Best Practices for Electric Vehicle Supply Equipment Installations in the National Parks

Challenges, Lessons Learned, Installation Best Practices, and Recommendations for the National Park Service

Kay Kelly,[1] Stacy Noblet,[2] and Abby Brown[2]

1 National Renewable Energy Laboratory
2 ICF

Produced under direction of the National Parks Service by the National Renewable Energy Laboratory (NREL) under IAG-16-2001 Mod 4.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Contract No. DE-AC36-08GO28308

Strategic Partnership Project Report
NREL/TP-5400-74806
December 2019

Best Practices for Electric Vehicle Supply Equipment Installations in the National Parks

Challenges, Lessons Learned, Installation Best Practices, and Recommendations for the National Park Service

Kay Kelly,[1] Stacy Noblet,[2] and Abby Brown[2]

1 National Renewable Energy Laboratory
2 ICF

Suggested Citation
Kelly, Kay, Stacy Noblet, and Abby Brown. 2019. *Best Practices for Electric Vehicle Supply Equipment Installations in the National Parks*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-74806. https://www.nrel.gov/docs/fy20osti/74806.pdf.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Contract No. DE-AC36-08GO28308

Strategic Partnership Project Report
NREL/TP-5400-74806
December 2019

National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

NOTICE

This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Support for the work was also provided by the National Parks Service under IAG-16-2001 Mod 4. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

Cover Photos by Dennis Schroeder: (clockwise, left to right) NREL 51934, NREL 45897, NREL 42160, NREL 45891, NREL 48097, NREL 46526.

List of Acronyms

AC	alternating current
BEV	battery electric vehicle
DC	direct current
DOE	U.S. Department of Energy
EV	plug-in electric vehicle
EVSE	electric vehicle supply equipment
GSA	General Services Administration
ICE	internal combustion engine
NPS	National Park Service
NREL	National Renewable Energy Laboratory
PHEV	plug-in hybrid electric vehicle

Table of Contents

1 Introduction 1
2 Electric Vehicle and Charging Overview 2
2.1 Electric Vehicles 2
2.2 Electric Vehicle Charging 2
2.3 Benefits of EVs in the National Parks 4
3 History of Charging in the National Parks 5
3.1 BMW 6
3.2 California Energy Commission 7
4 Challenges and Lessons Learned 8
4.1 Knowledge and Expertise 8
4.2 Project Coordination 8
4.3 Siting and Installation 9
4.4 Fee Collection 10
4.5 Park Conditions 11
4.6 Equipment Procurement 12
5 Installation Best Practices 14
5.1 Confirm the Need, Demand, and Feasibility 14
5.2 Project Scope and Management 14
5.3 Charging Equipment 15
5.4 Siting and Installation 16
5.5 Maintenance and Operation 17
5.6 Education and Outreach 17
6 Recommendations 19
6.1 Agency Procedures 19
6.2 Centralized Coordination 19
6.3 Education and Outreach 20
7 Conclusion 21

List of Figures

Figure 1: EVSE in National Parks 5
Figure 2. Charging at Great Smoky Mountains National Park. Bill Eaker, Land of Sky Clean Vehicles Coalition (Western North Carolina); Andrew Hudgins, NREL; and Jonathan Overly, East Tennessee Clean Fuels. Photo by Jonathan Overly, NREL 37373. 6
Figure 3. BMW EVSE installations in or en route to national parks 7
Figure 4. Charging at Shenandoah National Park. Photo by Margaret Smith, NREL 52265. 10
Figure 5. Charging at Petroglyph National Monument. Photo by Frank Burcham, Land of Enchantment Clean Cities (New Mexico) 11
Figure 6. Charging at Yellowstone National Park. Photo by Yellowstone Teton Clean Cities, NREL 35924 12
Figure 7. Networked vs. Non-Networked EVSE Capabilities 15
Figure 8. Non-networked EV charging station at Zion National Park, utilizing a keypad payment method. Codes are sold at park visitor centers at a set price. 16
Figure 9. Charging at Thomas Edison National Historical Park. Photo by David Rose, BMW of North America. 17
Figure 10. Catoctin Mountain Park advertises the availability of public charging infrastructure on their website. 18

List of Tables

Table 1. EV Characteristics 2
Table 2. EV Charging Characteristics 3

1 Introduction

In recent years, the National Renewable Energy Laboratory (NREL) and the National Park Service (NPS) have partnered to undertake a variety of projects intended to provide electric vehicle supply equipment (EVSE) to park visitors. Efforts to install charging infrastructure in the national parks have been underway for almost a decade, with installation projects as part of NPS partnerships with several organizations. These projects have been initiated through a variety of funding sources, such as coordinated donations and agreements with other governmental agencies including the U.S. Department of Energy (DOE).

This report captures challenges, lessons learned, and best practices from recent NPS EVSE projects based on interviews with NPS employees and stakeholders involved in the projects. The report summarizes notable takeaways and makes recommendations to help ensure the success of future charging installation projects. Preserving this information will be valuable for informing and ensuring the success of future charging installation efforts at national parks, as well as for organizations outside of NPS. Note that this report focuses on light-duty plug-in electric vehicle (EV) projects, though NPS is also pursuing medium- and heavy-duty EV efforts.

2 Electric Vehicle and Charging Overview

This section provides a brief introduction to EVs, including the different types of vehicles, how they charge, their benefits, and other considerations such as costs and operations. There are a number of existing resources available that also provide comprehensive overviews of this information, such as the Clean Cities Handbooks for public and workplace hosts, and fleet managers, and DOE's Alternative Fuels Data Center.

2.1 Electric Vehicles

All EVs can be plugged-in and powered solely by electricity; however, some are also powered using an engine and gasoline or conventional vehicle fuels (see Table 1).

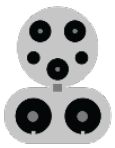
Table 1. EV Characteristics

Vehicle Type	Description	Example
Plug-in Hybrid Electric Vehicle (PHEV)	PHEVs are powered by an internal combustion engine (ICE) and an electric motor that uses energy stored in a battery. The vehicle can be plugged in to an electric power source to charge the battery. PHEVs can travel on either electricity or gasoline. The all-electric range of a PHEV can be from 10 to over 50 miles, depending on the model.	Mitsubishi Outlander
Battery Electric Vehicle (BEV)	BEVs use a battery to store the electric energy that powers the motor. A BEV does not have an ICE. BEV batteries are charged by plugging the vehicle in to an electric power source. The range of a BEV on a full charge can be over 300 miles, depending on the model.	Nissan Leaf

2.2 Electric Vehicle Charging

Charging equipment for EVs, also called EVSE, is available in different levels based on the rate that the battery is charged, and the type of power supplied; either alternating current (AC) or direct current (DC). The time needed to fully charge an EV will vary based on the size of the battery, how depleted the battery is, and the power supplied by the EV charging equipment. Table 2 provides an overview of EV charging levels, including the amount of range each level provides an EV and the connector types used. The charging power is measured in kilowatts (kW), and is determined by both the voltage, measured in volts (V), and the current measured in amps (A).

Table 2: EV Charging Characteristics

Charger Type	Maximum Charging Power (Common application)	Charging Rate	Connector(s)	
AC Level 1 (SAE J1772)	**1.9 kW AC power 120 V at up to 16 A** (1.4 kW cord-set)	2 to 5 miles of range per hour	J1772	
AC Level 2 (SAE J1772)	**19.2 kW AC power 208 V or 240 V at up to 80 A** (7.7 kW pedestal)	10 to 20 miles of range per hour	J1772	
DC Level 1 (J1772 CCS)	**80 kW DC power 50 to 1,000 V, up to 80 A** (50 kW public station)	60 to 80 miles of range in 20 minutes	J1772 Combo	
DC Level 2 (J1772 CCS)	**400 kW DC Power 50 to 1,000 V at up to 400 A**	Up to 200 miles of range in 20 minutes	J1772 Combo	
CHAdeMO v2.0	**400 kW DC power 120 to 1,000 V, up to 400 A** (50 kW public station)	60 to 80 miles of range in 20 minutes	CHAdeMO	
Tesla	**250 kW DC power** (120 kW Supercharger)	Up to 75 miles of range in 5 minutes	Tesla	

The cost of EV charging infrastructure varies based on charging level, the number of connectors, type of mounting (wall, pedestal), and additional features such as networking and communication capabilities. Typically, before incentives and installation costs, the price of Level 1 charging equipment can range from $300 to $1,500, Level 2 equipment can range from $400 to $6,500, and DC fast infrastructure can range from $10,000 to $40,000.[1] Installation costs can also vary greatly depending on the number of EV chargers installed, indoor versus outdoor installation, and any electrical upgrades required. Installation costs alone can range from $0 to $51,000 per unit.[2]

Reports with helpful information on charging infrastructure include:

- California Energy Commission's Electric Vehicle Charger Selection Guide
- DOE's Costs Associated with Non-Residential Electric Vehicle Supply Equipment

EV drivers have the flexibility to charge at a variety of locations, including home, work, and other destinations such as shopping centers, hotels, and restaurants. Many EV drivers also choose to travel to a variety of desired destinations, such as national parks.

Three primary categories of charging infrastructure are discussed in this report as they apply to NPS:

- **Public** charging infrastructure is available for park visitors. Public charging allows visitors with EVs to access the parks by providing opportunities to charge either on route or while visiting the park before returning to their original destinations. DC fast and Level 2 are typical of public charging locations.
- **Workplace** charging infrastructure is intended for use by NPS employees to charge their personal EVs, though it may also be available to park visitors during specified periods. Both Level 1 and Level 2 equipment is commonly used for workplace charging.
- **Fleet** charging infrastructure is designated for NPS fleet vehicles only and is not available for visitor or employee personal use. Because fleet vehicles are often parked for long periods of time (e.g., overnight), Level 1 and Level 2 charging is sufficient for light-duty vehicles.

2.3 Benefits of EVs in the National Parks

NPS supports the use of different transportation options for employees and visitors—including biking, walking, public transportation, and carpooling or vehicle sharing. That said, a private vehicle is often most convenient to get to national parks, especially when traveling to remote destinations. EVs align with NPS air quality, climate, transportation, and sustainability goals outlined in the 2016 Green Parks Plan by helping to reduce vehicle congestion, air pollution, and resource degradation, and preserving the long-term quality of the parks.

[1] Smith, Margaret and Jonathan Castellano. 2015. "Costs Associated with Non-Residential Electric Vehicle Supply Equipment." New West Technologies, LLC for the U.S. Department of Energy Vehicle Technologies Office. https://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf
[2] *ibid*

The benefits of EVs include:

- EVs have little or no tailpipe emissions (depending on the type of vehicle).
- Depending on the electricity generation mix, EVs have much lower GHG emissions than conventional vehicles. Even in areas that primarily use coal as an electricity source, EVs offer life-cycle GHG emissions reductions.[3] EVs also have the capability to use cleaner sources of electricity, such as solar and wind, to charge.
- The cost to charge an EV is much cheaper than the cost to fuel a conventional vehicle with gasoline, by about 50%. DOE's eGallon tool provides an up to date cost comparison.
- BEVs (and PHEVs when using electricity) are significantly quieter than conventional vehicles because they are not using an ICE, which can be noisy during operation. The quiet nature of EVs help keep the parks serene by lowering noise levels, which can be important for various wildlife habitats to flourish.

3 History of Charging in the National Parks

Efforts to install EV infrastructure in the national parks have been underway for almost a decade, ever since the first major auto manufacturers began offering EV models in 2010. With EVs becoming more mainstream and a viable transportation option for national park visitors as a result of increased battery ranges, NPS is ensuring that visitors can access the parks in their EVs by offering EV charging as an amenity. NPS has partnered with and completed charging installation efforts with several organizations, including DOE and BMW, and is currently working with the California Energy Commission to complete additional installations at national parks in California.

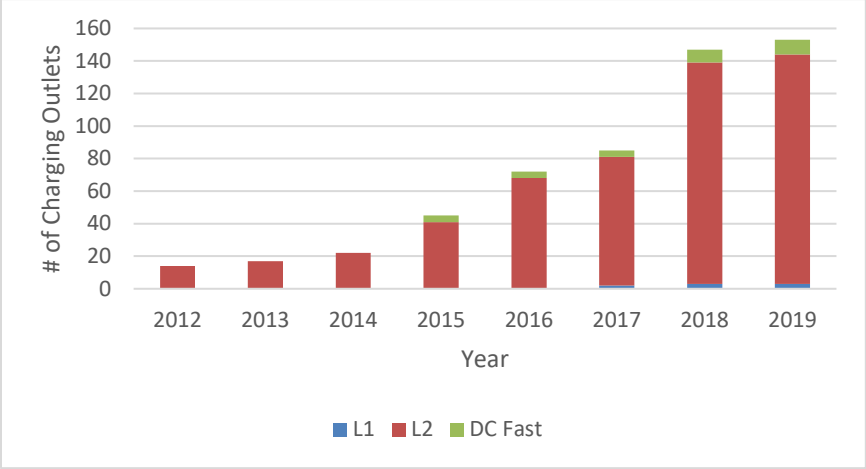


Figure 1: EVSE in National Parks

[3] AFDC. 2019. "Emissions from Hybrid and Plug-In Electric Vehicles." Alternative Fuels Data Center (AFDC). U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Vehicle Technologies Office. https://www.afdc.energy.gov/vehicles/electric_emissions.php

Figure 1 shows a timeline for the growth of public and private (i.e., workplace and fleet) charging availability in the national parks over time.

Building on a long-time partnership, DOE's Vehicle Technologies Office entered into a formal agreement with NPS in 2010, establishing the Clean Cities National Parks Initiative. The initiative supports transportation projects that educate park visitors on the benefits of shifting to alternative fuels, advanced vehicles, and fuel-saving technologies and strategies. Since the initiative began, the Vehicle Technologies Office and Clean Cities coalitions have partnered with NPS on 35 projects to put alternative fuel and fuel-efficient vehicles on the road, reduce vehicle idling, and improve vehicle efficiency.

This partnership has also included efforts to install charging infrastructure at the parks. Because early EVSE installations were relatively new at the time, information sharing on a regular basis was a key to success. To provide an avenue for parks to share their challenges and successes with one another, NPS and NREL convened EV charging forums on a regular basis. The forums were intended primarily for NPS staff involved in charging installation projects, with time for brief presentations on specific projects, question and answer, and conversations around available tools and resources.

The partnership between NPS and DOE continues to support the use of EVs and installation of EVSE service wide.

Figure 2. Charging at Great Smoky Mountains National Park. Bill Eaker, Land of Sky Clean Vehicles Coalition (Western North Carolina); Andrew Hudgins, NREL; and Jonathan Overly, East Tennessee Clean Fuels. Photo by Jonathan Overly, NREL 37373.

3.1 BMW

In 2016, as part of activities surrounding the NPS Centennial celebration, BMW and NPS entered into a partnership with the goal of helping to make EVs a feasible option for travel to

national parks. BMW donated funding to install Level 2 and DC fast EVSE both within park boundaries and at en route locations nearby to enable visitor EV travel. At the conclusion of the project in 2019, almost 100 EV charging installations were complete in park, en route, and in workplace and fleet locations. Key to the successful installation of these chargers was addressing the challenges and implementing the lessons learned from the Clean Cities National Parks Initiative projects, which will be discussed in detail in this report.

Figure 3. BMW EVSE installations in or en route to national parks

3.2 California Energy Commission

In 2017, the California Energy Commission and NPS entered into a multiyear agreement to fund Level 2 charging infrastructure in national park units throughout California. Visitors will benefit from access to this infrastructure as well as education about how EVs and charging stations can reduce fuel use and emissions. The project is expected to be complete by July 2020.

4 Challenges and Lessons Learned

To inform this report, more than 10 in-person and phone interviews were conducted with NPS staff, Clean Cities coordinators, concessioners, NREL staff, and others involved in charging installations at national parks. Each interviewee was asked about the specific project or projects they worked on, what was successful and what was not, what they would do differently, resources they felt were necessary but unavailable, and advice they could provide to inform future projects. The following section summarizes the recurring themes drawn from these interviews, including specific challenges and how those challenges were addressed or could be addressed in the future.

4.1 Knowledge and Expertise

Challenges

There is an overall lack of technical knowledge and assistance related to EV charging infrastructure. Ideally, project leads would have **access to a technical expert** to refer to throughout the project's duration to help determine charging levels, infrastructure needs, and siting expertise to prevent blocking of the charging infrastructure by traditional internal combustion engine (ICE) vehicles, a practice known as "ICEing." **Access to an electrical engineer** was also mentioned as a challenge, with some parks finding that they needed to subcontract with an entity able to provide electrical engineering support.

> *"It would be nice to have a technical person to talk to first to determine charging levels, infrastructure needs, and siting support to prevent ICEing."*

Lessons Learned

Involve a technical expert, such as a Clean Cities coordinator or outside consultant, and an electrical engineer in every project from the very beginning to ensure a successful charging station installation with minimal delays as a result of lack of knowledge.

> *"Every project needs technical support, which is immensely valuable, in addition to an electrical engineer, concessions specialist, and project manager."*

4.2 Project Coordination

Challenges

While EV charging installations are on the list of projects many parks wish to pursue, they are often not prioritized or feasible because of the time and coordination required to successfully install charging stations. In most cases, these projects are led by NPS staff who are already very busy with other responsibilities. Therefore, the projects typically did not move along as quickly as expected. External stakeholders, such as Clean Cities coordinators, were often willing to monitor and manage projects to keep things moving, but these individuals were not necessarily familiar with NPS processes or were not in a position to direct NPS staff.

Lessons Learned

Ensure that each project has a **dedicated project manager** for the duration of the installation of charging infrastructure, whether that is an NPS staff member or someone outside of the park

> *"We needed to monitor the project closely but did not have the support we needed within the park service to move the project along and prioritize it."*

service. If the project manager is not NPS park staff, designate a dedicated point person at the park in charge of moving the project forward internally, such as a sustainability or transportation lead.

At the start of the project, the project manager should **draft a timeline for the project** and use the timeline to keep those involved accountable for key milestones and progress. The project manager should **schedule regular and frequent meetings** with all relevant parties, holding them in-person as feasible, to keep the project a priority. The project manager should also factor in the need to include key decision makers at meetings, as needed.

4.3 Siting and Installation

Challenges

The **lack of sufficient access to electricity** in some parks, especially those in remote or rural areas, is a significant challenge for siting and installing charging infrastructure. Having to extend or upgrade electrical service from an existing source can add substantial installation costs. Early collaboration with the park's electric utility will help to assess grid impacts and potential equipment upgrades. Another challenge with rural parks is the lack of cell phone service in many cases, which can limit the ability to use networked charging infrastructure that need access to Wi-Fi or cellular service to operate properly.

> *"One location did not get environmental compliance permits to move forward because it is a National Historic Site."*

Many national parks contain sites on the National Register of Historic Places, meaning that obtaining compliance approval and permitting needed to install charging infrastructure at these locations can be very challenging, and can delay the timeline of the project significantly.

Lessons Learned

Choose a site that has **easy access to existing electricity** to minimize installation costs. Ensure there is enough electricity available at the location to account for any future charging installations that may be needed. If the park is remote with no viable electricity sources, consider using renewable energy to power the charging station, such as solar. If possible, select a site that has cellular network coverage to allow for networked charging infrastructure. If cellular service is not available, select non-networked charging infrastructure. Finally, whenever possible, choose a site that does not need to go through extra permitting to avoid delays as a result of compliance with the National Register of Historic Places. If a selected site will likely require extra permitting, factor additional time into the project schedule.

Figure 4. Charging at Shenandoah National Park. Photo by Margaret Smith, NREL 52265.

4.4 Fee Collection

Challenges

The Fixing America's Surface Transportation Act[4] authorizes federal agencies to install, operate, and maintain EV charging stations for visitors and employees and requires the collection of fees to recover costs. Therefore, the cost of electricity used for public and workplace EV charging must be recovered by collecting a fee, including for NPS staff who use the chargers for their personal vehicles. Because of this policy, **parks must find a way to charge users for electricity**, which can add additional costs for payment mechanisms. Parks are encouraged to work with existing concessioners to take payment for charging station use; however, some parks do not have a concessioner available. In these cases, parks must use alternatives such as point of sale credit card readers, which are costly, or recreation fees, which are not always viable. Other options for taking payment include using a charging network, which is not feasible for rural parks because of the lack of cellular service and Wi-Fi and can be expensive because of annual networking fees and maintenance.

"Our Parks Conservancy is funding the cost of the electricity, giving us the ability not to charge visitors or employees for use."

"We involved our concessioner who paid the fee for the credit card reader. The fee to maintain the reader was too expensive over time, coupled with high charging maintenance costs, which forced us to remove the charging equipment."

The federal requirement to charge for use of EV charging has caused some parks to decide not to install charging infrastructure because of complications of taking payment. Furthermore, state regulations vary with regard to how electricity may be sold via EV charging stations (e.g., by the amount of electricity used, by length of the charging session) making it more confusing for some parks to navigate. These challenges have resulted in many parks making the decision not to install charging infrastructure for public or employee use.

[4] Fixing America's Surface Transportation Act § 1413(c), 42 U.S.C. 6364 (2015)

Figure 5. Charging at Petroglyph National Monument. Photo by Frank Burcham, Land of Enchantment Clean Cities (New Mexico).

Lessons Learned

Whenever possible, **partner with other organizations to help cover the cost** of charging. For example, work with a park foundation, friends group, or local utility to cover the cost of the electricity used, eliminating the need for the park to charge visitors for use. If a concessioner is available, partner with the concessioner to take payment. In some cases, the concessioner is willing to offer charging as an amenity and not seek payment from visitors. The mechanisms through which a park or concessioner can collect payment range from smartphone apps to credit cards to access codes, depending on the technology.

4.5 Park Conditions

Challenges

Many national parks experience **extreme weather** conditions, which can cause challenges during installation and throughout the lifetime of the charger. For example, winter weather and frozen ground can delay installation. In addition, if preventive actions are not taken, snow buildup can block access to the charging infrastructure throughout the winter season. Similarly, parks that experience periods of intense sun and heat should consider ways to protect the charging station, such as with a structural canopy.

> *"It's hard for us to train an electrician on charging infrastructure because there is high turnover, and maintenance was not factored into the original grant funds."*

Urban parks that install charging infrastructure in highly trafficked areas may have a need for more **frequent maintenance** of the charger because of vandalism or vehicle damage, and may also experience more frequent ICEing of the charger. Many parks do not have electricians that know how to repair charging infrastructure. Training park electricians to service charging infrastructure may be an option but that skill will be lost in the event of staff turnover. NPS staff who are qualified electricians are generally overbooked and other park maintenance takes priority over charging infrastructure.

Finally, **seasonal peak visitation** can be a factor in several aspects of EVSE installation and operation. When parks are at their busiest, it can be difficult for work crews to undertake construction and installation projects. Furthermore, at times when visitor numbers are at their peak, it can be challenging for visitors to find available parking spots, increasing the chances for designated EV charging spaces to be ICEd.

Lessons Learned
Factor winter weather into project timelines and **schedule installation during warmer months**. If a winter installation is the only feasible option, factor winter weather delays into the project timeline. Also factor in park busy seasons and schedule installation during off-peak seasons, if possible. Once installation is complete, ensure that there is a plan in place for snow removal around the charging infrastructure, and consider building a cover or enclosure to protect the charger from snow drifts.

Figure 6. Charging at Yellowstone National Park. Photo by Yellowstone Teton Clean Cities, NREL 35924.

While maintenance will likely be needed at chargers in all parks at times, urban parks in particular should always **factor in the cost of maintenance** and purchase a maintenance plan for charging infrastructure when possible, to ensure timely and effective maintenance. In addition, parks that have low electrician turnover should train at least one electrician on charging infrastructure maintenance to have on call in emergency situations.

Always **install signage and pavement markings to designate EV charging locations** and prevent ICE vehicles from parking there. See the Clean Cities Handbooks for public hosts for more detail on signage best practices.

4.6 Equipment Procurement

Challenges
During the early Clean Cities National Parks Initiative charging infrastructure installations, the market was nascent and the infrastructure options available through the General Services Administration (GSA) were limited. Since then, the market has matured, technology has advanced, and there are many more reliable equipment options available to parks. That said,

procurement policies and procedures often favor the lowest cost option rather than the most suitable in certain circumstances. For example, one park that had existing EV charging infrastructure went through a formal solicitation process for additional chargers. While the park would have preferred to use the same manufacturer in both locations to provide a cohesive experience to drivers, the process resulted in the selection of a different manufacturer with a lower cost solution.

Lessons Learned

GSA should be the first stop for any park unit looking to purchase EV charging stations. In addition to providing specifications for a range of available chargers, GSA has developed a decision tree and other resources to assist parks in their research and product selection.

If the GSA procurement pathway is not feasible for some reason and parks need to initiate a formal solicitation, design the request for proposals in such a way that accounts for the specifics of the park and intended installation site.

GSA can assist national parks in acquiring EV charging stations through a Blanket Purchase Agreement (BPA).

See www.gsa.gov/evse for more information and go to GSA Advantage to purchase equipment.

5 Installation Best Practices

The process of installing charging infrastructure, from the concept through the first use of the installed charger, can be daunting. This section provides a high-level overview of the best practices for each step of the process and draws upon the challenges and lessons learned from Section 4.

5.1 Confirm the Need, Demand, and Feasibility

One of the first steps in the installation process is completing a feasibility analysis, which should be completed by the prospective project manager prior to taking steps to procure and install stations. The results of the analysis will be indicative of likely EV charger demand or utilization and whether EV charging is an achievable option for the park.

Key considerations for national parks include:

- Daily park visitation;
- Whether visitors are likely to be EV drivers;
- Nearby charging opportunities, including available en route charging to allow EV travel from nearby cities and metropolitan areas;
- Current and future demand from EV drivers; and,
- Whether your state allows the resale of electricity.

In addition, complete a preliminary site analysis by inventorying the following:

- Concessioner availability;
- Existing power infrastructure availability and capacity, including if upgrades may be required; and,
- Any foreseen compliance issues, such as a National Historic Site.

5.2 Project Scope and Management

Once the project is determined to be viable, the next step is to discuss the scope and how it will be managed. Key factors to consider are:

- Project budget and funding mechanisms, including any available incentives;
- Timeline for project completion, factoring in any foreseen delays such as weather conditions or compliance;

Installation Checklist

- ✓ Confirm the need, demand, and feasibility of the project
- ✓ Determine project scope, budget and funding mechanism, and timeline
- ✓ Obtain approvals from key decision makers to move forward
- ✓ Identify project partners, including electric utilities, concessioners, and Clean Cities coalitions
- ✓ Determine the number, type(s), and costs of charging equipment needed, including public, workplace, and fleet applications
- ✓ Decide whether the stations will need to be networked, including if charger utilization data will be collected and if payment capabilities are necessary
- ✓ Determine if a formal solicitation is needed
- ✓ Choose a network and/or charging infrastructure manufacturer and provider
- ✓ Determine ideal project site, based on existing power infrastructure and future demand
- ✓ Inform local electric utility of the anticipated loads and assess impacts on service equipment
- ✓ Identify installation needs and costs, including electrical upgrades such as service panels, circuit breakers, wiring, and conduit
- ✓ Obtain any required permits, such as for a National Historic Site
- ✓ Determine additional site needs, including signage and accessibility
- ✓ Schedule and accomplish compliance and complete installation
- ✓ Assess charging infrastructure maintenance and operation needs and costs and determine who is responsible
- ✓ Inform visitors of the existence of the charger by adding information to the park website and installing signs and pavement markings

- Project partners, including concessioners, NPS employees, technical experts such as an electrical engineer and concessions specialist, Clean Cities coordinators, utilities, and any third parties such as park foundations; and,
- Project management, including designating a manager to oversee all matters related to the project, such as coordinating regular meetings with relevant parties or project partners.

5.3 Charging Equipment

Next, it is important to consider the number and type of chargers needed, such as the charging level, public, workplace, and/or fleet charging, and whether solar charging is an option. Reference the project budget to consider how much funding is available for infrastructure, and look for available incentives, such as those offered by the utility, that may be available to help offset costs.

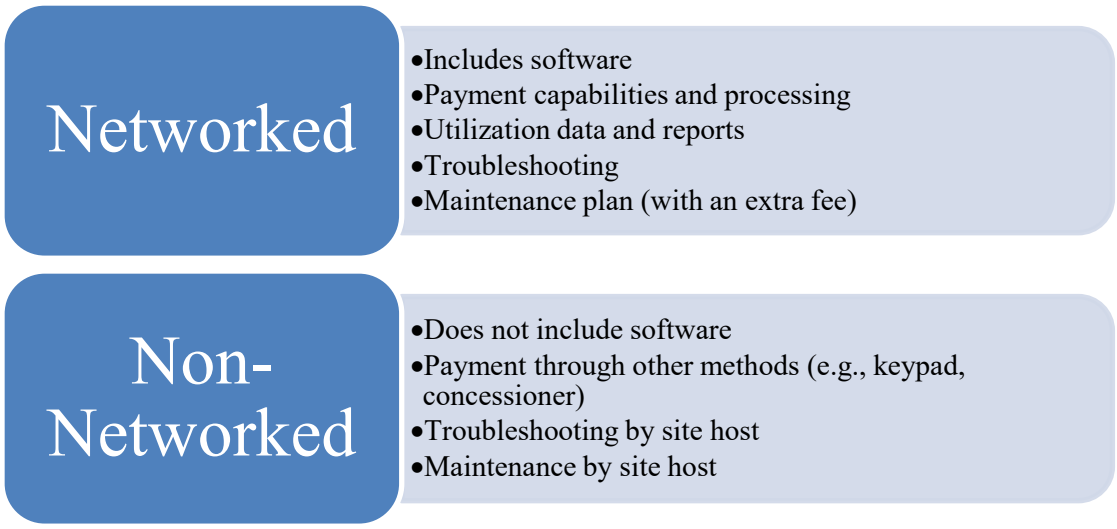


Figure 7. Networked vs. Non-Networked EVSE Capabilities

Also discuss the pros and cons of networked vs. non-networked chargers. For example, is there a concessioner that is willing to take payment for use of the chargers and accept responsibility for any maintenance costs? If so, a non-networked charger is likely sufficient. If not, consider a networked option to cover payment and maintenance costs. If choosing a networked charger, ensure that there is adequate cell service at the proposed installation site to ensure the station can communicate properly with the network. Options and capabilities of networked and non-networked charging are outlined in Figure 7.

Another aspect to consider is data collection capabilities. In the interest of energy management, a best practice is to separately meter all charging installations to allow NPS to understand energy usage, track electricity consumption and costs, monitor demand and trends, and better understand the NPS EV charging profile. Non-networked chargers must be separately metered, while networked chargers can act as a separate meter and track utilization using the charging network.

Finally, ensure the equipment is available via GSA or other approved procurement channels.

Figure 8. Non-networked EV charging station at Zion National Park, utilizing a keypad payment method. Codes are sold at park visitor centers at a set price.

5.4 Siting and Installation

Discuss siting and installation once equipment has been selected and procured.

To determine the final placement of the charging equipment, first consider the current power availability, and work with an electrical contractor for a recommendation on the best location for the charging station based on existing conditions. If electrical upgrades are required, determine costs for additional electrical work. Also consider whether placement is sufficient to meet both current and future charging demand, taking into account any future charging infrastructure needs and accounting for the potential space required for expansion. Ensure siting takes into consideration the view and sensitivities of the cultural landscape and historical context, being cognizant of how a charging station may potentially alter those aspects. Also consider the existing traffic flow and visitor dwell time (the amount of time a visitor stays at a given location), and ensure that the placement of the charging station will not disrupt the traffic flow significantly and will allow users to get a sufficient charge while visiting the park. Finally, comply with Architectural Barriers Act of 1968 requirements, if applicable

To move forward with construction, park unit staff must review the scope of work and identify National Environmental Policy Act compliance requirements to be accomplished prior to installation. Next, schedule and accomplish compliance and obtain any park use permits needed, and complete installation.

Figure 9. Charging at Thomas Edison National Historical Park. Photo by David Rose, BMW of North America.

5.5 Maintenance and Operation

It is important to determine potential maintenance and ongoing operation costs and decide who will be responsible for costs, including electric utility payments and any applicable networking fees, for the duration of the life of the charger. The life of an average charger is generally assumed to be 10 years, and total lifetime maintenance costs vary based on a variety of factors including charging level, networking capabilities, location, and warranties. Some parks, especially those in urban areas, may wish to consider purchasing a maintenance plan from the charging infrastructure provider to ensure repairs are made on a timely manner to minimize downtime.

All charging station users, including NPS staff and visitors, must pay to charge their vehicles as part of federal policy unless the use of the charger is sponsored by an outside organization. Set a pricing structure by considering rates in the surrounding community to confirm users are not being over or under charged for use, helping to ensure the charging station gets used. The rate should also take into consideration what rate would offset the overall cost of the charging station (including installation, infrastructure, and electricity costs). Finally, determine how payment collection will be managed, either by the concessioner, credit card reader, charging network, or recreational fee.

5.6 Education and Outreach

Once the charger has been installed, educate park visitors and staff about its availability and why the park pursued the project. Develop a list of talking points or bullets for park rangers and interpreters to use in each location where EVs are introduced that help to communicate the highlights and benefits of the project to the public in an easy to understand manner. At a minimum, inform staff and install directional signage as well as charger-specific signage and pavement markings at the site. Highlight the project externally by holding a ribbon-cutting event, publishing a press release, or ensuring information about charging availability is included on the park's website. There are education and outreach resources available to parks and partners, such as the Green Rides Toolkit, which equips NPS staff, concessioners, and Clean Cities

coordinators with ways to share successes and collaborate on alternative transportation projects without developing outreach materials from scratch. Finally, ensure the charger is included in the Alternative Fueling Station Locator, whether it is for public or park use only.

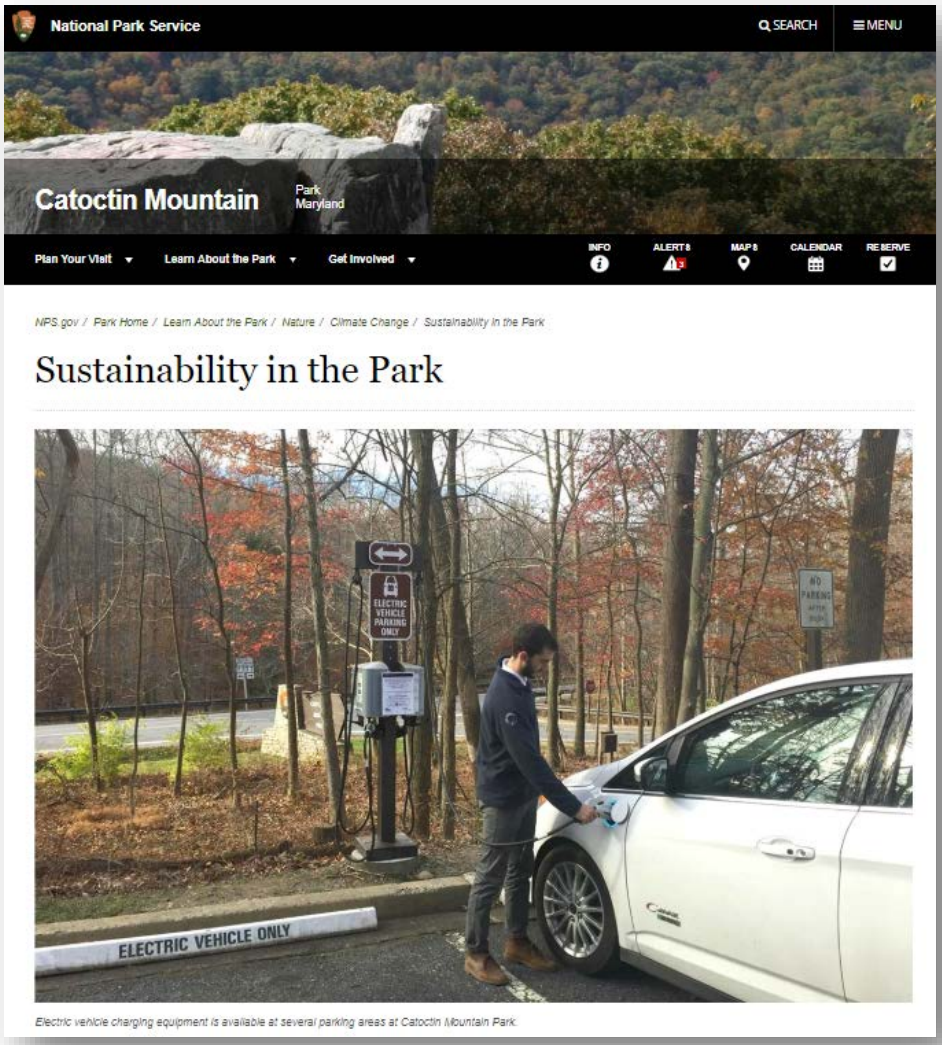


Figure 10. Catoctin Mountain Park advertises the availability of public charging infrastructure on their website.

6 Recommendations

The previous sections of this report have summarized challenges, lessons learned, and best practices for EV charging station installations in the national parks and have highlighted key areas where NPS may be able to help improve future charging installations in the parks. This section includes several recommendations for the NPS, including how to improve NPS policies, staffing, and marketing efforts.

6.1 Agency Procedures

Many parks have found the federal prohibition on providing EV charging at no cost to be restrictive. This is because it is difficult to justify the slow return on investment for the payment infrastructure required to charge for the use of charging, such as contracts with vendors or EVSE providers, credit card readers, etc. In some cases, this policy has contributed to chargers being removed from service and has been a reason other parks have not pursued EV charging. The procedures in place at NPS should support market growth and make charging an EV easy for visitors and staff. It is important to note that while fee collection may be challenging to implement today, as more EVs visit the parks, the potential revenue for charging will accelerate the return on investment for payment infrastructure.

There are two suggested ways to address this challenge. One way is to consider vehicle charging as comparable to allowing free access to other amenities such as drinking fountains and restroom facilities. Each charging event would be relatively small, so not substantially more expensive than the cost for providing these other amenities. For example, assuming electricity costs $0.11 per kilowatt-hour (kWh), fully charging an EV with a 70-mile range will cost about $2.64. This cost is about the same as operating an average central air conditioner for about six hours.[5] Another way to offset electricity charge is to implement solar powered EV charging, where feasible. In addition to aligning with climate goals, using solar power can offset the cost of electricity used.

To help NPS prepare for the growing number of EVs on the roads, driven in part by state and local goals specific to increased transportation electrification by 2030, more charging infrastructure will be needed. To help minimize those costs, NPS should take steps to pre-wire parking lots and facilities during the construction phase. A policy could require all new or remodeled public parking areas contain some percentage of spots equipped with EV charging equipment or spaces that are "EV-ready" with the necessary electrical conduit. NPS may also consider a service-wide goal of having EV charging installed in a certain percentage of national park units or available to some percentage of visitors by 2050.

6.2 Centralized Coordination

Because NPS is a distributed organization with parks and offices in all regions of the country, it is important that EV resources, including technical assistance, are centralized and coordinated. Specifically, providing a central point of contact for parks considering charging installation and

[5] DOE. 2019. "Charging Plug-In Electric Vehicles at Home." Alternative Fuels Data Center. Available online: https://afdc.energy.gov/fuels/electricity_charging_home.html

other alternative fuel options, as well as for potential donors and partners interested in supporting NPS, will contribute to continued success of EV projects in the parks.

This coordinator, whether it is an individual or team, would ideally be part of the Washington Office but could also be organized at the NPS regional level. They would be the central source of information on how to begin the process of installing charging infrastructure as well as the benefits and how charging aligns with NPS goals and policies. In addition to providing ad hoc or on-call support as needed, the coordinator could proactively distribute information about EV charging through NPS newsletters, internal websites, or direct messages to park contacts.

Further, each park should consider the feasibility of designating an EV charging lead, likely someone involved in sustainability or transportation. This staff person would be the primary resource at the park for charging station installation, maintenance, and other related issues. In most cases, this individual will have other park responsibilities but should be able to allocate a notable portion of their time to sustainable transportation efforts, including EVSE projects.

6.3 Education and Outreach

Making visitors aware of the availability of EV charging and other alternative fuels at the parks is critical to the lasting success of these projects and to accomplishing related goals. The NPS has the ability to reach a significant portion of the U.S. public, and should consider a greater focus on publicizing efforts around EV charging at the regional and national levels. For example, dedicating a section of the NPS Climate Change or Transportation website to information about EV charging projects, including a map or list of all public charging available. The existing Green Rides Toolkit, while somewhat outdated now, can be revisited and refreshed for use as a resource for parks wishing to market their EV or other alternative fuel efforts. The connection between EV charging and “green” or eco-friendly tourism is another opportunity for NPS to explore further, possibly in partnership with the National Park Foundation or other entities.

7 Conclusion

The Institute for Electric Innovation and the Edison Electric Institute estimate that there will be 18.7 million EVs on the roads in the United States in 2030,[6] and that 9.6 million charging stations will be needed to support them. Because EVs are likely to be a primary mode of transportation to national parks in the future, NPS should increase efforts to make charging feasible in the parks. The challenges, lessons learned, installation best practices, and recommendations outlined in this report will help guide NPS's EV-related efforts and ensure that future charging infrastructure projects are successful.

[6] Cooper, Adam and Kellen Schefter. 2018. "Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030." Institute for Electric Innovation and Edison Electric Institute. Available online: http://www.edisonfoundation.net/iei/publications/Documents/IEI_EEI%20EV%20Forecast%20Report_Nov2018.pdf