major roadways may also contribute to demand for these services in the future.[41]

Potential players and value propositions: From the perspective of the charging station owner-operator, the value proposition consists of direct revenues from charging services fees. Automakers could value DC fast charging stations along major roadways as a useful marketing tool to help sell more EVs.

In addition to automakers, a range of other businesses may see value in helping to fund a network of charging stations along major roadways, including:

- Battery suppliers who also benefit from EV sales;
- Electric utilities or electricity power generators, who may wish to expand access to charging in their service territories to serve their customers; and
- For all private sector participants, support for and operation of EV charging stations may also present marketing opportunities.

Automakers invest in the deployment of publicly available charging infrastructure because of the potential of increased EV sales in local markets. During a 2013 promotion by Nissan, for example, the company offered to subsidize the cost of DC fast charging installations by $10,000.[42] In January 2015, BMW and Volkswagen announced a joint venture to install 100 DC fast charging stations along East and West Coast travel corridors, followed shortly by Nissan's announcement of its plan to invest in more than 1,000 DC fast charging stations across the United States.[43] These initiatives demonstrate the value that automakers may place on public charging infrastructure.

The example analyses in this guide estimate charging stations' value to automakers by assuming that publicly available charging primarily serves a marketing purpose for automakers. The analyses assume that an automaker would only invest a small fraction of the value it receives from a charging station into a new infrastructure project. Estimates are based in part on the number of EVs and charging stations in the state (see **Table 7**). The results are the following state-specific subsidies that an automaker would provide to an owner-operator per charging station:

- DC fast charging station: $7,000 in Washington and $10,000 in New York
- Level 2 charging station: $600 in both Washington and New York[44]

These investment levels subsidize the cost of a DC fast charging station by up to 35 percent and a Level 2 charging station by up to 24 percent.

TABLE 7: EV and Charging Infrastructure Deployment as of December 2014

	WASHINGTON	NEW YORK	UNITED STATES
DC Fast Charging Locations	45	7	795
Level 2 Charging Ports	864	845	19,441
All-Electric Vehicles	8,608	2,833	131,303
Total EVs	12,291	11,271	278,769

This table summarizes EV and charging infrastructure deployment in Washington, New York, and the United States as of December 2014.

Source: National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, Accessed March 17, 2015. DOE. 2014. Alternative Fuels Data Center. http://www.afdc.energy.gov.

An automaker investing a portion of the expected revenue from additional EV sales with an owner-operator improves the net value of a charging project, but not enough to reach profitability. The automaker subsidy improves the net value of a project to the owner-operator by 12 percent in Washington and by 14 percent in New York. Although neither project is profitable for the owner-operator in this example, this additional investment results in a material improvement to the financial performance of both projects. See **Table 8** for a comparison of the financial performance of the sales boost business model applied to the same charging project in New York and Washington.

TABLE 8: Financial Performance of Sales Boost Business Model on Charging Projects

FINANCIAL METRIC	WASHINGTON		NEW YORK	
	No Subsidy	With Automaker Subsidy	No Subsidy	With Automaker Subsidy
Total project level perspective				
Total capital investment (spent on charging station deployment)	$1,368,249	$1,378,249	$1,373,436	$1,386,436
NPV	-$434,394	-$330,523	-$466,239	-$331,208
Payback period	No payback	No payback	No payback	No payback
Owner-operator perspective				
Funds spent on stations (equity)	$547,299	$551,299	$549,375	$554,575
Funds spent on stations (debt)	$820,949	$826,949	$824,062	$831,862
NPV	-$447,466	-$396,565	-$478,499	-$412,329
Payback period	No payback	No payback	No payback	No payback
Automaker perspective				
Amount of funds transferred to owner	N/A	$100,000	N/A	$130,000

FINANCIAL METRIC	WASHINGTON		NEW YORK	
	No Subsidy	With Automaker Subsidy	No Subsidy	With Automaker Subsidy
operator initially				
Amount of funds transferred to owner operator annually	N/A	$0	N/A	$0
NPV	N/A	+$46,505	N/A	+$60,456
Payback period	N/A	5 years	N/A	5 years

The project is unprofitable even if the automaker substantially increases its subsidy to the owner-operator. The example analysis provides evidence that an owner-operator is unlikely to reach profitability in New York or Washington even with a subsidy up to three times larger than the baseline assumption. In New York, an automaker's subsidy of $30,000 for each DC fast charging station and $1,800 for each Level 2 charging station is not sufficient for the owner-operator to reach profitability. These subsidies account for 86 and 72 percent of the equipment cost of the DC fast charging and Level 2 charging stations, respectively. In Washington, an automaker subsidy level of $21,000 for each DC fast charging station and $1,800 for each Level 2 charging station is not sufficient for the owner-operator to reach profitability. These subsidies account for 60 and 72 percent of the equipment cost of the DC fast charging and Level 2 charging stations, respectively. See **Table 9** for a summary of the effects of different automaker subsidy levels on the owner-operator NPV in the sales boost business model.

TABLE 9: Effects of Different Subsidy Levels on Owner-Operator NPV

STATE	AUTOMAKER SUBSIDY LEVEL		OWNER-OPERATOR NPV	% DIFFERENCE FROM BASELINE NPV
	Per DC Fast Charging Station	Per Level 2 Charging Station		
Washington	$7,000	$600	-$396,565	-
	$14,000	$1,200	-$345,665	13%
	$21,000	$1,800	-$294,765	26%
	$63,000	$5,400	+$10,638	103%
New York	$10,000	$600	-$412,329	-
	$20,000	$1,200	-$346,158	16%
	$30,000	$1,800	-$279,988	32%
	$75,000	$4,500	+$17,780	104%

Revenue Sharing Business Model

Hosting charging stations can encourage additional sales at local businesses while EV drivers charge, which may draw new customers and increase the dwell time of existing customers.[45] Sharing a portion of this additional sales revenue with the charging station owner-operator can greatly improve the financial performance of the project for the owner-operator (see **Box 7**).

Box 7: Revenue Sharing Business Model Example: Local Businesses Pool Funds to Invest in a Charging Network

Summary: A group of businesses located in a popular tourism destination contribute to a funding pool that provides an annual subsidy to the charging network owner-operator. The charging network enables travel to and within the destination region. Members of the group commit to hosting charging sites. Charging stations could be owned and managed by the site hosts or by a third-party charging service provider.

Form of funding: Local businesses contribute to a funding pool from which funding is transferred to the charging station owner-operator each year for the expected life of the equipment (10 years). Since the local businesses simply share a fraction of their increased revenue with the owner-operator, there is no upfront investment and they earn a return immediately depending on charging station use.

Target market for charging services: The primary target market of this business model is all-electric vehicle drivers taking trips to tourism destinations. These drivers may demand charging services to travel to and from the tourism destination and/or to travel within the destination region. Plug-in hybrid drivers seeking charging on trips to, from, and within the tourism destinations may also contribute to demand for these services.

Potential players and value propositions: From the perspective of the charging station owner-operator, the value proposition consists of direct revenues from charging services fees. Businesses located in tourism destinations may see value in collectively supporting a network of charging stations that enable all-electric travel to, from, and within their region. For each business, the value of contributing funds towards the deployment of these charging stations would be increased sales associated with on-site charging as well as clean energy marketing opportunities. These businesses could include hotels, retailers, commercial real estate owners, restaurants, and tourist attractions. In addition to direct involvement of local businesses, local chambers of commerce could also play a role in planning, coordinating, and/or funding charging station deployment.

Retailers value hosting publicly available charging stations on their premises because the stations can lead to additional sales revenue. By offering customers EV charging services while they shop, retailers can increase customer dwell time (the time spent shopping), thereby increasing revenue. One charging service provider, ChargePoint, estimated users of charging stations at one retail location had a dwell time more than 300 percent longer than the average customer.[46] Retailers could share a portion of the incremental sales revenue with a charging station owner-operator, similar to an advertising expense. Assuming a customer spends $1 per minute of shopping[47] up to $25, each retailer that contributes to the pooled fund would share 5 percent of its incremental sales revenue with an owner-operator. This financial contribution could annually subsidize the cost of the project by $1,500 to $4,500 for a DC fast charging station and $500 to $1,500 for a Level 2 station.[48]

TABLE 10: Financial Performance of Revenue Sharing Business Model on Charging Projects

FINANCIAL METRIC	WASHINGTON		NEW YORK	
	No Subsidy	With Retailer Subsidy	No Subsidy	With Retailer Subsidy
Total project level perspective				
Total capital investment (spent on charging station deployment)	$1,368,249	$1,371,049	$1,373,436	$1,376,236
NPV	-$434,394	+$443,564	-$466,239	+$411,719
Payback period	No payback	7 years	No payback	7 years
Owner-operator perspective				
Funds spent on stations (equity)	$547,299	$548,419	$549,375	$550,495
Funds spent on stations (debt)	$820,949	$822,629	$824,062	$825,742
NPV	-$447,466	-$252,196	-$478,499	-$283,229
Payback period	No payback	No payback	No payback	No payback
Retailer perspective				
Amount of funds transferred to owner operator initially	N/A	$0	N/A	$0
Amount of funds transferred to owner operator annually	N/A	$28,000 - $84,125	N/A	$28,000 - $84,125
NPV	N/A	+$619,699	N/A	+$619,699
Payback period	N/A	<1 year	N/A	<1 year

Retailers sharing a portion of the additional sales revenue annually with an owner-operator significantly improves the net value of a charging project, but not enough to reach profitability. The retailers' annual subsidy improves the net value of a project to the owner-operator by 39 percent in Washington and in New York. Although neither project is profitable for the owner-operator in this example, this additional investment results in a material improvement to the financial performance of both projects. **Table 10** provides a comparison of the financial performance of the revenue sharing business model being applied to the same charging project in New York and Washington.

Raising the price of charging services can make charging projects profitable for an owner-operator using the revenue sharing business model, but the time frame would likely be too long for most private investors. In order for the owner-operator to achieve payback for the charging project in Washington, the price of DC fast charging and Level 2 charging services would have to be increased by 30 percent. This investment payback would occur in year 10 of the project, which is likely too long a duration for most private investors. For the same project in New York, raising the price by 30 percent results in a payback in nine years for the owner-operator, a timeframe that is also likely too long for most private investors. See **Table 11** for a summary of the analysis results from increasing the price of charging services.

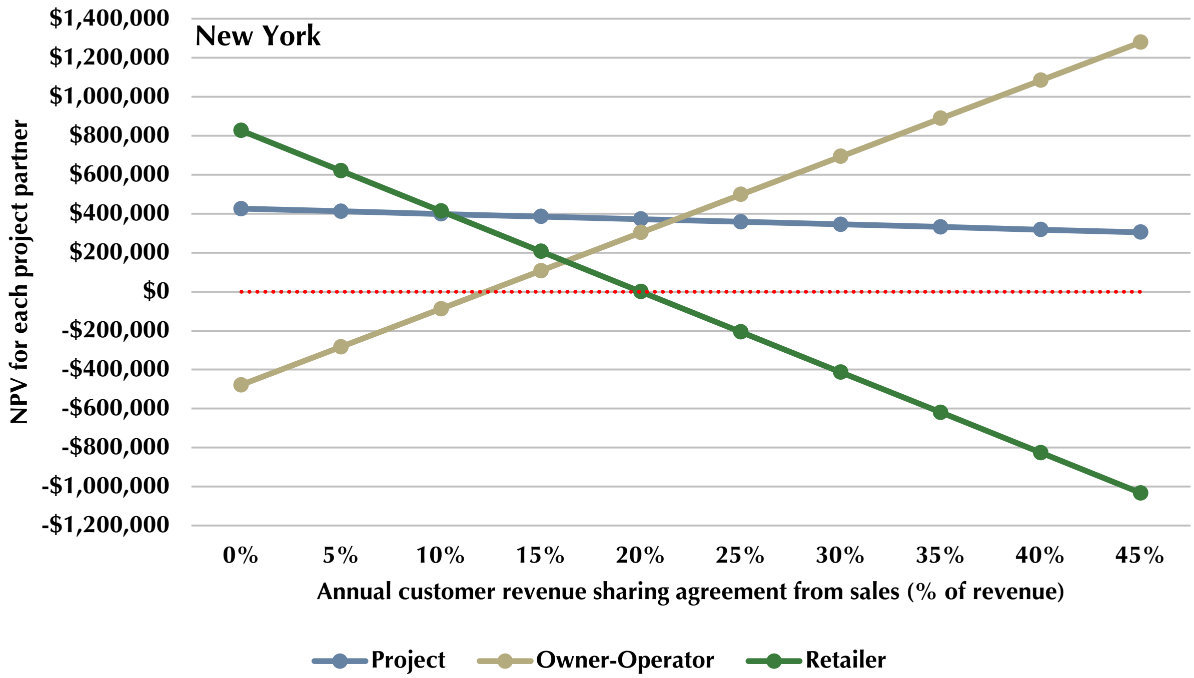
TABLE 11: Effects of Increasing Price of Charging Services on Revenue Sharing Business Model

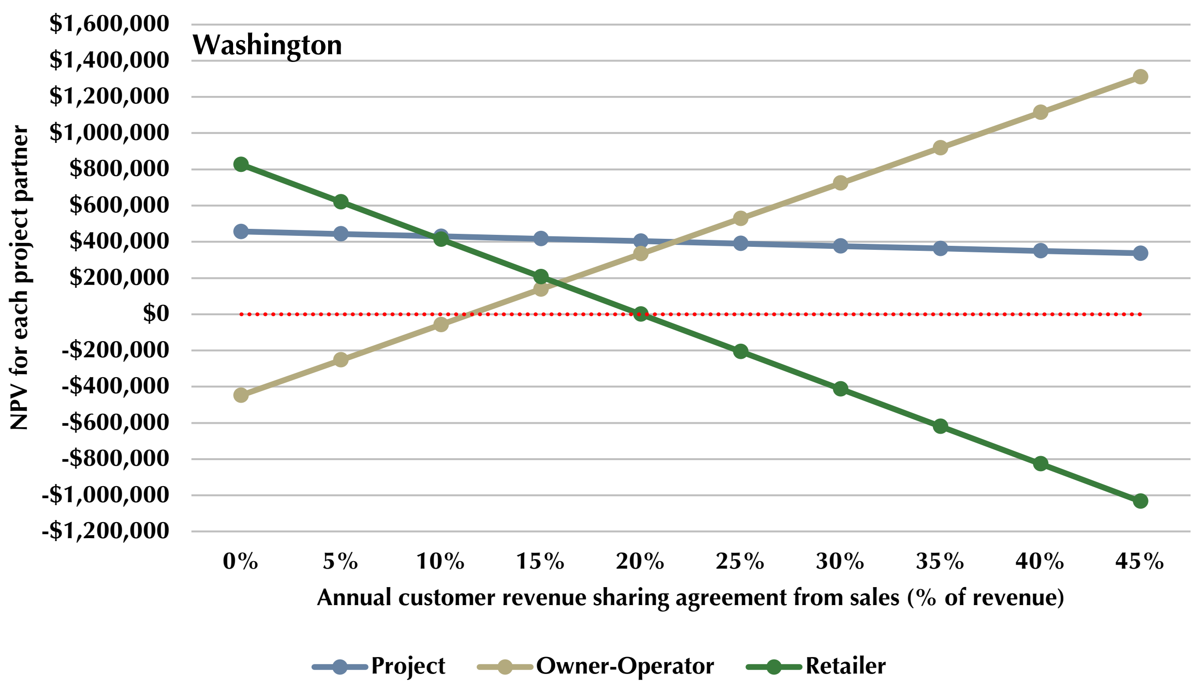
FINANCIAL METRIC	WASHINGTON		NEW YORK	
	Baseline Charging Service Price	30% Higher Charging Service Price	Baseline Charging Service Price	30% Higher Charging Service Price
Project NPV & Payback	$443,564 (7)	$741,398 (6)	$411,719 (7)	$825,944 (6)
Owner-Operator NPV & Payback	-$252,196	$25,464 (10)	-$283,229	$102,949 (9)
Retailer Partner NPV & Payback	$619,699 (<1)	$619,699 (<1)	$619,699 (<1)	$619,699 (<1)

The table below summarizes the effects on the project NPV of increasing the price of DC fast charging and Level 2 charging services by 30 percent. For projects that are profitable, the payback period in years is shown in parentheses.

An owner-operator can reach profitability with the revenue sharing business model if the percentage of revenue shared is greater than 13 percent. High-margin businesses could benefit from the addition of nearby EV charging stations by attracting EV drivers, thereby increasing their annual revenues. If these businesses shared 13 percent of the additional revenue with the owner-operator, the owner-operator would achieve payback in 10 years in New York and nine years in Washington, though that is still likely too long for many private investors. A retailer would have to share 35 percent of its increased revenue for the owner-operator to achieve payback in five years or less, a critical threshold for many private investors, in both example projects. This share of additional revenue is likely too large for most businesses to benefit from hosting charging stations given the assumption that the retailers' profit margin is 20 percent of new revenue. See **Figure 15** for the effect of different revenue share levels on the owner-operator NPV.

FIGURE 15: Increasing the Amount Retailers Share with the Owner-Operator Greatly Improves the Owner-Operator's NPV





These figures show the effects of different percentages of retailers' revenue sharing on the owner-operator NPV. At a 13 percent share of new retailer sales revenue, the owner-operator achieves profitability in New York and Washington. The retailers' begin to lose money at shares greater than 20 percent, because that is the retailers' assumed profit margin.

Summary: Business Models that Capture Indirect Value of Charging Services

The two business models presented in this section help to address two of the three key barriers to a profitable charging project: high upfront equipment and installation costs, and uncertainty over demand. Automakers may see charging infrastructure as a reasonable marketing investment, and have recently demonstrated this by announcing large-scale plans to deploy charging stations across the United States. The sales boost business model captures this value by modeling an automaker's direct cash transfer to the owner-operator at the outset of the charging project, thereby lowering the project's upfront costs. Automaker subsidies, however, are not sufficient to make the hypothetical charging projects in Washington and New York profitable, even at three times the cost of a comparable marketing initiative.

Many retailers have decided to host charging stations (e.g., Kohl's, Safeway, Target), in part, because they anticipated a boost in sales from extended customer dwell time.[49] The revenue sharing business model captures this value by modeling a retailer sharing an annual percentage of its additional sales revenue with the owner-operator, thereby adding a new revenue stream for the owner-operator. This subsidy significantly improves the financial performance for an owner-operator, but not by enough to make the hypothetical projects in either Washington or New York profitable with a payback period that would attract most investors.

The next section explores ways to improve the financial performance of the charging projects in New York and Washington through public interventions that can lower upfront costs, lower the cost of funds, and increase station utilization.

QUESTION 4. CAN THE PUBLIC SECTOR IMPROVE THE FINANCIAL VIABILITY OF PUBLICLY AVAILABLE CHARGING STATIONS IN THE NEAR TERM AND PROMOTE MORE PRIVATE INVESTMENT IN THE MEDIUM TERM?

This section presents the effects of targeted public interventions on two hypothetical charging projects in Washington and New York to overcome private investment barriers. In the near term, private investors are unlikely to earn a return on publicly available charging projects without some public assistance because of high upfront costs, uncertainty about demand, and consumers' low willingness to pay for public charging services. This is especially relevant for private investors that seek an investment payback of five years or less, a common objective.

As demonstrated in previous sections of this guide, the same example charging project in either Washington or New York is not profitable under current market conditions if revenue to the owner-operator only comes from the provision of charging services. Capturing some of the indirect revenue to automakers and retailers generated by charging stations through new business models can improve the financial performance for the owner-operator, but is unlikely to result in a profitable private sector investment.

Several public sector interventions were tested to identify a combination of polices that would make the two hypothetical charging projects profitable with a payback of five years or less. Additionally, the same charging projects starting five years after the initial projects were evaluated to estimate the effects of near term interventions on medium term projects. As a reminder, the example charging project consisted of 10 DC fast charging stations (8 corridor-based stations and 2 locally-based stations) and 50 Level 2 charging stations used to enable travel to and within a popular destination for EV drivers.

Three policy interventions were identified that would address the key barriers to charging infrastructure: high upfront costs, demand uncertainty, and consumers' willingness to pay for charging services. These policies include grants, low-interest loans, and vehicles incentives. Their impacts on projects' viability are summarized below.

- **Grants**: A grant would subsidize the upfront cost of purchasing and installing charging stations, but would not require a charging station owner-operator to repay the funds. Grants improve a charging project's financial performance before the project begins, thereby lowering risk of failure immediately. Grants may also be easier to implement and administer than other public programs, such as loan programs.

- Several states offer grants programs for private charging station investments. The Connecticut Department of Energy and Environmental Protection, for example, created a 2013 grant program that funded public charging projects for amounts between $1,000 and $5,000. The program has the explicit objective to increase private investment in publicly available EV charging infrastructure.[50] Many grant programs for public charging infrastructure, such as a grant program run by the Michigan Energy Office[51] or a rebate program run by the Illinois Department of Commerce and Economic Opportunity,[52] set a government funding limit at 50 percent of a project's total costs. By requiring a significant private investment, grant programs can reduce the costs to the government and ensure that owner-operators have an incentive to maximize a project's profitability.
- **Low-Interest Loans**: Local or state governments could issue loans directly to charging station owner-operators on an individual basis as part of a solicitation of proposals for charging station projects. Alternately, local or state governments could establish a fiscally self-sustaining, dedicated revolving loan fund that would offer low-interest loans to the owner-operators of qualified projects. Low-interest loans would reduce the high interest rates that saddle public charging projects, which are extremely unlikely to earn a profit with costly debt payments. By providing low-interest loans, state and local governments would assume the risk that investors may default on loan payments. However, the low interest charged on the loans would improve the business case for owner-operators and reduce the risk of default from the standard business case without public sector intervention.
- Several of Vermont's state agencies have joined a partnership to fund public EV charging projects. The interest rate of the loan is fixed at 1 percent over the useful life of the charging station, which is estimated at approximately 10 years, with loans available up to $100,000.[53] Utah's Division of Air Quality funds EV charging infrastructure programs with a maximum grant of $100,000 and a maximum loan of $200,000,[54] as the state can offer more funds for loans since there is a chance of repayment. Although charging projects must still receive enough revenue to make loan repayments, low-interest loans can improve an owner-operator's cash flow relative to the high-interest loans expected to be offered for EV charging projects, thereby improving the financial performance of a project.
- **Vehicle Purchase Incentives**: By subsidizing the price premium of EVs and making the vehicles more attractive to the market, a state or local government can increase the EV deployment, which can increase demand at publicly available charging stations. Charging use is a key determinant of the financial performance of an EV charging project, affecting an owner-operators' direct and indirect revenue streams. For the revenue sharing business model, higher utilization rates would lead to higher revenue for retailers and charging owner-operators. Regarding the size of an incentive, automakers have stated that taking $1,000 or more off the price of a vehicle can spur sales, though this assumes that the incentive is a rebate available at the time of purchase, not a tax credit redeemed later.[55]
- The effects of vehicle purchase incentives on the EV market are uncertain, and the cumulative cost of these incentive programs can be expensive for state governments. For example, extending Washington's sales tax exemption for all-electric vehicles beyond July 1, 2015 would reduce government tax revenue by $13 million for fiscal years 2016 and 2017.[56] However, recent studies on the economic

impacts of EVs to state economies indicate that the annual economic benefits of EV deployment may outweigh the costs of vehicle purchase incentives.[57,58,59,60]

- Georgia and Colorado each offer high consumer EV tax credits, with a maximum benefit of $5,000 and $6,000, respectively. Georgia's all-electric vehicle tax credit has helped make the state the second largest EV market behind California with more than 13,000 all-electric vehicles on its roads, though the credit will be eliminated on July 1, 2015. Colorado, with about half the population of Georgia, has not experienced the same success with its credit available to all-electric and plug-in hybrid electric vehicles, and has approximately 4,000 combined EVs on its roads.[61]

The implications of applying these market interventions, including the estimated effects of low-interest loans, grants, and vehicle incentives on charging utilization, upfront equipment and installation costs, and the cost of funds, are summarized in **Table 12**.

TABLE 12: Public Sector Intervention Summary

INTERVENTION	DESCRIPTION	WASHINGTON ASSUMPTION	NEW YORK ASSUMPTION
Low-Interest Loan	Provide 10-year, low-interest loan to cover a share of the cost of the project debt. The assumed private-sector loan interest is 8%.	Finance 50% of project debt (30% of the total project capital costs) at an interest rate of 5.4%.62	Finance 50% of project debt (30% of the total project capital costs) at an interest rate of 3%.63
Grant	Subsidize cost of charging station equipment via a cash transfer to the owner-operator.	65% equipment cost subsidy	70% equipment cost subsidy
Vehicle Purchase Incentive	In Washington, extend the sales tax exemption for all-electric vehicles, which is set to expire on June 30, 2015, for five years. In New York, institute a rebate for EVs at up to $1,500 for plug-in hybrid electric vehicles and $2,500 for all-electric vehicles; the rebate would last for five years.	This intervention is estimated to increase the annual growth rate of charging station utilization by an additional 7%.	

While several other public policy interventions have the potential to improve charging stations' financial viability, they were excluded for the following reasons:

- Although some states have considered a low-carbon fuel standard (LCFS), only California has implemented a program, and the effects of the program on EVs is uncertain. Governors of nine states in the Northeast and Mid-Atlantic signed a 2009 memorandum of understanding to explore an LCFS,[64] but progress on implementing the regional initiative has stalled for several years. Washington state Governor Jay Inslee supports a clean fuel standard that treats EVs in a similar to California's LCFS, but it must first be approved by the state's legislature.[65] Oregon may be the second state to implement the standard following a recent law enacted to repeal a sunset provision in the state's existing low-carbon fuel standard program.[66] An LCFS will encourage low-carbon emitting vehicles like EVs, but the extent to which program fuel credits or other program aspects improves the financial performance of a charging project is largely uncertain.

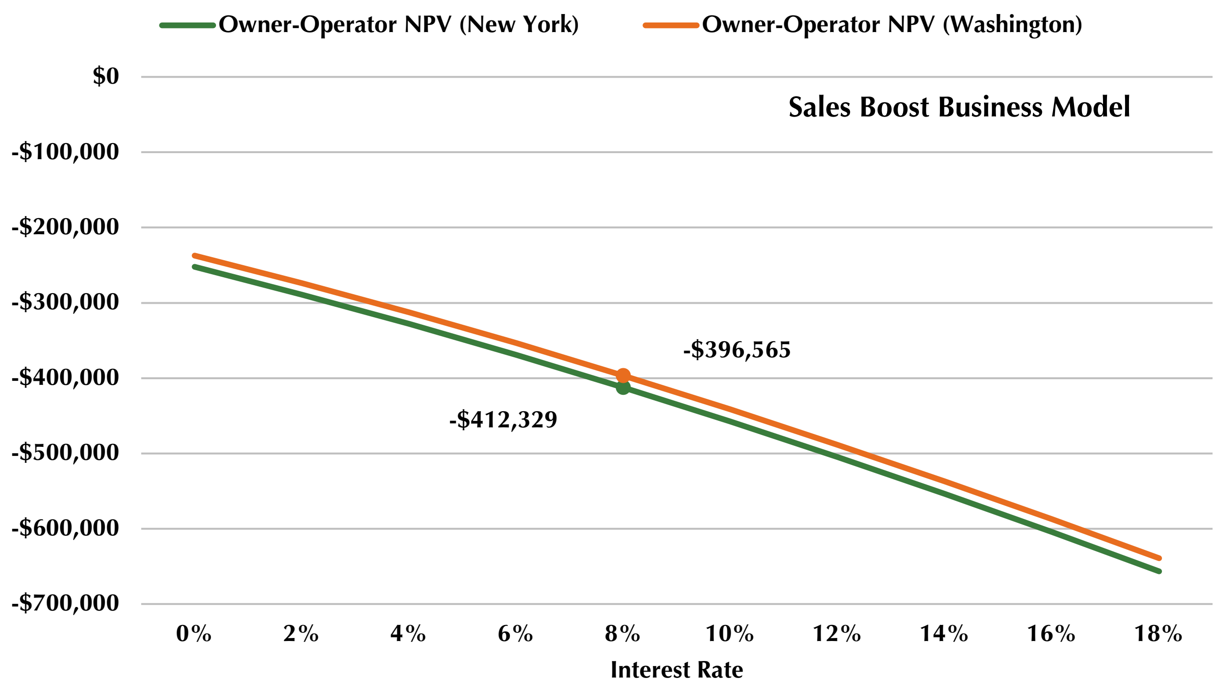
- California's zero emissions vehicle (ZEV) program requires automakers to make vehicles with zero-emission (all-electric or hydrogen fuel cell) vehicles available for sale in the state in increasing numbers, reaching 15 percent of new vehicles by 2025. Nine states in addition to California currently follow the program.[67] The steep curve will be difficult to meet for most states that do not have California's complementary programs, such as a vehicle rebate program, a cap-and-trade program, and an LCFS. Though the program could lead to notable increases in EV deployment, a lack of complementary programs in states decreases the certainty of the program's effect on EV deployment.
- New building codes to prepare EV-ready buildings affect new or remodeled buildings. While these building codes are generally cost-effective and would greatly reduce the cost of installing infrastructure, they would have a small effect on the existing built environment. Creating a scenario analysis would require projections not only for charging infrastructure, but for real estate markets across entire states. Variations on building codes for types of buildings (municipal, commercial, public lots) and requirements unique to cities and rural areas further complicate projections.
- Consumer education may be a valuable tool to ease public understanding of EVs and the basic uses of charging infrastructure, but the effects of a consumer education campaign could not be projected with any great accuracy. Such campaigns could be undertaken at a national, regional, state, or city level through a variety of media and would require broad estimations of behavior change.

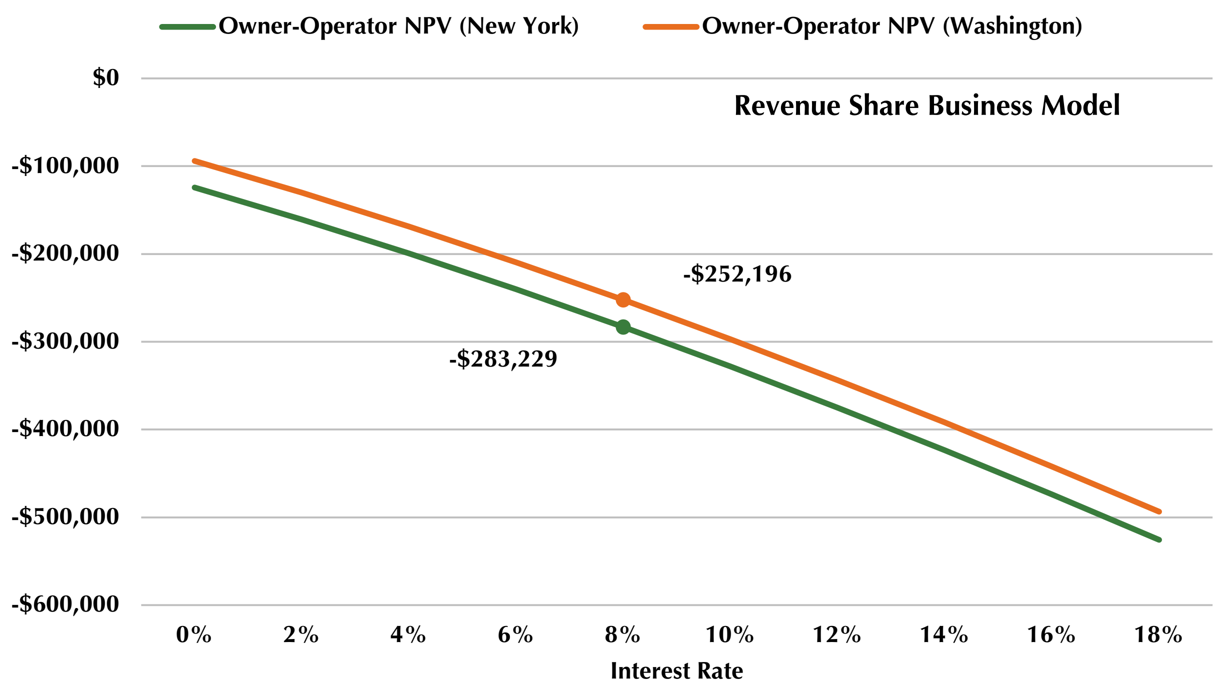
Access to low-cost funds can greatly improve the financial performance of the owner-operator. For projects that are at high risk of losing money, such as many EV charging projects under present market conditions, private finance institutions will increase their interest rates to protect against the chance of default. For those EV charging projects that are unable to make a profit, the cost of this high-interest debt can greatly decrease the NPV for the owner-operator since revenues are unable to keep up with debt payments. As the interest rate increases, the debt problem is exacerbated, as is illustrated by the application of both business models to charging projects in New York and Washington.

For the sales boost business model, at 0 percent interest, the NPV for the owner-operator is -$252,274 and -$237,456 for New York and Washington, respectively. At the baseline assumption rate (8 percent) the NPV for the owner-operator decreases to -$412,329 and -$396,565 for New York and Washington, respectively. At 18 percent interest, the NPV for the owner-operator decreases by 59 percent (-$656,494) and 61 percent (-$639,289) for New York and Washington, respectively (see **Figure 16**).

For the revenue sharing business model, at 0 percent interest, the NPV for the owner-operator is -$124,352 and -$93,917 for New York and Washington, respectively. At the baseline assumption rate (8 percent), the NPV for the owner-operator decreases to -$283,229 and -$252,196 for New York and Washington, respectively. At 18 percent interest, the NPV for the owner-operator decreases by 86 percent (-$525,598) and 96 percent (-$493,651) for New York and Washington, respectively (see **Figure 16**).

FIGURE 16: **Effects of Debt Cost (Interest Rate) on Owner-Operator NPV**





The charging projects in Washington and New York assume 60 percent of the project capitalization cost is financed through debt. The baseline interest rate used was 8 percent, as indicated in this figure.

The state governments' access to low-cost capital in New York and Washington can greatly improve owner-operators' financial performance with the sales boost and revenue sharing business models. State governments in Washington and New York have access to low-cost capital that they could make available to charging project developers through a low-interest loan program. It was assumed that Washington could lend funds at 5.4 percent and New York could lend at 3 percent. Using these loan rates in the sales boost business model would increase an owner-operator's NPV by 25 and 14 percent in New York and Washington, respectively. Using these loan rates in the revenue sharing business model would increase an owner-operator's NPV by 37 and 22 percent in New York and Washington, respectively (see **Table 13**). In both projects, the owner-operator is financing 60 percent of the project's total capitalization costs through a publicly supported low-interest loan program. The remaining 40 percent of the project's total capitalization costs is funded through equity.

TABLE 13: Effects of Low-Cost Capital on Owner-Operator NPV and Payback

	WASHINGTON (5.4% INTEREST RATE)		NEW YORK (3% INTEREST RATE)	
	NPV	Percentage Increase from Baseline	NPV	Percentage Increase from Baseline
Sales Boost Business Model				
State Rate	-$341,063	14%	-$308,153	25%
8% (Baseline)	-$396,556	N/A	-$412,329	N/A
Revenue Sharing Business Model				
State Rate	-$196,983	22%	-$179,820	37%
8% (Baseline)	-$252,196	N/A	-$283,229	N/A

The table below shows the owner-operator's NPV is improved by a range of 14 to 37 percent by borrowing 60 percent of total capitalization costs for the project through a publicly supported low-interest loan program. Washington could lend funds at 5.4 percent and New York could lend at 3 percent.

Public grants can significantly lower the upfront cost of a charging project and allow an owner-operator to achieve payback for the sales boost and revenue sharing business models. At the outset of the EV market, much of the publicly available charging infrastructure was subsidized through public grants, mostly from the federal government. In many cases, these grants covered all or most of the equipment and/or installation costs. Much lower grants are required for the owner-operator to achieve payback in less than five years for Washington and New York projects that implement the sales boost and revenue sharing business models. Grants totaling 40 percent of the total capitalization costs (or 100 percent of the share of equity) would allow both Washington projects and the sales boost project in New York to achieve payback in a year or less. The owner-operator would have a 4-year payback at that grant level for the revenue sharing project in New York. See **Table 14** for the effects of public grants on the owner-operator NPV and payback.

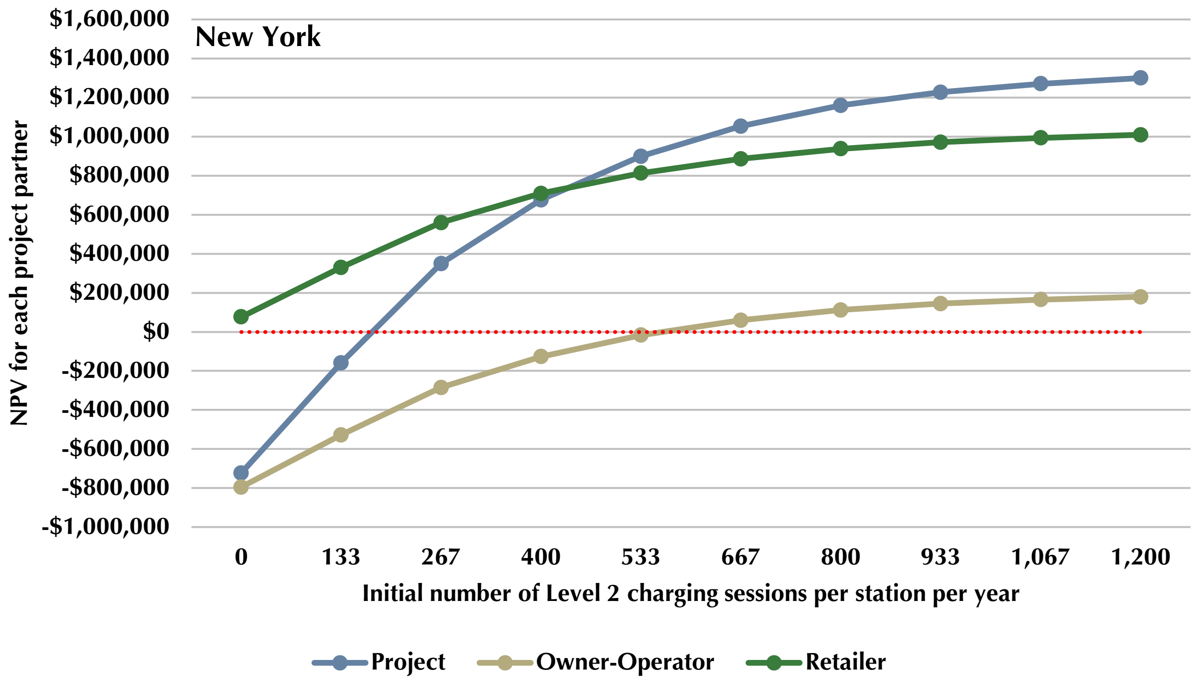
TABLE 14: Effects of Public Grants on Owner-Operator NPV and Payback

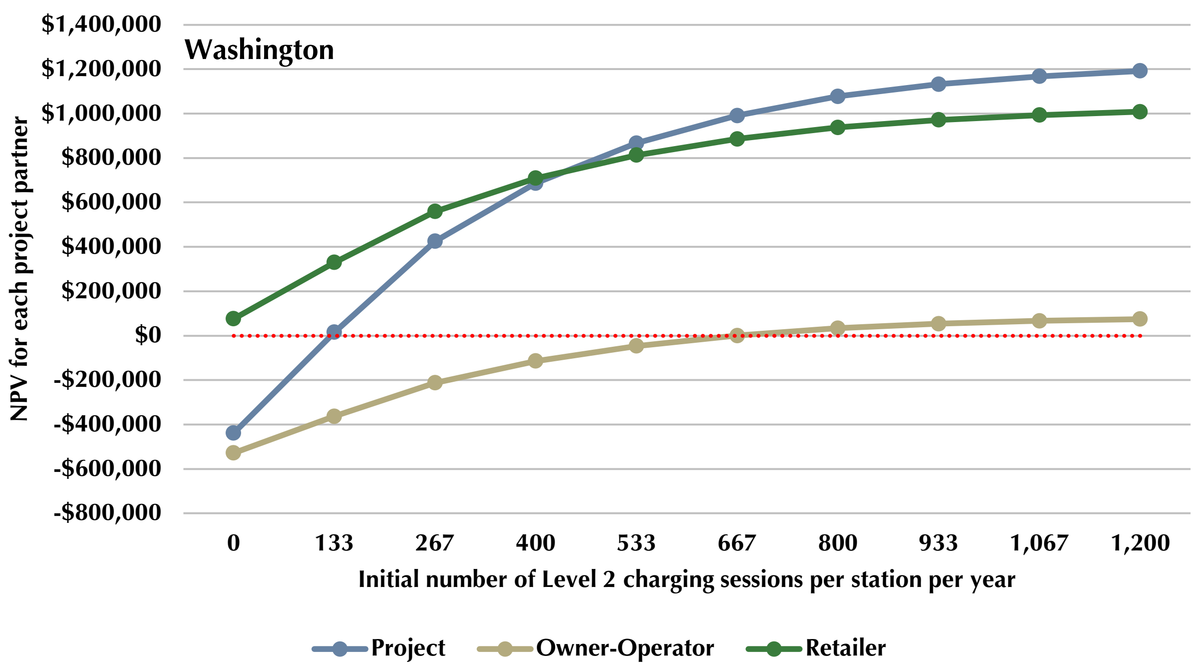
GRANT AS PERCENTAGE OF EQUITY	SALES BOOST BUSINESS MODEL		REVENUE SHARING BUSINESS MODEL	
	Washington	New York	Washington	New York
0%	-$396,565	-$412,329	-$252,196	-$283,229
25%	-$258,741	-$273,685	-$115,091	-$145,606
50%	-$120,916	-$135,041	$22,014 (10)	-$7,982
75%	$16,909 (9)	$3,602 (10)	$159,118 (7)	$129,642 (8)
100%	$154,733 (1)	$142,245 (1)	$296,223 (1)	$267,265 (4)

This table shows the effect of different levels of public grants as a share of equity. The charging projects assume that 40 percent of the initial project capitalization comes from equity and 60 percent is from debt. At levels between 75 and 100 percent, the owner-operator is able to achieve a payback in less than five years, an objective of many private investors. For projects that are profitable, the payback period in years is shown in parentheses.

Vehicle incentives can grow the EV market, resulting in increased charging station utilization that can enable an owner-operator to achieve profitability with the revenue sharing business model. The state vehicle incentive would increase annual station utilization growth for DC fast charging and Level 2 charging stations from 15 to 22 percent. As a result, the charging projects in Washington and New York would be profitable for an owner-operator if the number of annual Level 2 charging sessions begins at 667 (approximately 1.8 sessions per day) or greater. The payback period ranges from 7 to 9 years, which is likely too long a duration for most private investors. The 667 sessions represent an increase of 67 percent from the baseline number of annual sessions, 400. For both projects, the increased EV market did not change the number of initial DC fast charging sessions in this scenario, set to 1,200 per year and growing at 22 percent per year. See **Figure 17** for the effect of Level 2 charging station utilization on the profitability of the charging projects in Washington and New York.

FIGURE 17: Increasing Utilization Improves the Financial Performance for Owner-Operator with Revenue Sharing Business Model





These figures show the effects of a higher utilization growth rate (from 15 to 22 percent per year) and Level 2 charging station use on the profitability of an application of the revenue sharing business model in New York and Washington. The graph shows the effects on the owner-operator NPV of changing the initial utilization of Level 2 charging stations in the network. The baseline number of initial DC fast charging sessions is 1,200 per year, the baseline number of initial Level 2 charging sessions is 400 sessions per year, and the maximum number of Level 2 session per year is 1,200.

A combination of low-interest loans, grants, and vehicle purchase incentives can make the revenue sharing business model attractive to private investors in Washington and New York. For charging projects that begin in the near term and with government interventions, the revenue sharing business model can achieve payback in five years in Washington and New York. The interventions include a low-interest loan for 60 percent of the project debt, a grant covering 75 percent of the charging equipment cost, and a 5-year EV purchase incentive. For Washington, the vehicle incentive is an extension of the existing all-electric vehicle sales tax exemption, and in New York, the incentive is a rebate on EVs of up to $2,500. The results in Washington are a profit of +$324,426 for the owner-operator at a cost of $411,315 to the government. The results in New York are a profit of +$343,843 for the owner-operator at a cost of $356,785 to the government.

Assuming the 5-year EV purchase incentive takes effect immediately and the EV market continues to grow, a project beginning in five years will also be profitable for an owner-operator, without any additional public incentives. More favorable market conditions, such as higher utilization rates and lower upfront costs for charging equipment, will reduce initial capitalization costs and improve the revenue streams of future projects. As a result, the owner-operator achieves an NPV of +$380,272 and payback in five years in Washington and +$421,873 and payback in five years in New York. The complete results of the near-term and future project are summarized in **Table 15** and **Table 16** for Washington and New York, respectively.

TABLE 15: Financial Performance of Revenue Sharing Business Model in Washington

FINANCIAL METRIC	NEAR-TERM	5 YEARS IN FUTURE
Total project level perspective		
Total capital investment (spent on charging station deployment)	$1,371,049	$1,275,630
NPV	+$729,571	+$1,480,475
Payback period	7 years	3 years
Owner-operator perspective		
Funds spent on stations (equity)	$137,105	$510,252
Funds spent on stations (debt, private loans)	$329,052	$765,378
Funds spent on stations (debt, public subsidized loans)	$493,577	$0
NPV	+$324,426	+$380,272
Payback period	5 years	5 years
Retailer perspective		
Amount of funds transferred to owner operator initially	$0	$0
Amount of funds transferred to owner operator annually	$28,000 - $84,125	$62,275 - $84,125
NPV	+$708,919	+$981,400
Payback period	1 years	1 years

FINANCIAL METRIC	NEAR-TERM	5 YEARS IN FUTURE
Public sector perspective		
Loan to owner-operator	$493,577	N/A
Grants to owner-operator	$411,315	N/A
NPV	-$411,315	N/A
Payback period	No payback	N/A

This table shows the financial performance of projects with near-term public incentives and subsequent projects with no incentives five years in the future. For the near-term projects, the incentives include a 10-year, low-interest loan to cover a sharing of the cost of the project debt. In addition, a grant is issued to subsidize the costs of charging station equipment via a cash transfer to the owner-operator. Finally, in Washington, the sales tax exemption for all-electric vehicles is extended for five years. In New York, a rebate is instituted for EVs at up to $1,500 for plug-in hybrid electric vehicles and $2,500 for all-electric vehicles; the rebate would last for five years.

TABLE 16: Financial Performance of Revenue Sharing Business Model in New York

FINANCIAL METRIC	NEAR-TERM	5-YEARS IN FUTURE
Total project level perspective		
Total capital investment (spent on charging station deployment)	$1,376,236	$1,287,171
NPV	+$787,944	+$1,524,080
Payback period	7 years	3 years
Owner-operator perspective		
Funds spent on stations (equity)	$137,624	$514,868
Funds spent on stations (debt, private loans)	$330,297	$772,303
Funds spent on stations (debt, public subsidized loans)	$495,445	$0
NPV	+$343,843	+$421,873
Payback period	5 years	5 years
Retailer perspective		
Amount of funds transferred to owner operator initially	$0	$0
Amount of funds transferred to owner operator annually	$28,000 - $84,125	$62,275 - $84,125
NPV	+$708,919	+$981,400
Payback period	<1 year	1 years

FINANCIAL METRIC	NEAR-TERM	5-YEARS IN FUTURE
Public sector perspective		
Loan to owner-operator	$495,445	N/A
Grants to owner-operator	$412,871	N/A
NPV	-$412,871	N/A
Payback period	No payback	N/A

This table shows the financial performance of projects with near-term public incentives and subsequent projects with no incentives five years in the future. For the near-term projects, the incentives include a 10-year, low-interest loan to cover a share of the cost of the project debt. In addition, a grant is issued to subsidize the costs of charging station equipment via a cash transfer to the owner-operator. Finally, in Washington, the sales tax exemption for all-electric vehicles is extended for five years. In New York, a rebate is instituted for EVs at up to $1,500 for plug-in hybrid electric vehicles and $2,500 for all-electric vehicles; the rebate would last for five years.

A combination of low-interest loans, grants, and vehicle incentives can greatly improve the financial performance of the sales boost business model as illustrated in Washington and New York. For projects that begin in the near term, these policies lower the upfront costs and boost charging use enough for an owner-operator to achieve payback in less than five years, a key objective for many private investors. The interventions include a low-interest loan for 70 percent of the project debt, a grant covering 80 percent of the charging equipment cost, and a 5-year EV purchase incentive. For Washington, the vehicle incentive is an extension of the existing all-electric vehicle sales tax exemption, and in New York, the incentive is a rebate on EVs of up to $2,500. The results in Washington are a profit of +$214,335 for the owner-operator at a cost of $468,605 to the government. The results in New York are a profit of +$227,674 for the owner-operator at a cost of $443,660 to the government.

Assuming the 5-year EV incentive takes effect immediately and the EV market continues to grow, a project that begins in five years achieves a payback of eight years in Washington and six years in New York, without any additional public incentives. These examples show that short-term public incentives could help develop the EV market and encourage private investments in EV charging in the near, medium, and long term. More favorable market conditions, such as higher utilization rates and lower upfront costs for charging equipment, will reduce initial capitalization costs and improve the revenue streams of future projects. Although the financial performances of these projects are significantly improved over projects that would begin today, the payback periods may take too long for many private investors. **Table 17** and **Table 18** summarizes the financial performance of the sales boost business model in Washington and New York, respectively.

TABLE 17: Financial Performance of Sales Boost Business Model in Washington

FINANCIAL METRIC	NEAR-TERM	5-YEARS IN FUTURE
Total project level perspective		
Total capital investment (spent on charging station deployment)	$1,378,249	$1,314,402
NPV	-$214,318	+$180,330

FINANCIAL METRIC	NEAR-TERM	5-YEARS IN FUTURE
Payback period	No payback	7 years
Owner-operator perspective		
Funds spent on stations (equity)	$82,695	$525,761
Funds spent on stations (debt, private loans)	$248,085	$788,641
Funds spent on stations (debt, public subsidized loans)	$578,864	$0
NPV	+$214,335	+$94,154
Payback period	5 years	8 years
Automaker perspective		
Amount of funds transferred to owner operator initially	$100,000	$100,000
Amount of funds transferred to owner operator annually	$0	$0
NPV	+$46,505	+$46,505
Payback period	5 years	5 years
Public sector perspective		
Loan to owner-operator	$578,864	N/A
Grants to owner-operator	$468,605	N/A
NPV	-$468,605	N/A
Payback period	No payback	N/A

This table shows the financial performance of projects with near-term public incentives and subsequent projects with no incentives five years in the future. For the near-term projects, the incentives include a 10-year, low-interest loan to cover a share of the cost of the project debt. In addition, a grant is issued to subsidize the costs of charging station equipment via a cash transfer to the owner-operator. Finally, in Washington, the sales tax exemption for all-electric vehicles is extended for five years. In New York, a 5-year rebate is instituted for EVs at up to $1,500 for plug-in hybrid electric vehicles and $2,500 for all-electric vehicles.

TABLE 18: Financial Performance of Sales Boost Business Model in New York

FINANCIAL METRIC	NEAR-TERM	5-YEARS IN FUTURE
Total project level perspective		
Total capital investment (spent on charging station deployment)	$1,386,436	$1,295,103
NPV	-$160,159	+$297,442
Payback period	No payback	6 years
Owner-operator perspective		
Funds spent on stations (equity)	$110,915	$518,041
Funds spent on stations (debt, private loans)	$249,559	$777,062
Funds spent on stations (debt, public subsidized loans)	$582,303	$0

FINANCIAL METRIC	NEAR-TERM	5-YEARS IN FUTURE
NPV	+$227,674	+$192,203
Payback period	5 years	6 years
Automaker perspective		
Amount of funds transferred to owner operator initially	$130,000	$130,000
Amount of funds transferred to owner operator annually	$0	$0
NPV	+$60,456	+$60,456
Payback period	5 years	5 years
Public sector perspective		
Loan to owner-operator	$582,303	N/A
Grants to owner-operator	$443,660	N/A
NPV	-$443,660	N/A
Payback period	No payback	N/A

This table shows the financial performance of projects with near-term public incentives and subsequent projects with no incentives five years in the future. For the near-term projects, the incentives include a 10-year, low-interest loan to cover a share of the cost of the project debt. In addition, a grant is issued to subsidize the costs of charging equipment via a cash transfer to the owner-operator. Finally, in Washington, the sales tax exemption for all-electric vehicles is extended for five years. In New York, a 5-year rebate is instituted for EVs at up to $1,500 for plug-in hybrid electric vehicles and $2,500 for all-electric vehicles.

Summary: Public Sector Interventions that Improve Charging Project Financial Performance

Public policy interventions can make private investments in public charging projects profitable in the near term. A 5-year EV purchase incentive can help to grow the EV the market and make some charging projects financially attractive without additional public subsidies.

The combination of policies considered in this analysis address the three key challenges to private investment in publicly available charging:

- Publicly funded grants lower initial capitalization costs enabling the revenue sharing and sales boost business models to reach payback far quicker than they would otherwise.
- Low-interest loans lower the cost of funds during the project and provide private developers with access to capital that they may not be able to attain at a reasonable cost due to uncertainty over demand for charging services.
- Vehicle purchase incentives encourage EV adoption thereby increasing public charging station use, which will increase revenue streams for the revenue sharing business model and encourage automakers to invest in charging infrastructure via the sales boost business model.

As illustrated above, policy interventions can make a significant difference in the near term. For example, charging projects in Washington and New York can be profitable for an owner-operator with a payback period of five years or less, with public policy support. With a 5-year vehicle purchase incentive, a growing EV market can make charging projects that begin five years in the future profitable in both states without additional public incentives. For applications of the revenue sharing business model, payback is expected to be less than five years, while the sales boost business model projects have a payback period that may be too long for many private investors.

III. CONCLUSIONS

More publicly available charging will be needed to grow the EV market and accommodate the daily travel needs of EV drivers. This infrastructure enables travel to more locations, provides charging for drivers without convenient access to home charging, and increases consumer confidence that the technology is here to stay. Currently, the business case for private investment in this infrastructure is challenging because of the high upfront costs of equipment and installation, demand uncertainty for these charging services, and the consumers' willingness to pay for public charging.

Three main factors could affect the financial viability of a charging project. First, the consumers' willingness to pay for publicly available charging must be considered. Although EV drivers use public charging less than charging at home or the workplace, it serves a critical need for a growing EV market. For charging service providers, the charging fee level and the cost that charging providers must pay for electricity make up the largest component of the operating profit margin. The larger the price differential, the larger the benefit to the direct revenue stream for a station owner-operator.

Second, the 10 largest EV state markets offer insight into the changing needs of public charging for EV drivers. As EV technology advances and EV driver behavior changes, the largest EV markets will likely continue to be a source of information on the amount and type of charging infrastructure needed for a robust market.

Finally, market opportunities for both DC fast charging and Level 2 charging stations exist, but investors must carefully select charging locations in order to build a robust network that attains a sufficient amount of average station use. Opportunities exist to install Level 2 charging in areas with high concentrations of EVs and little existing public infrastructure. In addition, adding DC fast charging locations can accommodate drivers without access to home charging and help to connect population centers as well as commercial and tourist areas.

Considering these three factors, constructing a business case for both DC fast charging and Level 2 charging projects is challenging under current market conditions. Investors are very unlikely to make a profit through a business model that has a revenue stream based solely on provision of charging services, and therefore must identify new revenue streams and methods to reduce upfront costs. The four general strategies to improve a charging station business model are: increasing revenues, decreasing capital costs, decreasing operating costs, and decreasing the cost of funds. Generally, a successful business model must achieve profitability within a five-year payback period to accommodate most private investors.

One strategy to increase revenues is to capture the indirect revenue that publicly available charging stations may provide to the private sector. For example, retailers could value increased sales and revenue by hosting charging stations, or automakers could value charging station deployment to increase EV sales. Capturing some of this indirect revenue through new business models will materially improve charging project financial performance for the owner-operator. However, current market conditions indicate these new business models are unlikely to achieve profitability within five years.

In the near term, public interventions can help make these business models profitable and grow the EV market. Three key public interventions that directly address financial barriers to investment in charging projects are grants, low-interest loans, and vehicle purchase incentives. Using a combination of these incentives, this guide demonstrated that charging projects in New York and Washington state can achieve profitability within a payback period that is attractive to private investors. With these near-term policies in place, and assuming the EV market continues to grow, applications of these business models in five years can be profitable without additional public incentives. As a result, action in the near term can induce a virtuous cycle that accelerates private investment and, thus, the development of a robust publicly charging EV network.

APPENDIX A: ADDITIONAL RESOURCES

Additional Information Related to Key Market Factors

The following resources provide additional insights into the key market factors that may affect the financial performance of a charging project.

- **EV availability**: Fueleconomy.gov has information on availability, fuel economy, and the cost of ownership of all-electric and plug-in hybrid vehicles. More information is available at www.fueleconomy.gov.
- **Publicly available charging infrastructure availability**: The U.S. Department of Energy Alternative Fuel Data Center has an interactive map of the publicly available charging infrastructure in the United States. The database is updated monthly. See www.afdc.energy.gov/locator/stations.
- **Local gasoline prices**: AAA provides gasoline prices updated weekly by state and local markets. See http://fuelgaugereport.aaa.com/todays-gas-prices.
- **State electricity prices**: OpenEI collects electricity rates for electric utilities nationwide. The database relies on user generated content to keep information up to date. See http://en.openei.org/wiki/Utility_Rate_Database.

More Information on Upfront Costs and Station Utilization Uncertainty

The following resources provide additional insights into the key market factors that may affect the financial performance of a charging project.

- **Charging and EV use**: The Idaho National Laboratory has a number of useful reports on EV charging use and EV travel through the EV Project. See http://avt.inl.gov/evproject.shtml.
- **State regulatory framework for EVs**: C2ES has a number of interactive maps on the state policy for EVs, including incentives and other public policies related to EVs. See www.c2es.org/initiatives/pev/maps.
- **Barriers to private investment in EV charging**: As part of this project, C2ES wrote a report on deployment barriers for alternative fuel vehicles and fueling infrastructure. See www.c2es.org/publications/alternative-fuel-vehicle-amp-fueling-infrastructure-deployment-barriers-amp-potential-r.
- **Siting and other guidelines for charging station installation**: C2ES summarized the lessons learned from reports by 16 government, educational, and nonprofit groups to advance the deployment of EVs. Participants in projects across 24 states and the District of Columbia spent 18 months assessing the barriers to and opportunities for PEV deployment in their regions and preparing and executing readiness plans. See http://www1.eere.energy.gov/cleancities/electric_vehicle_projects.html.

More Information on Business Models for Publicly Available Charging

The following resources provide additional information on business models that could improve the financial performance of a charging project.

- **Business Models for Financially Sustainable EV Charging Networks**: A 2015 study by C2ES for the Washington State Legislature to develop new business models that will foster private sector commercialization of publicly available EV charging services and expand the role of private sector investment in EV charging throughout the state. See www.c2es.org/publications/business-models-financially-sustainable-ev-charging-networks.

APPENDIX B: EV CHARGING FINANCIAL ANALYSIS TOOL

To evaluate the financial performance of an EV charging project, C2ES and Cadmus Group developed the EV Charging Financial Analysis Tool. The tool can analyze a variety of alternative EV charging investment arrangements under a wide range of market assumptions. The tool uses the discounted cash flow analysis method to determine the expected financial returns for EV charging infrastructure investments over the expected lifetime of the charging equipment based on inputs provided by the user. The tool also provides financial viability metrics from the perspective of both private and public sectors as well as sensitivity analyses for key inputs and assumptions.

The tool can estimate the performance of a charging station deployment project from four distinct perspectives:

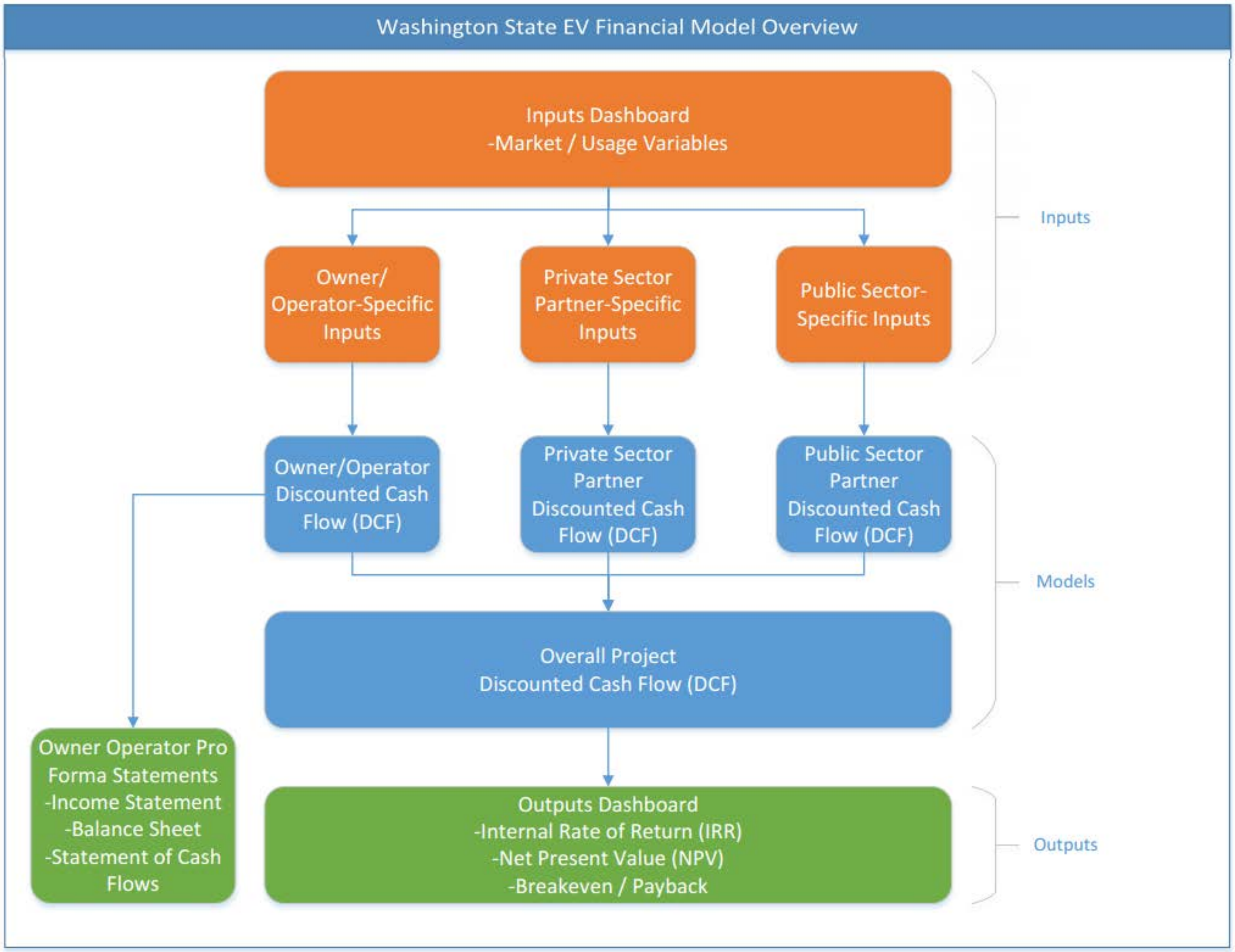
- Charging station project owner-operator
- External project partner (e.g., large business funding partner funder, tourism bureau, chamber of commerce, or a group of local businesses contributing to a deployment "funding pool")
- State or local government
- Total project performance as a whole as if all of the entities' perspectives are combined into a single entity

Each perspective was modeled with its own discounted cash flow analysis, which allows for calculation of project cash flows, internal rates of return, and payback to be calculated from each perspective. In addition, the charging station project owner-operator perspective is modeled as a standalone business, with income statements, balance sheets, and cash flows that encapsulate the performance of the charging services business as an independent entity (not simply as a small project conducted by a larger existing company). The model is also capable of accounting for business funding partners or funding pool contributors who also act as charging station owner-operators. An overview of the EV Charging Financial Analysis Tool structure is presented in **Figure 18**.

There are four categories of user input:

- **Market inputs**: Contains inputs related to the expected overall demand for EV charging services and expected growth in that demand. The user can select one of two options for entering expected charging station utilization. The first option attempts to derive utilization from traffic patterns along the route. The second option allows the user to enter utilization numbers directly.
- **Owner-operator inputs**: Contains inputs for the owner-operator organization, including unique information on up to three kinds of charging equipment, revenue sources, additional costs, assumptions regarding how the investment will be funded, and assumptions used in the production of a set of financial statements for the owner-operator.
- **Private sector partner inputs**: Contains inputs related to the revenue sources and costs for the private sector partner. The tool allows for three sources of revenue: revenue from site leasing, revenue from sales due to increased traffic at the site, and indirect revenue (revenue unrelated to time spent by the customer at a charging site). These can be used in conjunction with each other or independently. The user can also customize the amount of revenue that be shared with the owner operator and whether the private sector partner will provide a subsidy
- **Public sector partner inputs**: Contains inputs that define the involvement of the public sector including whether the public sector will provide low interest debt, equity, a one-time grant, or ongoing financial support.

FIGURE 18: Overview of EV Charging Financial Analysis Tool Structure



The Tool contains a dashboard of outputs that displays key performance metrics for each of the partners. Financial metrics include:

- **Total capital investment**: The total outlay of funds by all participating organizations.
- **Net present value (NPV)**: Shows the net profit or loss an investment by summing incoming and outgoing cash flows over the expected lifetime of the charging equipment and adjusting for the time value of money. A positive NPV indicates an investment will result in a net profit in today's money. A negative NPV indicates a net loss in today's money.
- **Internal rate of return**: Measures the profitability of an investment. Expressed in an annual rate.
- **Discounted payback**: A simple payback (or breakeven measure) based on cash flows adjusted for the time value of money.

The dashboard also displays non-financial metrics like number of charging sites, number of new stations, projected number of charging sessions provided over the 10-year analysis timeframe and charging energy provided.

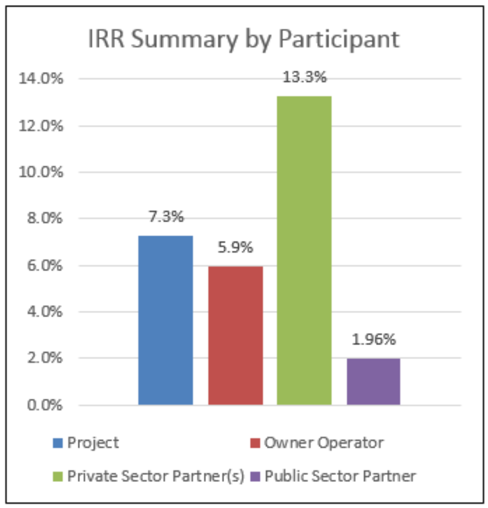
FIGURE 19: **Sample of the Dashboard Output for the EV Charging Financial Analysis Tool**

Financial Performance Statistics

Project		
Total Capital Investment	$	1,409,000
Total Net Present Value	$	410,681
Total Internal Rate of Return (IRR)		7.3%
Discounted Payback (Years)		8.0
Owner Operator		
Total Capital Investment (Equity)	$	563,600
Total Net Present Value	$	167,743
Total Internal Rate of Return (IRR)		5.9%
Discounted Payback (Years)		8.0
Private Sector Partner(s)		
Total Capital Investment	$	-
Total Other Contributions	$	1,336,350
Total Net Present Value	$	151,763
Total Internal Rate of Return (IRR)		13.3%
Discounted Payback (Years)		7.0
Public Sector Partner		
Total Capital Investment	$	253,620
Total Other Contributions	$	-
Total Net Present Value	$	27,257
Total Internal Rate of Return (IRR)		1.96%
Discounted Payback (Years)		9.0
Other Non-Partner Private Sector		
Total Capital Investment (Loans)	$	591,780

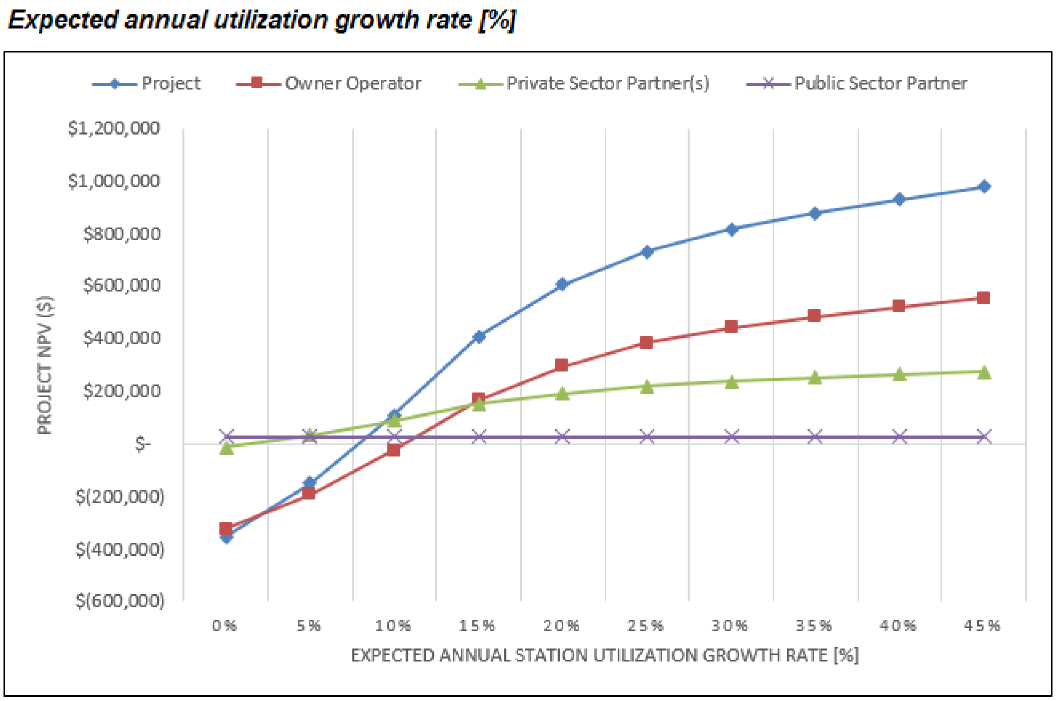
Charging Infrastructure Statistics

Total New Sites
20
Total New Stations
60
Number of Charging Sessions Provided
215,757
kWh of Charging Provided
2,562,110



The tool also provides a series of sensitivity analysis charts as output. The sensitivity analysis charts isolate a single input and run multiple versions of a scenario varying only that input. The chart shows how the results of the analysis would be different for each of the partners if that assumption was higher or lower than initially projected (all other inputs held equal). The figure below shows how the net present value of the scenario would change if the annual growth rate in charging station utilization were higher or lower than projected, over a range from 0 percent utilization to 45 percent utilization.

FIGURE 20: Example Sensitivity Analysis from the EV Charging Financial Analysis Tool



The Tool also includes a set of financial statements for the owner-operator. These statements include:

- **Income statement**: Shows the revenues, costs, and resulting income for the owner-operator over the expected lifetime of the charging equipment.
- **Balance sheet**: Shows the assets, liabilities, and resulting equity for the owner-operator over the expected lifetime of the charging equipment.
- **Statement of cash flows (SCF)**: Shows the flow of money in and out of owner-operator organization and the resulting cash balance over the expected lifetime of the charging equipment.

The financial statements may be of interest to potential partners in the private sector who are considering pursuing an owner-operator role.

APPENDIX C: FINANCIAL MODEL ASSUMPTIONS

The tables below contain the assumptions used with the EV Charging Financial Analysis Tool for the creation of this guide.

TABLE 19: Market Assumptions

PARAMETER	ASSUMPTION	SOURCE
Annual compounded growth rate in number of charging sessions	15%; 22% for policy intervention analyses	C2ES assumption
DC Fast Charging Station initial average utilization [# of charging sessions per station per year]	1,200 (3.3 sessions per day, in use 4% of a 24-hour day); 2,700 (5 years in the future)	C2ES assumption
Level 2 Charging Station initial average utilization [# of charging sessions per station per year]	400 (1.1 sessions per day, in use 7% of a 24-hour day); 900 (5 years in the future)	C2ES assumption

TABLE 20: Owner-Operator Assumptions

PARAMETER	ASSUMPTION	SOURCE
Charging Station Assumptions – DC Fast Charging Station (highway)		
Total number of stations [#]	8	C2ES assumption
Total number of sites [#]	8	C2ES assumption
Charging station equipment cost (per station) [$]	$35,000; $25,000 (5 years in the future)	Plug-In America and ABB Ltd.; C2ES assumption
Construction and equipment installation cost (per station) [$]	$26,000	Washington State Department of Transportation (WSDOT)
Electric utility upgrades and grid interconnection cost (per site) [$]	$20,000	WSDOT
Lease and property transaction costs (per site – one-time fee) [$]	$6,000	WSDOT
Host site identification and screening (per site) [$]	$5,000	WSDOT
Maximum number of charging sessions per station [sessions/year/station]	3,650 (10 sessions per day, in use 13% of a 24-hour day)	C2ES assumption

PARAMETER	ASSUMPTION	SOURCE
Average charging energy per session [kWh/session]	15 kWh	C2ES assumption
Maximum power draw [kW/session]	50 kW	C2ES assumption
Average time of charging session (minutes)	30 minutes	C2ES assumption
Per-energy user fee [$/kWh]	$0.518 per kWh; $0.505 per kWh	Based on energy-equivalent price of gasoline in New York; Based on energy-equivalent price of gasoline in Washington
Electricity retail price in first year [$/kWh]	$0.152 per kWh; $0.0694 per kWh	Average Commercial Electricity Price New York (2012); Average Commercial Electricity Price Washington (2012)
Annual compounded growth rate in electricity price [%]	0.25%	C2ES assumption
Demand charge [$/kW/month]	$8.32 per kW; $2.20 per kW	National Grid average demand charge for New York; Seattle City Light High Demand General Service Rates
Annual maintenance cost as percentage of equipment value [%]	3%	C2ES assumption
Host site lease or access cost (average per site/year) [$]	$1,200 per year	C2ES assumption
Charging Station Assumptions – Level 2 Charging Station		
Total number of stations [#]	10	C2ES assumption
Total number of sites [#]	10	C2ES assumption
Charging station equipment cost (per station) [$]	$2,500; $1,800 (5 years in the future)	WSDOT
Construction and equipment installation cost (per station) [$]	$4,000	Rocky Mountain Institute
Electric utility upgrades and grid interconnection cost (per site) [$]	$0	C2ES assumption
Lease and property transaction costs (per site – one-time fee) [$]	$6,000	WSDOT
Host site identification and screening (per site) [$]	$5,000	WSDOT
Maximum number of charging sessions per station	1,200 sessions (3.3 sessions per day, in use	C2ES assumption

PARAMETER	ASSUMPTION	SOURCE
[sessions/year/station]	21% of a 24-hour day)	
Average charging energy per session [kWh/session]	10 kWh	C2ES assumption
Maximum power draw [kW/session]	6.6 kW	C2ES assumption
Average time of charging session (minutes)	90 minutes	C2ES assumption
Per-energy user fee [$/kWh]	$0.456 per kWh; $0.2082 per kWh	Assume three times the price of electricity
Electricity retail price in first year [$/kWh]	$0.152 per kWh; $0.0694 per kWh	Average Commercial Electricity Price New York (2012); Average Commercial Electricity Price Washington (2012)
Annual compounded growth rate in electricity price [%]	0.25%	C2ES assumption
Demand charge [$/kW/month]	$8.32 per kW; $2.20 per kW	National Grid average demand charge for New York; Seattle City Light High Demand General Service Rates
Annual maintenance cost as percentage of equipment value [%]	3%	C2ES assumption
Host site lease or access cost (average per site/year) [$]	$1,200 per year	C2ES assumption
Charging Station Assumptions – DC Fast Charging Station (local)		
Total number of stations [#]	2	C2ES assumption
Total number of sites [#]	2	C2ES assumption
Charging station equipment cost (per station) [$]	$35,000; $25,000 (5 years in the future)	Plug-In America and ABB Ltd.; C2ES assumption
Construction and equipment installation cost (per station) [$]	$26,000	WSDOT
Electric utility upgrades and grid interconnection cost (per site) [$]	$20,000	WSDOT
Lease and property transaction costs (per site – one-time fee) [$]	$6,000	WSDOT
Host site identification and screening (per site) [$]	$5,000	WSDOT
Maximum number of charging sessions per station	3,650 (10 sessions per day, in use 13% of a	C2ES assumption

PARAMETER	ASSUMPTION	SOURCE
[sessions/year/station]	24-hour day)	
Average charging energy per session [kWh/session]	15 kWh	C2ES assumption
Maximum power draw [kW/session]	50 kW	C2ES assumption
Average time of charging session (minutes)	30 minutes	C2ES assumption
Per-energy user fee [$/kWh]	$0.518 per kWh; $0.505 per kWh	Based on energy-equivalent price of gasoline in New York; Based on energy-equivalent price of gasoline in Washington
Electricity retail price in first year [$/kWh]	$0.152 per kWh; $0.0694 per kWh	Average Commercial Electricity Price New York (2012); Average Commercial Electricity Price Washington (2012)
Annual compounded growth rate in electricity price [%]	0.25%	C2ES assumption
Demand charge [$/kW/month]	$8.32 per kW; $2.20 per kW	National Grid average demand charge for New York; Seattle City Light High Demand General Service Rates
Annual maintenance cost as percentage of equipment value [%]	3%	C2ES assumption
Host site lease or access cost (average per site/year) [$]	$1,200 per year	C2ES assumption
Additional Cost Assumptions		
General & Administrative costs as percent of revenues	5%	C2ES assumption
Initial Capitalization Assumptions		
Percent Equity Funded [%]	40%	C2ES assumption
Owner Operator Cost of Equity	10.25%	C2ES assumption
Owner Operator Cost of Debt (Long Term)	8%	C2ES assumption
Maximum Debt Term [years]	10 years	C2ES assumption
Expected equipment lifespan [years] - All equipment types	10 years	ABB Ltd.
Income Statement Assumptions		
Interest Expense Rate [%]	4.3%	C2ES assumption

PARAMETER	ASSUMPTION	SOURCE
(Revolving Line of Credit)		
Income Tax Rate [%]	31.6%	C2ES assumption
Projected Shares Outstanding (Millions)	1	C2ES assumption
Balance Sheet Assumptions		
Accounts Receivable [% of Revenue]	5%	C2ES assumption
Accounts Receivable [% of Revenue]	0%	C2ES assumption
Prepaid Expenses [% of Revenue]	0%	C2ES assumption
Maximum Debt Term [years]	10 years	C2ES assumption
Expected equipment lifespan [years] - All equipment types	10 years	ABB Ltd.

TABLE 21: Private Sector Partner Assumptions

PARAMETER	ASSUMPTION	SOURCE
Private Sector Weighted Average Cost of Capital (WACC)	10.3%	C2ES assumption
Private Sector Cost of Goods Sold [% of Revenue]	80%	C2ES assumption
Private Sector Marginal Tax Rate	31.6%	C2ES assumption
Retailer Assumptions		
Average expected revenue per customer per minute ($)	$1 per minute	C2ES assumption
Maximum retail revenue per customer per session ($)	$25	C2ES assumption
Annual customer revenue sharing agreement (from sales) [% of revenue]	5%	C2ES assumption
Automaker Assumptions		
Estimated NPV of lifetime after-tax profit per station – DC Fast Charging Station [$]	$17,500 for New York; $12,250 for Washington	C2ES assumption

PARAMETER	ASSUMPTION	SOURCE
Estimated NPV of lifetime after-tax profit per station – Level 2 Charging Station [$]	$1,050	C2ES assumption
Per Station Subsidy – DC Fast Charging Station[$]	$10,000 for New York; $7,000 for Washington	C2ES assumption
Per Station Subsidy – Level 2 Charging Station[$]	$600	C2ES assumption

TABLE 22: Public Sector Assumptions

PARAMETER	ASSUMPTION	SOURCE
Public Sector Cost of Capital [%]	3% for New York; 5.4% for Washington	Communication with Washington State Legislature and New York State Energy and Research Development Authority.
Public sector funded portion of debt [% of debt needed]	70% for sales boost and 60% for revenue sharing in New York; 70% for sales boost and 60% for revenue sharing in Washington	C2ES assumption
Term [years]	10 years	C2ES assumption
Rate (APR) [%]	3% for New York; 5% for Washington	C2ES assumption
Public sector funded portion of equity investment [% of equity needed]	0%	C2ES assumption
Non-shareholder contribution to capital (grants, etc.) [% of equity needed]	80% for sales boost and 75% for revenue sharing in New York; 85% for sales boost and 75% for revenue sharing in Washington	C2ES assumption

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$$Charging\ Station\ Value\ =\ EV\ to\ Charging\ Station\ Ratio\ \times\ Marketing\ Funds\ Per\ EV \times Charging\ Allocation$$

Assuming: auto dealers commonly spend up to 1 percent of total sales on marketing, or $300 for a $30,000 EV; the current ratio of charging stations to EVs in Washington is 14:1 and in New York is 13:1 for EVs and Level 2 charging station ports and 191:1 in Washington and 405:1 in New York for all-electric vehicles and DC fast charging locations; and an automaker allocates between 10 and 15 percent of its marketing budget to charging stations.

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$$Annual\ Charging\ Station\ Value$$
$$= Max(\$1\ \times Charging\ Session\ in\ Minutes, \$25) \times Annual\ Charging\ Sessions\ \times Share\ of\ Sales$$

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The Center for Climate and Energy Solutions (C2ES) is an independent non-profit, non-partisan organization promoting strong policy and action to address the twin challenges of energy and climate change. Launched in 2011, C2ES is the successor to the Pew Center on Global Climate Change.

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