FLORIDA ELECTRIC VEHICLE ROADMAP

EXECUTIVE REPORT
December 2020

FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES
OFFICE OF ENERGY

CENTRAL FLORIDA CLEAN CITIES COALITION

EXECUTIVE REPORT
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Dear Floridians:

Our 663 miles of beautiful beaches and enchanting theme parks draw visitors from all over the world making Florida's roadways some of the most traveled in the nation. Historically, Florida's tourism industry has been one of the largest contributors to the state's economy and the reason for Florida having the third-highest motor gasoline demand and sixth-highest jet fuel use in the nation.[1]

In the United States, the transportation sector is one of the largest contributors to greenhouse gas emissions accounting for 28 percent of total emissions in 2018.[2] Cars, trucks, commercial aircrafts, and railroads, among other sources, all contribute to transportation end-use sector emissions. The science is clear: climate change is accelerating because of human activity and few places are more vulnerable to its effects than Florida.

Electric vehicles can reduce the emissions that contribute to climate change, improve public health, and reduce ecological damage. In order to encourage adoption and growth of electric vehicles (EV) in Florida, the state must provide guidance for the charging infrastructure and power needs that are associated with these vehicles.

In May 2019, the Florida Department of Agriculture and Consumer Services' Office of Energy began working on an EV Roadmap for the state of Florida. The goals of this roadmap are to:

- Identify EV charging infrastructure impacts on the electric grid.
- Identify solutions for any negative impacts.
- Locate areas that lack EV charging infrastructure.
- Identify best practices for siting EV charging stations.
- Identify technical or regulatory barriers to expansion of EV charging infrastructure.

The Florida EV Roadmap is the first comprehensive investigation into the status and needs of EV charging infrastructure in Florida for the next three to four years. Also included in the report is a map with recommended sites for charging infrastructure to meet the growing needs of our state. There are also planning recommendations that address various topics such as permitting, emergency evacuation needs, and education.

This report is not meant to be the final forecasting guidance from the state for EV charging infrastructure. The adoption rate of EVs is growing and will continue to grow as the technology gets better and better and the price of EVs becomes equivalent to or better than traditional combustion engine vehicles. The analysis performed in this report needs to be updated every three years, so the state keeps pace with the charging needs of its citizens and the millions of people who visit our state every year.

Over the course of this project, more than 500 stakeholders attended over eight hours of webinars all occurring during a global pandemic. I applaud and thank everyone who took time to be part of such an important project. It is only by working together that we will solve the challenges facing our state and protect our lands for future generations. Together, we can keep Florida growing!

Sincerely,

Nicole Fried

Nicole "Nikki" Fried
Florida Commissioner of Agriculture

[1] United States Department of Energy (USDOE) Energy Information Administration (EIA), State Profile and Energy Estimates, https://www.eia.gov/state/?sid=FL

[2] United States Environmental Protection Agency (USEPA) Fast Facts on Transportation Greenhouse Gas Emissions, https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

EXECUTIVE REPORT

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EXECUTIVE SUMMARY

The transportation landscape is being reshaped by technologies that will dramatically improve the efficiency and safety of the way we travel and transport goods. Electric vehicles (EVs) are poised to assume a significant role in transportation over the next five to ten years. EV battery prices continue to decline and EV costs are expected to reach price parity with conventionally fueled vehicles across the passenger vehicle segment by 2025.[3]

EV adoption in Florida continues to accelerate. It is expected to dramatically increase as price parity is achieved and consumers begin to take advantage of EV's reduced fuel and maintenance costs when compared to traditional, internal combustion engine vehicles. However, a lack of adequate infrastructure will result in barriers to the driver's full use of their EVs. The deployment of autonomous vehicles, electric taxis and shuttles, and transportation network companies such as Lyft and Uber will also be impacted, as these services significantly increase infrastructure demand.

EV supply equipment (EVSE) providers have done an excellent job of installing infrastructure for Florida's current needs. Florida's EV adoption rates are accelerating, the challenge now is to accommodate the accelerated deployment rate of EVs and improve the performance and capabilities of Florida's charging infrastructure. A significant portion of the existing EV infrastructure has been installed for more than six years, or approximately two-thirds of its useful life. Many of these installations are not networked, employ older technology, have proprietary operating and billing systems, and are typically a lower power Level 2 installation. This analysis does not account for replacing this infrastructure, but considerations will have to be made moving forward to replace this infrastructure in order to meet EV charging needs.

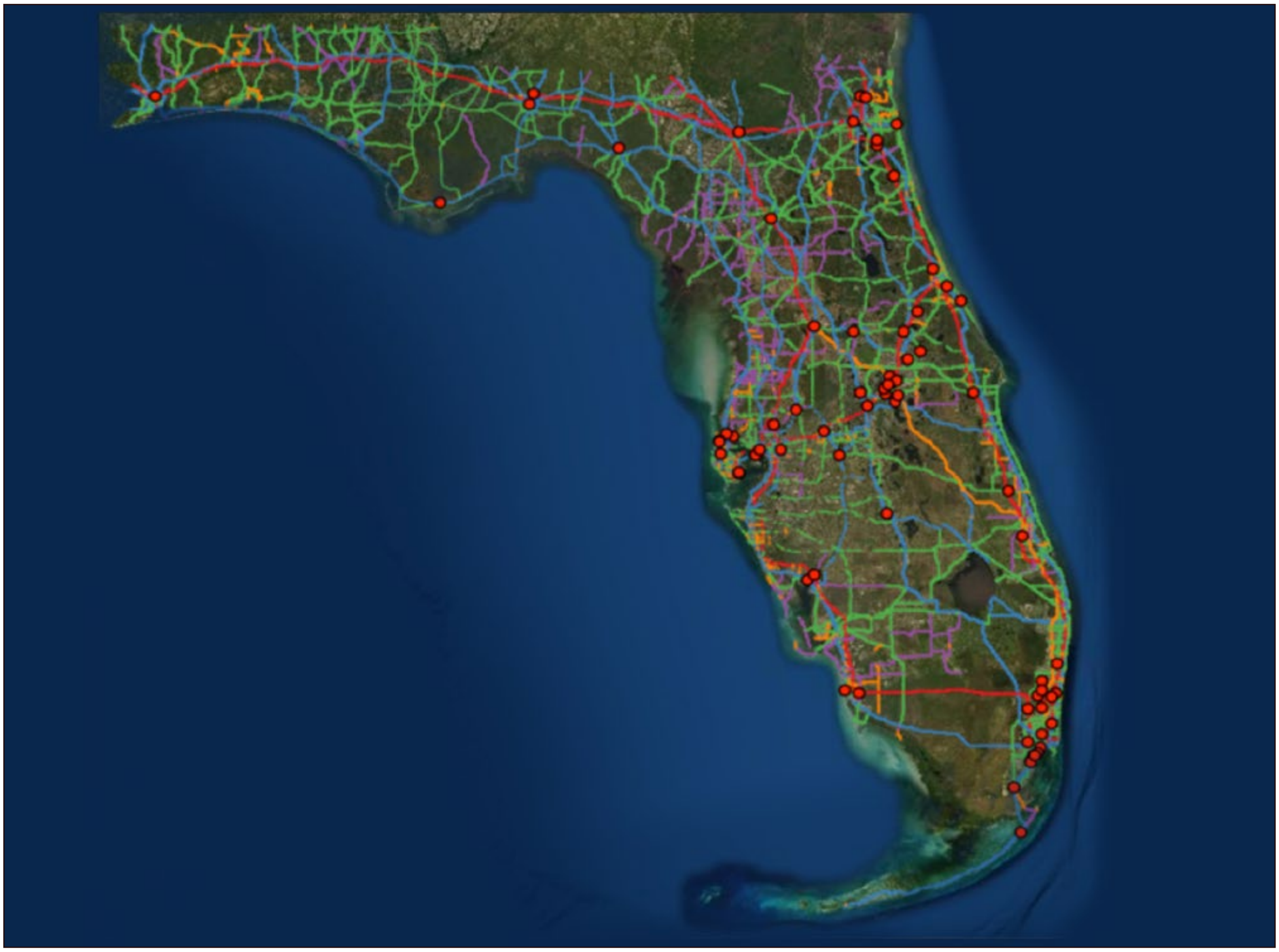
As the industry grows and adapts, preparing for future demand will become increasingly necessary. With a few small adjustments, stations can be upgraded to meet future demand without incurring substantial additional costs. Multi-family, workplace, and public interest sites parking spaces can also be made ready to support future growth.

Florida faces additional challenges when preparing to provide sufficient EVSE for future needs. Currently, many rural and underserved communities lack any EVSE infrastructure. Communities with low vehicle ownership rates, which are disproportionately impacted by air pollutants due to their proximity to heavily trafficked roads and highways, will benefit from a greater share of EVs on the roads. The challenges to establishing infrastructure in these areas, include lack of education and return on investment for EVSE providers. Auto manufactures are now producing EVs with travel ranges of 125-300+ miles, making electric commutes from rural areas possible. There is still work to be done to develop financially feasible methods of serving these communities. Rural communities and communities of color need to be afforded the opportunity to realize the fuel savings and health advantages EVs provide.

[3] https://www.greencarreports.com/news/1111144_electric-cars-will-cost-less-to-buy-than-regular-cars-by-2025-analysis

Available charging infrastructure is crucial to meet the needs of existing drivers, and to encourage prospective buyers. There are currently 3,907 Level 2 charging plugs and 844 direct current fast charges (DCFC) plugs located in Florida. The following map provides locations for all Florida's current DCFC locations as of June 2020, including Tesla charging network that serves roughly half of the EVs in Florida.

FL MAP WITH CURRENT DCFC INFRASTRUCTURE



Current fast charge network, June 2020 Source: AFDC/CFLCCC

EV sales forecasts are instrumental in determining the amount of EVSE charging infrastructure that will be required to meet charging needs. The data used for this analysis is for the next four years and was gathered on a county by county basis. Determining the possible EVSE locations is performed through a suitability analysis using variables such as travel data and the capacity to support EVSE infrastructure. The methodology used for this analysis was reviewed and approved by industry leaders including the U.S. Energy Information Administration (EIA) and the U.S. Department of Energy, Nation Renewable Energy Laboratory (NREL).

Based on our analysis, projected counts reveal that there is enough DCFC to meet charging demand until 2025 and enough Level 2 chargers exists throughout the state to meet infrastructure needs for the next ten years. These projections will surprise many that believe Florida lacks sufficient EVSE to meet current charging demand. Addressing misconceptions like this one is critical to widespread EV adoption. A state-wide education effort would help address misconceptions and misunderstanding about EVs and EVSE. It will also help EV users better utilize the EVSE already installed in the state. It is important to note this analysis should be performed again in three years to capture changes in EV sales rates and EVSE numbers in the state.

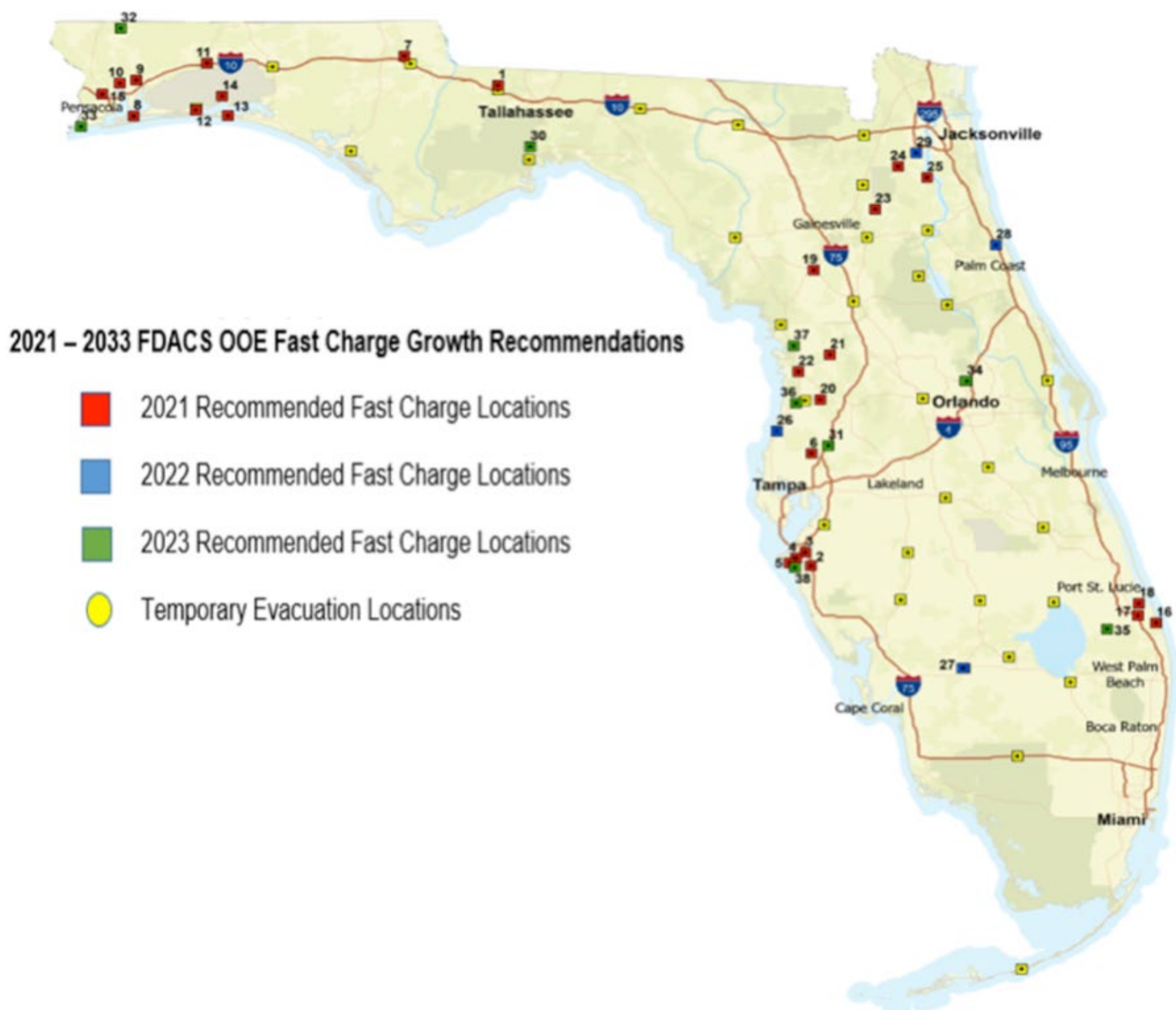
The location of EVSE is just as important as the amount of EVSE. While Florida's existing charging infrastructure meets the projected infrastructure need at the state level for the next three years, the charging stations are not evenly distributed, so some counties require additional infrastructure. Charging Infrastructure Location: 2020-2030 of this report covers this topic in more detail.

To ensure the safety and wellbeing of its residents, Florida must consider more than EV sales forecasts and suitability analysis when recommending locations for EVSE. Florida has withstood more direct hurricane strikes than any other state, and it is often grazed by storms that end up making landfall elsewhere. It is essential to consider evacuation routes for Floridians fleeing natural and man-made disasters when considering EVSE locations.

The FDACS OOE identified multiple, potential EVSE sites that would benefit Floridians during times of evacuations. However, these sites would not provide the day to day charging needed to justify the initial investment. The FDACS OOE believes that temporary EV charging installations would be a solution to this problem. Several methods of temporary charging have been developed, including small self-contained portable battery systems, larger scale battery systems on heavy duty trucks, and stand-alone, transportable, temporary charging installations. Temporary EV charging not only has the benefits of charging before a disaster, but also afterwards when power has been disrupted.

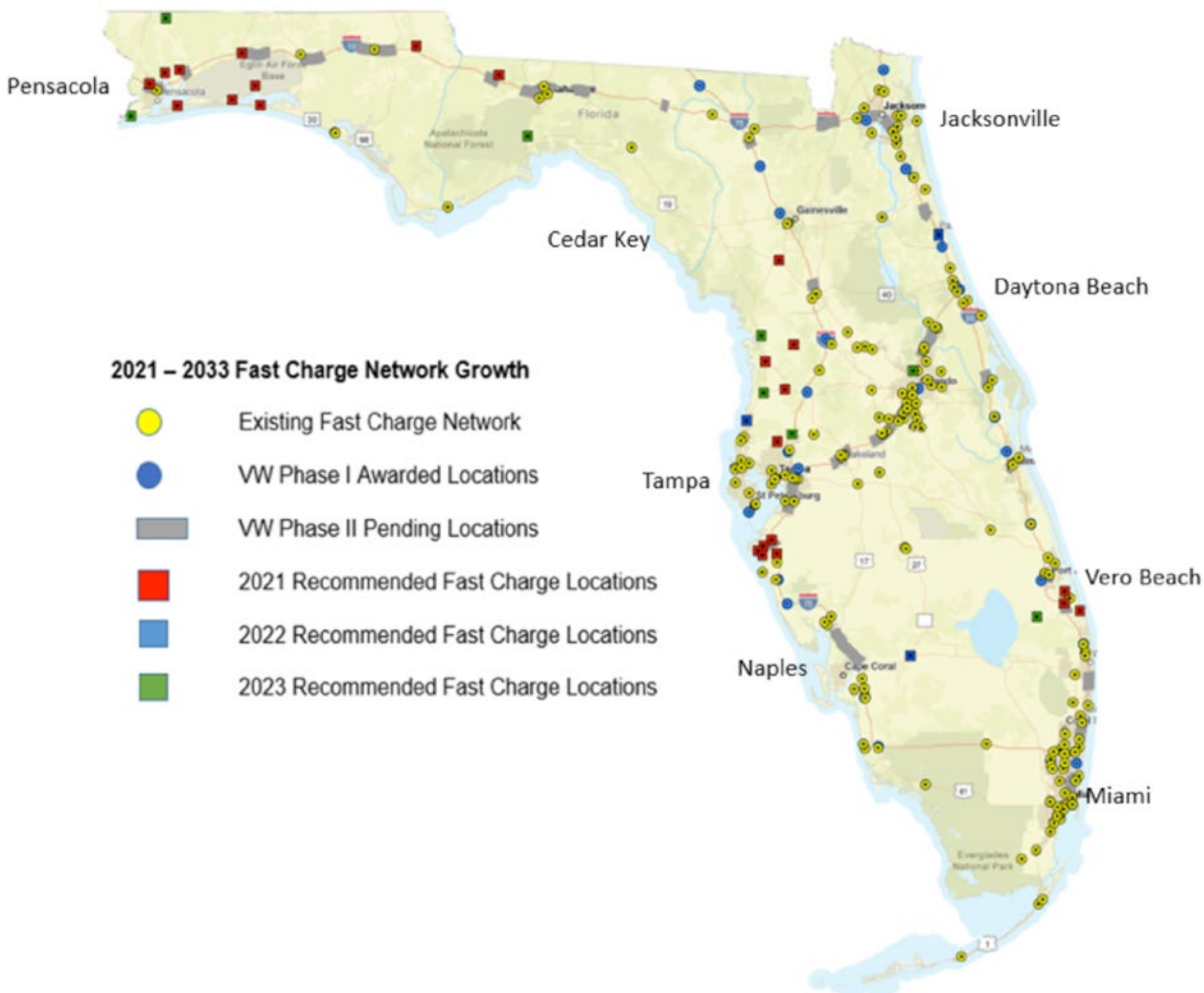
The following map contains recommendations for potential DCFC EVSE sites for the next three years as well as where temporary charging should be included in the event of a natural or man-made disaster. All recommended DCFC locations are agnostic to vendor technology and represent locations that have complementary existing commercial development. Vendors have the freedom to explore the recommended area for an exact location that is suitable to their needs.

FL MAP WITH FDACS OOE SITE RECOMMENDATIONS



EVs and the EVSE landscape are evolving at a rapid pace. It is difficult to accurately forecast charging infrastructure needs beyond a three-year timeframe. Therefore, it is recommended that another analysis is conducted in three years to account for changes in EV growth rates as well as additions of new EVSE infrastructure in the state and retirements of old, outdated EVSE infrastructure.

FL MAP WITH CURRENT DCFC INFRASTRUCTURE AND FDACS OOE SITE RECOMMENDATIONS



The above map includes both current infrastructure and recommended EVSE site locations.

EVs and the infrastructure that supports them require more planning than traditional combustion engine vehicles. And the planning that is required must be coordinated among multiple state agencies, local governments, electric utilities, private stakeholders, and the EV drivers themselves. The benefits EVs provide in terms of lower greenhouse gas emissions and public health benefits far out weigh the added planning that is required. The FDACS OOE believes that by coordinating efforts and simplifying paths to EVSE is critical to supporting the deployment of clean transportation and realizing the inherent benefits.

PLANNING AND DEPLOYMENT RECOMMENDATIONS

Based on information contained in our interim reports, the EV Owners' Survey, and verbal and written feedback from stakeholders, we offer the following recommendations for consideration.

PLANNING

1. Information regarding EV sales in Florida is difficult to collect, analyze and report; it is recommended that the Florida Department of Motor Vehicles develop and publish quarterly standardized reporting for all classes of electric vehicles.
2. Permitting requirements for EV infrastructure installation is highly variable in Florida; it is recommended that the Florida Building Commission develop a standardized process for reviewing and permitting infrastructure installations.
3. Multi-family developments represent an untapped source for the expansion of EV use and infrastructure. They also present unique challenges to deployment; it is recommended that the Florida Building Commission develop guidance, policies and incentives to maximize this opportunity.
4. Florida municipalities, counties, and state agencies purchase products and services from vendors included on the State Contract and Agreements List; it is recommended that Florida Department of Management Services (FDMS) encourage vendors to provide more EV options under the state term contract.
5. Florida Statutes require state agencies to select the vehicle with the greatest fuel efficiency within a given class; it is recommended that the Florida Legislature remove this outdated language and instead require agencies to perform an analysis on the total cost of ownership of a vehicle prior to its purchase.
6. Florida has critical gaps in charging infrastructure as it relates to emergency evacuation; it is recommended that the State purchase portable, solar powered EV chargers with battery storage as a means of addressing this immediate need.
7. EVs and the associated infrastructure offer substantial advantages in mitigating impacts from fossil fuels; it is recommended that the use of solar power and battery storage be investigated by FDACS OOE as a means of extending these benefits and reducing operating expense.

FINANCING AND INCENTIVES

1. Florida has allocated the maximum allowable funding under the Volkswagen Settlement for infrastructure installation, which will be used primarily for the installation of capital intensive DCFC; it is recommended that existing federal funding be reviewed by the Florida Department of Transportation (FDOT) to support EV infrastructure installation by local governments, underserved communities, and rural areas.
2. Workplace charging has been proven to increase EV adoption and expand its benefits; it is recommended that the FDACS OOE develop state incentives that can be made available to support work place charging.
3. The Florida Legislature previously provided incentives that supported the deployment of alternative fuel vehicles that use natural gas; it is recommended that the Florida Legislature authorize similar incentives for the deployment of electric transportation and infrastructure with priority given to disadvantaged and rural communities.

EDUCATION

1. Lack of education is one of the biggest barriers to EV adoption; it is recommendation the Florida Legislature provide funding to the FDACS OOE to develop a statewide EV educational campaign that can be rebranded locally.

FORECASTING EV ADOPTION AND INFRASTRUCTURE NEEDS

1. The rate of EV adoption is key to determining the required infrastructure. The ability to do so has been difficult; it is recommended that that the FDACS OOE, the FDOT and the Florida Public Service Commission (FPSC) develop methodologies to track and forecast EV sales and infrastructure requirements.

INFRASTRUCTURE INTEROPERABILITY, PERFORMANCE, AND MONITORING

1. State standards for EV infrastructure interoperability, monitoring, availability, reliability and reporting have not been established; it is recommended that the FDACS OOE, the FDOT, and the FPSC develop these standards.
2. State standards for emergency response to restore EV infrastructure have not been established; it is recommended that the FDACS OOE, the FDOT, the FPSC, and the Florida Department of Emergency Management (FDEM) develop standards for restoration of this critical infrastructure, in conjunction with industry and stakeholder input. Standards should include provider staffing and spares inventory.

STAKEHOLDER ENGAGEMENT & ACKNOWLEDGMENTS

The Florida EV Roadmap process began in 2019 with a public meeting to solicit input from interested groups and individuals. This process was open, transparent, and built on stakeholder engagement. This report could not have been accomplished without the time, consideration, and contributions of the following.

Broward MPO
City of Orlando
City of West Palm Beach
ChargePoint
Duke Energy
Electrify America
EV Atlas Hub
EV Noire
Florida Department of Transportation
Florida Division of Emergency Mgmt.
Florida Power & Light
Florida Public Service Commission
Florida League of Women Voters
Florida Tesla Enthusiasts
Greenlots
National Renewable Energy Laboratory
North Florida Clean Fuels Coalition
North Florida TPO
Orlando Utilities Commission
Renaissance Planning
Siemens eMobility
Southeast Energy Efficiency Alliance
S.E. Florida Regional Climate Change Compact
Southern Alliance for Clean Energy
Space Coast EV Drivers
Sumter Electric Cooperative
Tampa Bay Clean Cities Coalition
Tampa Electric Company
Underwriters Laboratory

With the assistance of our program partner, Central Florida Clean Cities Coalition (CFCCC), seven webinars were conducted in 2020 along with follow up conference calls. The webinars included an initial program to review the Roadmap purpose and how information could be submitted. A final webinar to review all interim reports and survey results was held in October of 2020. Five primary groups were targeted for input for each of the remaining webinars, those groups were:

- Power Service Providers
- Infrastructure Providers
- State Agencies
- Advocacy Groups
- Planning Organizations

A total of fifteen representatives, three from each stakeholder sector, served as facilitators for their group's webinar. More than 500 stakeholders attended over eight hours of webinars all occurring during a global pandemic. Discussions during the webinars were very productive and useful. Feedback from participants was very positive. Recordings of the webinars and other information is available on the project website at, https://www.fdacs.gov/Energy/Florida-Electric-Vehicle-Roadmap

Additionally, a survey of Florida EV owners was conducted in August of 2020. The results of the survey are summarized in this section and fully detailed later in this report.

REPORT METHODOLOGY

CFCCC developed and performed several analyses to provide data for this report, including:

1. State-Wide EV Sales Analysis and Projections
2. State-wide Infrastructure Analysis and Projections
3. Comprehensive Literature Review
4. Interactive Webinars
5. Written input from stakeholders
6. Interviews with stakeholders
7. Florida EV Owners' Survey

The basic objective of this report is to identify light-duty EV infrastructure needs. To do so requires knowing how many EVs need to be supported in a general area and to identify the most suitable locations for the chargers.

The report's focus for needed infrastructure is on higher power Level 2, and DCFC. Power output levels for Level 2 and DCFC will be determined by the infrastructure provider.

Online tools developed by EIA and NREL were used for analysis. Modifications to the tools to reflect Florida's vehicle and infrastructure deployment were vetted and approved by EIA and NREL.

Florida has eight commonly recognized geographic regions. Sales and infrastructure projections for this report began with a regional level analysis, with final outputs at the county level. The EVSE Suitability Analysis ultimately had visibility down to a half square mile.

Determining the number of EV sales is crucial to understanding the required infrastructure and estimating that number has been historically difficult. Below are recent projections by several leading organizations.

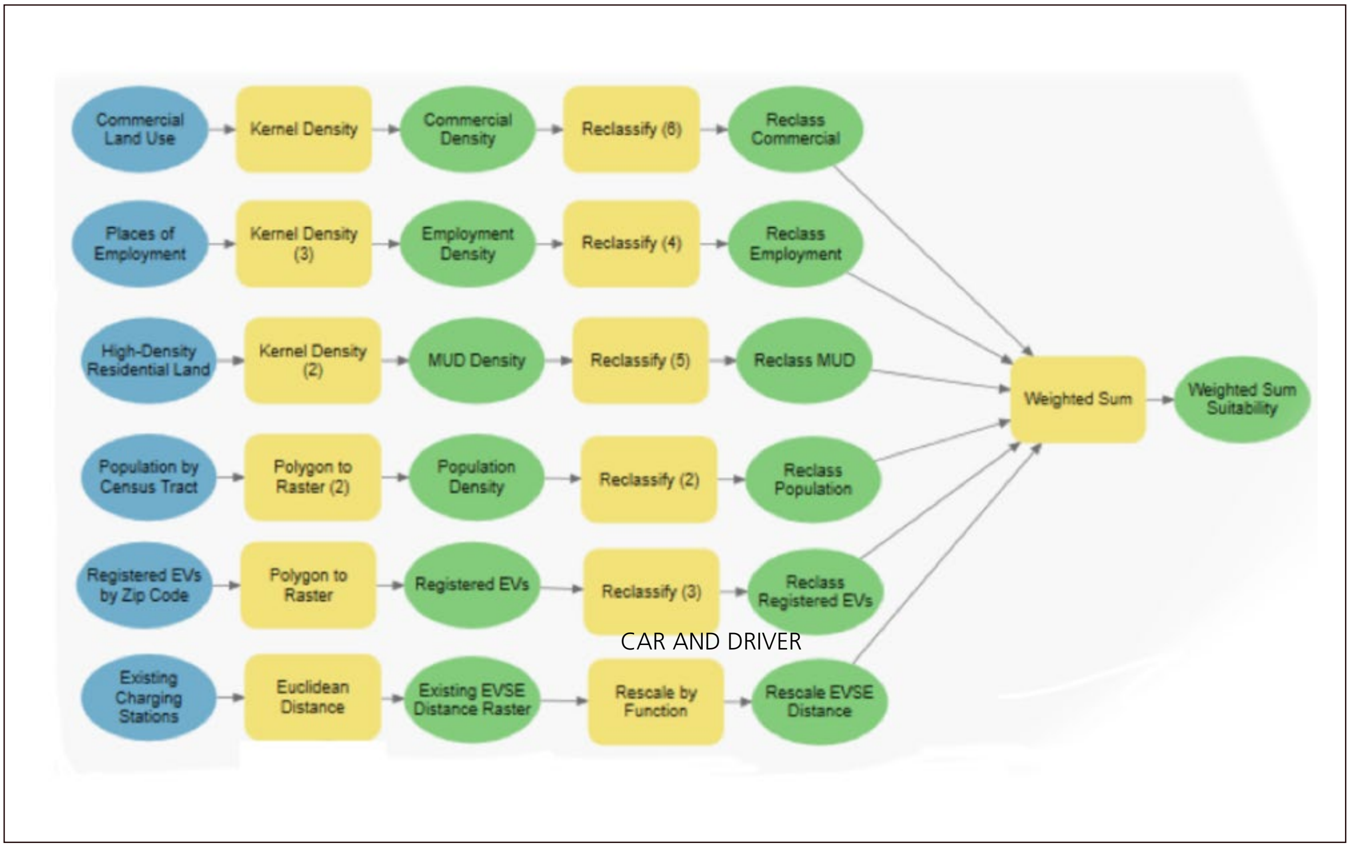
Projected EV sales for Florida were found using the EIA's Annual Energy Outlook (AEO). AEO is an annual report that presents an assessment by the EIA of the outlook for energy markets through 2050. The outlooks are developed using the National Energy Modeling System, which is an integrated model that captures interactions of economic changes and energy supply, demand, and prices.

Available charging infrastructure is crucial to meet the needs of existing drivers, and to encourage prospective buyers. EV sales forecast help infrastructure providers estimate demand, and a location suitability analysis helps identify possible infrastructure locations.

For this analysis, NREL's EVI-Pro Lite tool was utilized to estimate future infrastructure needs based on projected charging demand. EVI-Pro Lite is an online module that estimates the number of public Level 2, workplace Level 2, and DCFC stations required to support the input number of EVs.

A suitability analysis was performed on each county to identify optimal areas to place charging stations, using Geographic Information Systems (GIS), and data from the Florida Department of Transportation (FDOT), EIA and others.

After determining suitable locations, a modeling process was developed using the inputs illustrated below.



The model looks at six different variables related to EV charging behavior:

1. Commercial land use
2. Places of employment
3. High-density residential land use
4. Population
5. Registered EVs
6. Existing station placement

Charging stations should be in an area that is safe, near commercial activity, accessible to residents in multi-unit dwellings, and efficiently distanced from existing charging locations.

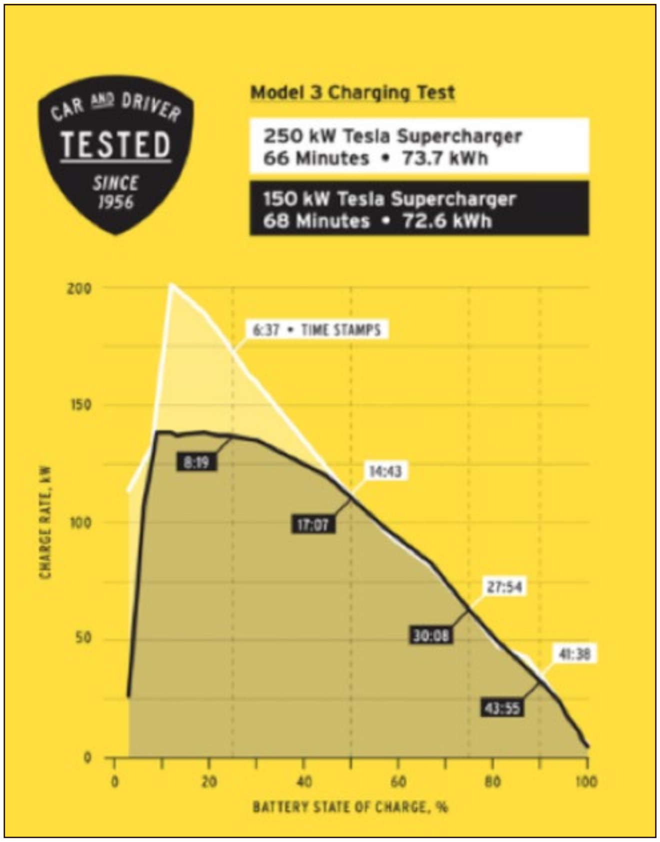
FUTURE EV INFRASTRUCTURE

First, it should be understood that there are no special requirements for the installation of charging infrastructure, when compared to other electrical appurtenances installed in similar fashion; and in many instances, the installations are less complex than a standard traffic control device. Permits and other approvals are required for installation, but generally no more so than other devices installed in similar fashion.

EV infrastructure technology is advancing at a rapid pace to meet the requirements of longer range EVs and support the increasing capability of these vehicles to manage much higher recharge power levels. The conventional 50kW DCFC is giving way to DCFCs of 100-350 kW that are currently being installed. Future output capacities are expected to exceed 650 kW. A 50kW DCFC can restore about 120 miles of travel per hour, a 150-350 kW DCFC can provide 800-1000 miles of travel in the same amount of time.[4]

Increased EVSE power outputs require increased grid inputs and other considerations. The placement of the higher power EVSE becomes more difficult and demanding in finding a suitable location that can accommodate the needed grid requirements, additional requirements for the thermal cooling of the supply cables, and data network availability to support monitoring, billing and other back office requirements.

TEST RESULTS



CAR AND DRIVER

EVSE installations in Florida continue at a strong pace. However, a significant portion of the installations are for Level 2 EVSE with a maximum output of 40kW, 10kW below the 50kW common output of a conventional DCFC.

Battery technology and consumer needs will strongly influence infrastructure needs. There are intrinsic incentives for choosing both long and short range EVs. Longer range EVs will provide the most travel flexibility. However, a shorter range EV with less battery capacity can be manufactured and sold at a much lower cost than an internal combustion engine vehicle.

[4] https://www.caranddriver.com/news/a32132062/tesla-250-kw-vs-150-kw-supercharger-tested/

EVSE TECHNOLOGY [5]

EVSE delivers electrical energy from an electricity source to charge an EV's battery. The EVSE communicates with the EV to ensure that an appropriate and safe flow of electricity is supplied. EVSE units are commonly referred to as charging stations.

BASIC EVSE COMPONENTS

The following is a fundamental description of the EVSE technology; these technologies can vary; for safety, please review and understand the technology of the specific vehicle and EVSE you use.

EVSE: The equipment, connected to an electrical power source, that provides the alternating current the direct current supply to the electric vehicle that is needed to charge the vehicle's traction batteries. EVSE charging capacity options are an important consideration as they have a direct bearing on how fast the batteries can be recharged. As an example, Level 2 EVSE is available in 20, 30, and 40-amp capacities and higher amperage equates to faster recharge times. However, the EV's onboard charger must have the ability to match the full output of the EVSE to realize the fastest recharge times.

Electric Vehicle Connector: The device attached to the EVSE cable that provides the physical connection between the EVSE and the EV. There are three predominant connectors in use today: the SAE J1772 based connector (developed by the U.S. auto standards development organization SAE), the CHAdeMO connector (developed by the Japanese auto standards development organization), and the Tesla developed Supercharger connector that is used exclusively for charging Tesla electric automobiles.

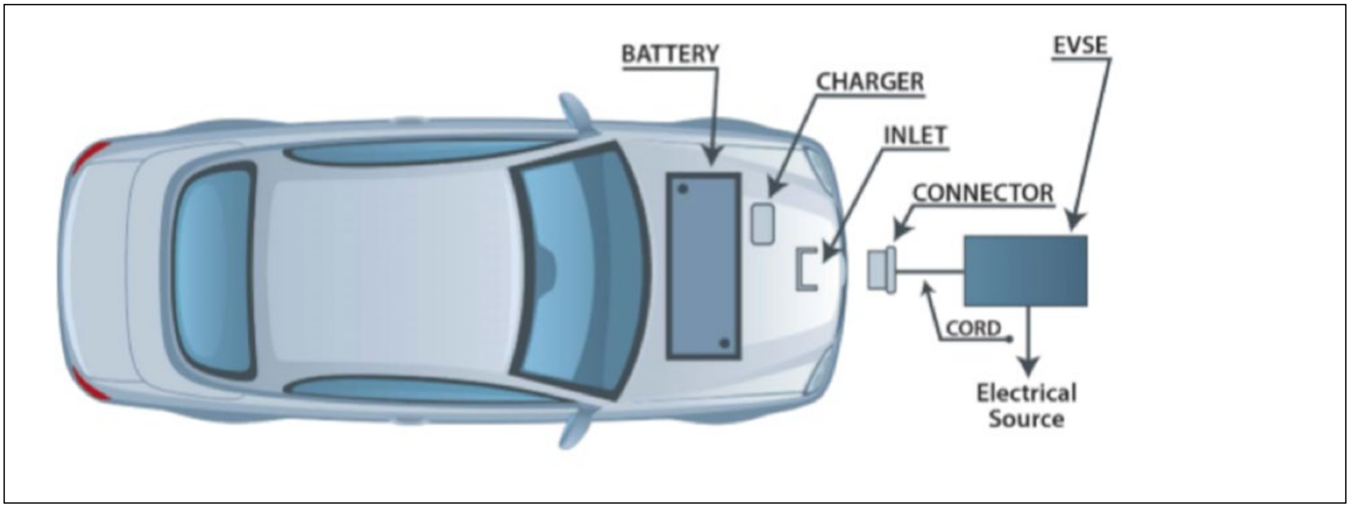
Electric Vehicle Inlet: The device on the electric vehicle that provides the physical connection between the EV and the EVSE connector. Some EVs have more than one inlet port and locations vary from vehicle to vehicle.

Battery Charger: Level 1 and 2 charging uses the EV's internal battery charger to convert the EVSE alternating current supply to the direct current needed to charge the car's traction batteries. DCFC supply high-current DC electricity directly to the EV's traction batteries. On-board battery charger options are an important consideration when purchasing an EV as they have a direct bearing on how fast the batteries can be recharged. There are several options available, some of which do not provide an option for DCFC.

[5] http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1996-15.pdf

EVSE CHARGER CLASSIFICATIONS

EVSE is normally classified as Level 1, Level 2 or DCFC. In general terms, EVSE classification pertains to the power level that the equipment provides to recharge an EV's batteries. The use of higher charge levels can significantly reduce the time required to recharge batteries.



AC LEVEL 1 CHARGING

Level 1 provides charging from a standard residential 120-volt AC outlet, its power consumption is approximately equal to that of a toaster. Most EV manufacturers include a Level 1 EVSE cord set so that no additional charging equipment is required. As a general rule, Level 1 recharging will add approximately four miles of travel per hour. Level 1 charging is the most common form of battery recharging and can typically recharge an EV's batteries overnight; however, a completely depleted EV battery could take up to 20 hours to completely recharge.

AC LEVEL 2 CHARGING

Level 2 equipment provides charging using 220-volt residential or 208-volt commercial AC electrical service, its power consumption is approximately equal to that of a residential clothes dryer. Generally, Level 2 recharging will supply up to approximately 15 miles of travel for one hour of charging to vehicles with a 3.3 kW on-board charger, or 30 miles of travel for one hour of charging for vehicles with a 6.6kWh on-board charger. Level 2 EVSE utilizes equipment specifically designed to provide accelerated recharging and can require professional electrical installation using a dedicated electrical circuit. Level 2 equipment is available for purchase online or from retailers that sell other residential appliances. A completely depleted EV battery could be recharged in approximately seven hours using a Level 2 charger.

DC FAST CHARGING (DCFC)

DCFC equipment requires commercial grade 480-volt AC power service and its power requirements are approximately equal to 15 average size residential central air conditioning units. Generally, DCFC recharging will add approximately 80-100 miles of travel with 20-30 minutes of charging. The DCFC EVSE converts AC to DC within the EVSE equipment, bypassing the car's charger to provide high-power DC directly to the EV's traction batteries through the charging inlet on the vehicle. DCFCs are deployed across the U.S., typically in public or commercial settings. While the power supplied to EVs by all DCFCs is standardized, there is not uniform agreement on the connector that is used to connect the charger to the vehicle. There are two competing standards for the vehicle connectors used with DCFCs; one standard is the SAE J1772 Combo developed by the U.S. auto standards development organization SAE and the other is the CHAdeMO connector developed by a Japanese auto standards organization. As a practical matter, both connectors work very well and many (but not all) EVs are equipped to utilize either connector. DCFC's high-power capabilities can restore a depleted EV battery in approximately 30 minutes.

EVSE General Characteristics (Completely depleted battery)

	Charge Time	Voltage/Amps	Power Equivalent	Installation
Level 1	Up to 20 hrs.	120/15	Toaster	Self
Level 2	Up to 7 hrs.	240/40	Clothes dryer	Professional
DC Fast Charge	Up to 30 min.	480/125	15 Central A.C.	Professional

EV BATTERY SYSTEMS

EVs have two battery systems, the larger "traction" batteries that provide propulsion for the vehicle, and a smaller, conventional 12-volt battery that provides auxiliary power for on-board systems such as the entertainment system, dash lights, etc. The traction batteries come in a wide variety of power ratings that are designed to meet the specific needs of the particular model of EV. Traction batteries are also becoming known by the more technical designation of Rechargeable Energy Storage System (RESS), a reference to their ability to store energy for purposes other than propelling the EV. Most of today's EVs use lithium-ion batteries, which are much larger versions of the battery technology used in cell phones and other personal electronics.

EVSE/EV SIGNALING AND COMMUNICATIONS

EVSE and EV interaction during the battery recharging process can be an interactive and dynamic process that requires communications between both elements. Multiple, ongoing communications exchanges occur during charging, one of the primary purposes of these communications is to regulate the amount of current provided to charge the vehicle. The EVSE informs the vehicle of the maximum current available, allowing the EV to manage current flow within the EVSE's service breaker capacity. Additional primary communications and interactions take place that monitor the State-of-Charge (SOC) of the batteries and allows the EV to bypass the on-board charger and use the EVSE charger if a DCFC station is being used.

SAE Recommended Practice SAE J2847/2 establishes requirements and specifications for communication between EVs and the DC Off-board charger. Where relevant, this SAE document notes, but does not formally specify, interactions between the vehicle and vehicle operator. This document applies to the off-board DC charger for conductive charging, which supplies DC current to the batteries of the electric vehicle through a SAE J1772™ coupler. Communications will be on the J1772 Pilot line for Power Line Communication (PLC). The details of PLC communications are found in SAE J2931/4. The specification supports DC energy transfer via Forward Power Flow (FPF) from source to vehicle.

SAE J2847/2 provides messages for DC energy transfer. The updated version in August 2012 was aligned with the DIN SPEC 70121 and additions to J1772™ for DC charging, published October 2012. This revision includes results from implementation and changes not included in the previous version. This revision also includes effects from DC discharging or Reverse Power Flow to off-board equipment that expands on J2847/3 for AC energy flow from the vehicle, and other Distributed Energy Resource functions that are being developed from the use cases in J2836/3™, published January 2013. [3] SAE International, Communication between Plug-in Vehicles and Off-Board DC Chargers.[6]

NETWORKING AND INTEROPERABILITY

Most new EVSE includes back-end software developed and maintained by a network service provider. Networked charging stations are connected to the Internet, which allows them to communicate with a central control system. Through the network, the station sends important information to the service provider and site host and, in turn, they can control the station remotely.

Networked EVSE allow the hosts to accept payment from EV drivers via credit card, smartphone, or radio-frequency identification (RFID) card. Without the networked connection, chargers are unable to accept any payment. Additionally, the host or network service provider can access stored data from the station to analyze electricity usage, total charge time, frequency of use, or other relevant information. With real-time data, providers can share information about charger availability and functionality with its user apps.

Charging networks need to be able to communicate with each other, and many network service providers use proprietary programming language that can only communicate with their own branded charging stations and networks. The Open Charge Point Protocol (OCPP), while not yet fully adopted as a standard, has been gaining popularity as a method of standardizing charger communications. Standardized protocols allow communications and enable data sharing among providers, which can facilitate network “roaming”. Like a cell phone roaming across networks while traveling, roaming allows EV drivers to charge at stations outside of their provider network without creating a new membership. EV drivers in much of Europe can use a single RFID card to access all public stations being operated by different network providers. Many US network companies, such as ChargePoint, Electrify America, EVgo, EVBox, and EV Connect, have begun bilateral agreements that allow users to charge at any of their stations.

[6] http://standards.sae.org/wip/j2847/2/

Networked charging stations offer several benefits compared to their non-networked counterparts, while the lack of standardization in the U.S. is a significant barrier. There are already over 20 EVSE network service providers throughout the country, most of which require a membership for access to their stations; drivers have a difficult time keeping up with their accounts and finding a station they can use. The success of the electric vehicle market depends on drivers having access to charging infrastructure whenever necessary, so networks must have interoperability. Interoperability allows chargers to communicate allowing drivers to charge at a station with a single identification or payment method.

OCPP is a standardized communications protocol that allows the site owner to switch network providers. This increases competition among vendors, encouraging them to constantly improve their service, and reduce the possibility of stranded assets.

MANAGED CHARGING

Managed or "Smart" charging of EVs is a technology that allows the owners of the infrastructure and vehicle to efficiently charge a single EV or a fleet. Managed charging intelligently balances vehicle, infrastructure and grid requirements to allocated charging assets in the most efficient and economical manner. Managed charging can also provide detailed reports for energy use by vehicle, allowing fleet managers and multifamily environments to assign the proper costs for specific vehicle.

BATTERY TECHNOLOGY

The capacity and efficiency of EV batteries continue to increase as the price for the batteries continues to decline. The primary factors for lower battery pricing are the increase in manufacturing scale and efficiency, advancements in battery technology, and the increased adoption of EVs. Automobile manufacturers continue their commitment to EVs through the acquisition of battery technology companies and their ongoing investment in new large-scale battery manufacturing facilities.

The convergence of factors in battery technology can be seen in Tesla's Model 3 EV. The Model 3 has an average range of 250 miles and cost of approximately $40,000; the combination of range and price resulted in the sale of over 16,000 vehicles in 2019 alone, or 28 percent of the total sales and a huge contributor to an overall increase of 33 percent.[7]

Researchers and vehicle manufacturers expect a shift from the current lithium-ion chemistry to solid state-batteries within the next five years. Solid-state batteries:

- Are inherently safer that lithium-ion
- Can recharge faster, with a longer useful life
- Use more common elements like sodium, a few rare-earth minerals
- Significantly less expensive to manufacture
- Potential to more than double the range of EVs

All the advantages of solid-state batteries will further reduce the cost of EVs and spur additional adoption, which will, in turn, increase infrastructure demand.

[7] FPL EV sales 2019

INDUCTIVE AND RESONANT CHARGING TECHNOLOGIES

Inductive charging, also known as Wireless Power Transfer (WPT), is an emerging technology that allows EV recharging without the use of a cabled connection. The most common application uses a charging pad installed on or in the pavement and a receiving pad installed underneath the EV. Electrical current is passed through the pavement pad, which creates an inductive electrical field that is captured by the EV's receiving pad to charge the vehicle's batteries.

The successful development and deployment of wireless technology presents the promise of having the convenience of pulling into your garage or a parking spot and having your car recharge without the need to connect and disconnect a cable. Some researchers are also exploring the possibility of embedding wireless charging in the roadway as a method of continuously recharging the vehicle while in motion; this system would dramatically reduce battery size requirements and extend the travel range of EVs. Wireless charging is now offered as an upgrade on some luxury model cars, it is also being actively used by transit agencies to provide on-demand charging of their buses.

Induction chargers typically use an induction coil to create an alternating electromagnetic field from within a charging base station, and a second induction coil in the portable device (i.e., EV) that takes power from the electromagnetic field and converts it back into electrical current to charge the battery. Greater distances between sender and receiver coils can be achieved when the inductive charging system uses resonant inductive coupling. Recent improvements to this resonant system include using a movable transmission coil, and the use of materials for the receiver coil made of silver-plated copper or aluminum.

A significant effort in research and development is underway by academic, governmental and private industry to help realize the promise of the untethered charging of EV batteries. The Massachusetts Institute of Technology (MIT) has marketed a patented WPT technology that applies magnetic resonance to an inductive electrical field.

This technology provides impressive power transfer efficiencies over larger air gaps between the charging transmitter and the EV's charging receiver. MIT's WPT has been licensed to several large automobile manufacturers.

Utah State University is also involved in wireless charging research and has a new research facility that includes an oval track to test technology for recharging electric vehicles while moving.

The Society of Automotive Engineers and the International Electrotechnical Commission develop standards for wireless technology and there is limited commercial availability. The standards reference for SAE is SAE J2954; the IEC reference is IEC 61851-1.

OBSOLESCENCE, UPGRADE, FUTUREPROOFING

A significant portion of the existing EV infrastructure has been installed for more than six years, or approximately two-thirds of its useful life. Many of these installations are not networked, employ older technology, have proprietary operating and billing systems, and are typically a lower power Level 2 installation.

As the industry grows and adapts, preparing for future demand will become increasingly necessary. Sites can be "future-proofed" by installing additional conduit and addressing other make-ready needs to support future growth. With a few small adjustments, the station can be upgraded to meet future demand without incurring substantial additional costs.

Provisioning the electrical capacity for upgrades during the initial charger construction can help support future demand changes. This includes laying extra conduit that can accommodate future power requirements and leaving space for additional transformers. When it is time to upgrade, installation costs will be significantly lower.

Future-proofing can also be achieved by installing a high-powered charging station upfront and then limiting its output power until necessary. For example, a site host may install a 350-kW charger but limit its output to 50 kW or 150 kW to save money until fast charging demand increases. As more power is needed, a software change and module exchange/additions allow the station to produce more power.

UPTIME, RESILIENCY AND BACKUP POWER

Many of the new EVSE installations include data network connectivity that allows the status monitoring of the installation, including whether the unit is online, how many ports are available, and other metrics.

Unfortunately, there are few established criteria for the performance of installations; it is not unusual for EVSE to be off-line for long periods of time. The cause for these issues can be traced to:

- Support abandonment by a manufacturer who is out of business,
- Low utilization
- No performance goals have been established
- No maintenance and support mechanism have been established

Fortunately, the availability and reliability of these installations is improving, due in large part to the entry of national-scale infrastructure providers that realize the need for monitoring and uptime.

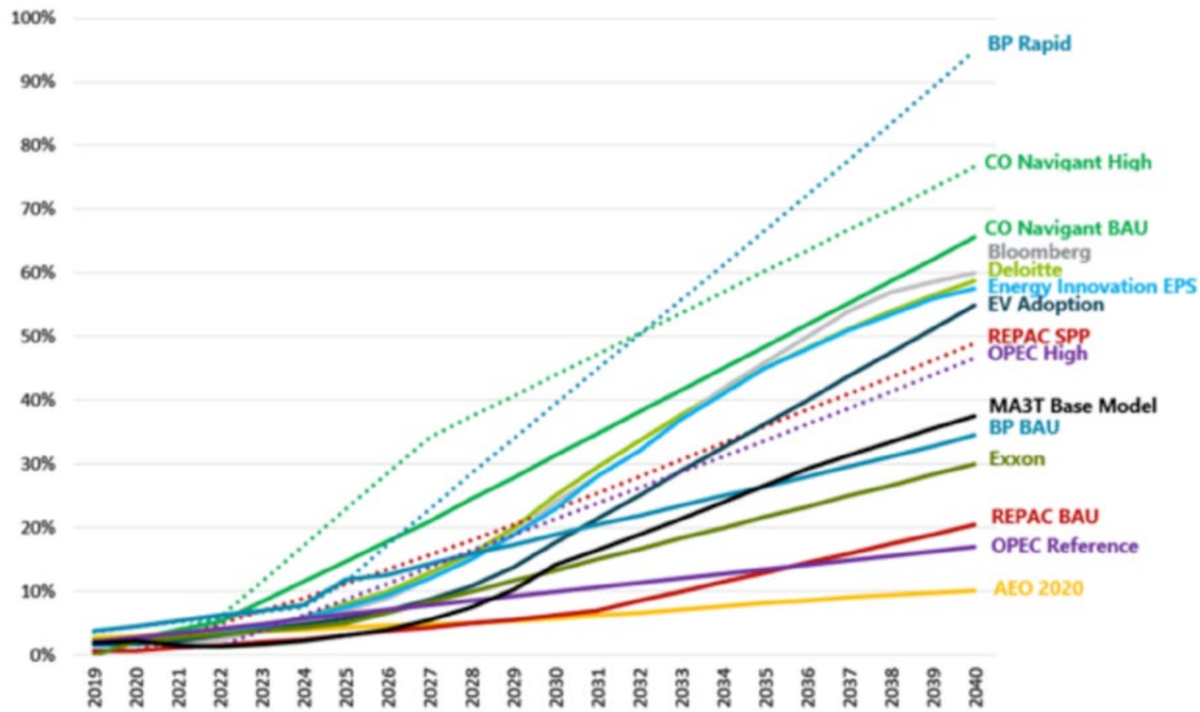
EVSE are critical installations that serve a life-line purpose and should be maintained as such. Backup power for EVSE installations is virtually non-existent but should be investigated as it provides critical uptime support for the installation. There is the very real possibility that backup batteries could also help mitigate demand charges for electrical power. Given the critical nature of these installations, requirements for uptime and availability of these installations needs to be addressed.

LIGHT-DUTY EV FLEET FORECAST: 2020-2030

The consensus across the U.S. EV industry is that sales will soon reach an inflection point where the market's growth function shifts from a linear increase to exponential. Once it reaches this point, sales will accelerate, rapidly expanding the market until it accounts for the majority of light-duty vehicle sales.

While many experts agree that the industry's tipping point is coming soon, there are differing opinions regarding the timeline and extent at which this growth will occur. Because so many variables influence the EV market, it is difficult to accurately predict future behavior. Several organizations have developed forecasting models to estimate EV adoption rates; some of the common models are shown below.

Figure 5-2: EV Light-Duty Vehicle Sales Reference Forecasts



Each model uses different assumptions and input variables, such as user behavior, travel demand, available vehicle models, technology advancements, government policies, etc. As the figure demonstrates, the longer the timeline, the greater the variance between models.

For this analysis, Florida's projected EV sales were found EIA's Annual Energy Outlook (AEO). The AEO is an annual report that presents an assessment by the EIA of the outlook for energy markets through 2050.The outlooks are developed using the National Energy Modeling System (NEMS), which is an integrated model that captures interactions of economic changes and energy supply, demand, and prices.

Found within the NEMS model, the Transportation Sector Demand Module is a computer-based energy demand model of the U.S. transportation sector. It includes four submodules, but for the purpose of this analysis, only the Light-Duty Vehicle (LDV) Submodule is needed. The LDV Submodule, which projects attributes and sales distributions of new LDVs, primarily consists of seven components:

1. **Manufacturer Technology Choice Component (MTCC)** – produces estimates of new light-duty vehicle fuel economy
2. **Regional Sales Component** – produces estimates of regional sales and characteristics of light-duty vehicles
3. **Consumer Vehicle Choice Component (CVCC)** – estimates market penetration of conventional and alternative fuel vehicles
4. **LDV Fleet Component** – estimates the stock of cars and trucks used in business, government, utility, and taxi fleets, along with the travel demand, fuel efficiency, and energy consumption by these fleets
5. **Class 2b Vehicle Component** – performs same functions as LDV Fleet component, but only includes Class 2b vehicles (trucks from 8,500 to 10,000 pounds)
6. **LDV Stock Accounting Component** – produces number and characteristics of total surviving fleet of LDVs, along with regional estimates of LDV fuel consumption
7. **Vehicle Miles Traveled Component (VMTC)** – projects the demand for personal travel in VMT per licensed driver

Overall, the Transportation Sector Demand Module is a complex model that uses an abundance of relevant data to generate accurate LDV projections. The model accounts for many variables, including vehicle price, vehicle range, fuel availability, battery replacement cost, performance, home refueling capability, maintenance costs, luggage space, make and model diversity or availability, fuel price estimates, and many more. A more in-depth description of the inputs/outputs, assumptions, methodology, estimation techniques, and source code can be found in EIA's Transportation Sector Demand Module Documentation Report.[8]

The AEO was chosen for this analysis as opposed to the other forecasting models because it offers a highly detailed analysis from a reputable source. Furthermore, the forecast is updated every year to align with actual sales data.

This analysis utilized AEO's "Light-duty Vehicle Sales: Total Cars and Light Trucks (Reference case, United States)", which expresses the total number of vehicle sales nationwide until 2050. All vehicle classes were filtered out except PHEVs and BEVs.

Since the AEO does not include state-level forecasts, the nationwide data was used to determine Florida's EV projections. The annual percent growth for PHEVs and BEVs was calculated using the national forecasts. Then, the same growth was applied to the known 2019 vehicle registration counts in Florida, accordingly. This process was then repeated for each year until 2030, resulting in an EV sales forecast for Florida that aligns with national growth.

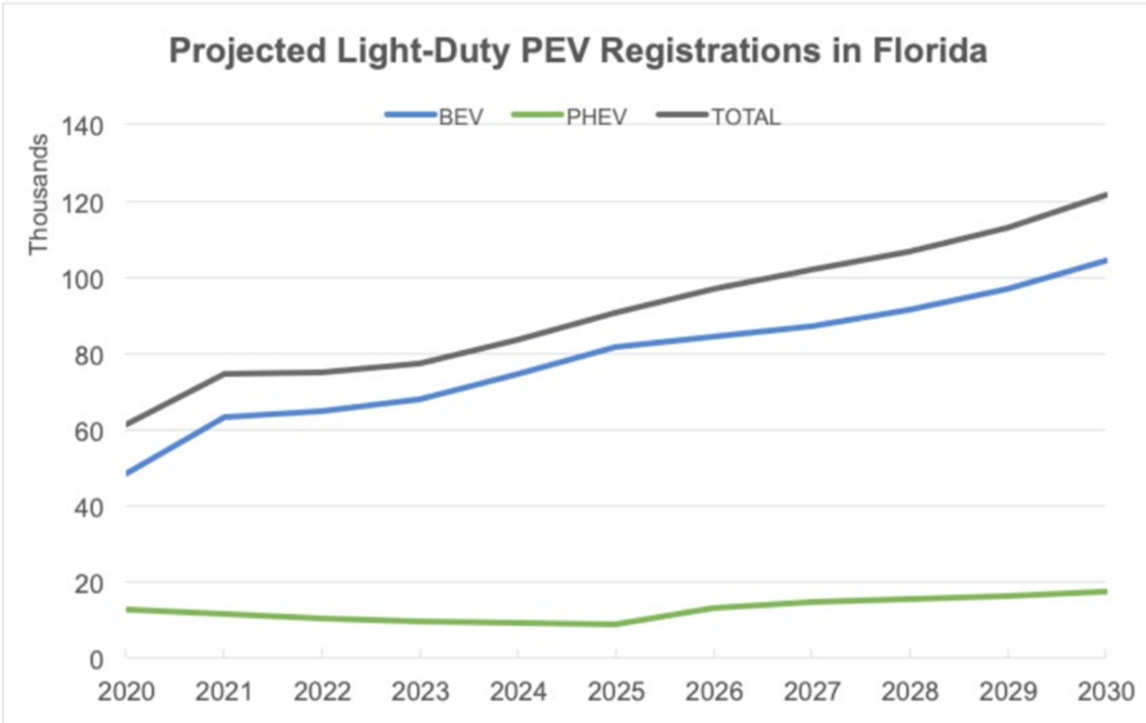
[8] https://www.eia.gov/analysis/pdfpages/m070index.php

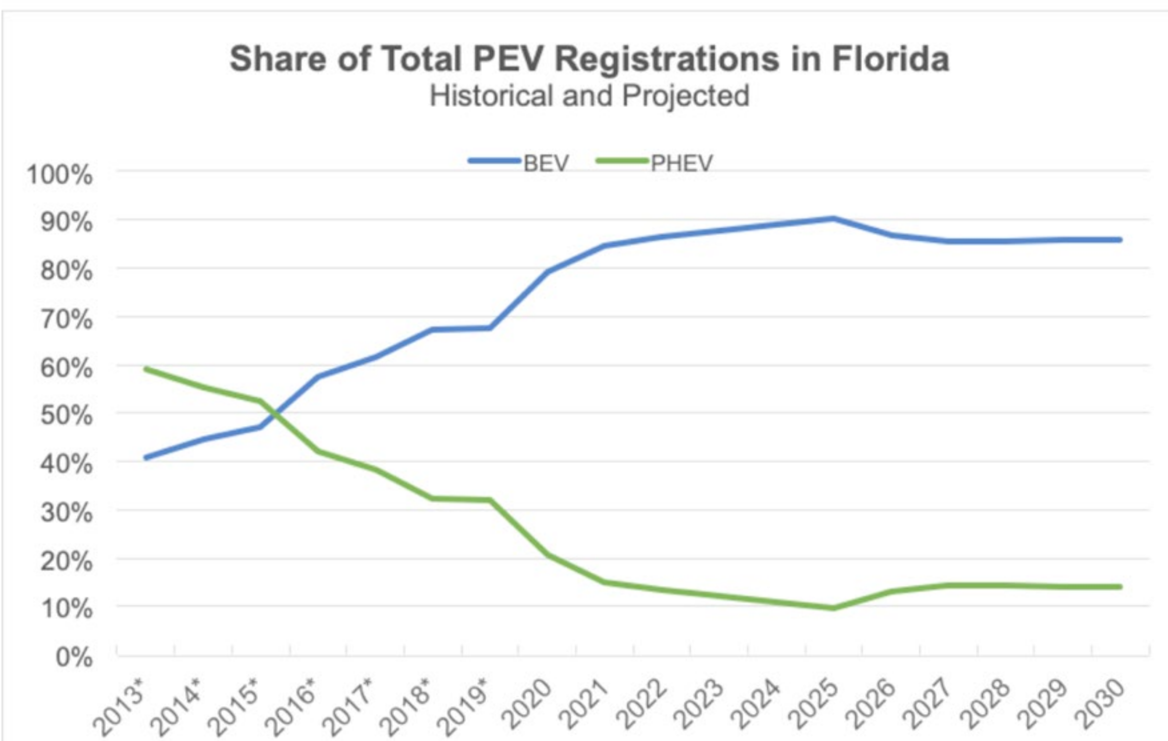
Before running the full analysis, the proposed growth formula process was reviewed and approved by EIA's expert in transportation demand forecasting. It is important to note that the national transportation model accounts for changes in population, so a large increase in Florida's population compared to the national average may impact the results. However, since the model is responding to many different factors, this is not expected to significantly impact our forecast.

The following figures illustrate Florida's 2020-2030 Light-Duty battery electric vehicle (BEV) and plug-in hybrid electric vehicle (PHEV) sales projections, which were found by applying the national growth rate to Florida.

FLORIDA LIGHT-DUTY PEV SALES
Historical (*) and Projected

YEAR	BEV	PHEV	TOTAL	% BEV	% PHEV
2013*	2,601	3,776	6,377	40.8%	59.2%
2014*	4,491	5,577	10,068	44.6%	55.4%
2015*	6,027	6,722	12,749	47.3%	52.7%
2016*	11,323	8,304	19,627	57.7%	42.3%
2017*	15,282	9,570	24,852	61.5%	38.5%
2018*	25,458	12,318	37,776	67.4%	32.6%
2019*	38,589	18,390	56,979	67.7%	32.3%
2020	48,294	12,678	60,972	79.2%	20.8%
2021	63,129	11,338	74,466	84.8%	15.2%
2022	64,581	10,036	74,617	86.6%	13.4%
2023	67,638	9,481	77,119	87.7%	12.3%
2024	74,292	9,104	83,396	89.1%	10.9%
2025	81,583	8,774	90,357	90.3%	9.7%
2026	84,009	12,833	96,841	86.7%	13.3%
2027	87,009	14,662	101,670	85.6%	14.4%
2028	91,208	15,409	106,617	85.5%	14.5%
2029	96,694	16,101	112,795	85.7%	14.3%
2030	104,152	17,259	121,411	85.8%	14.2%

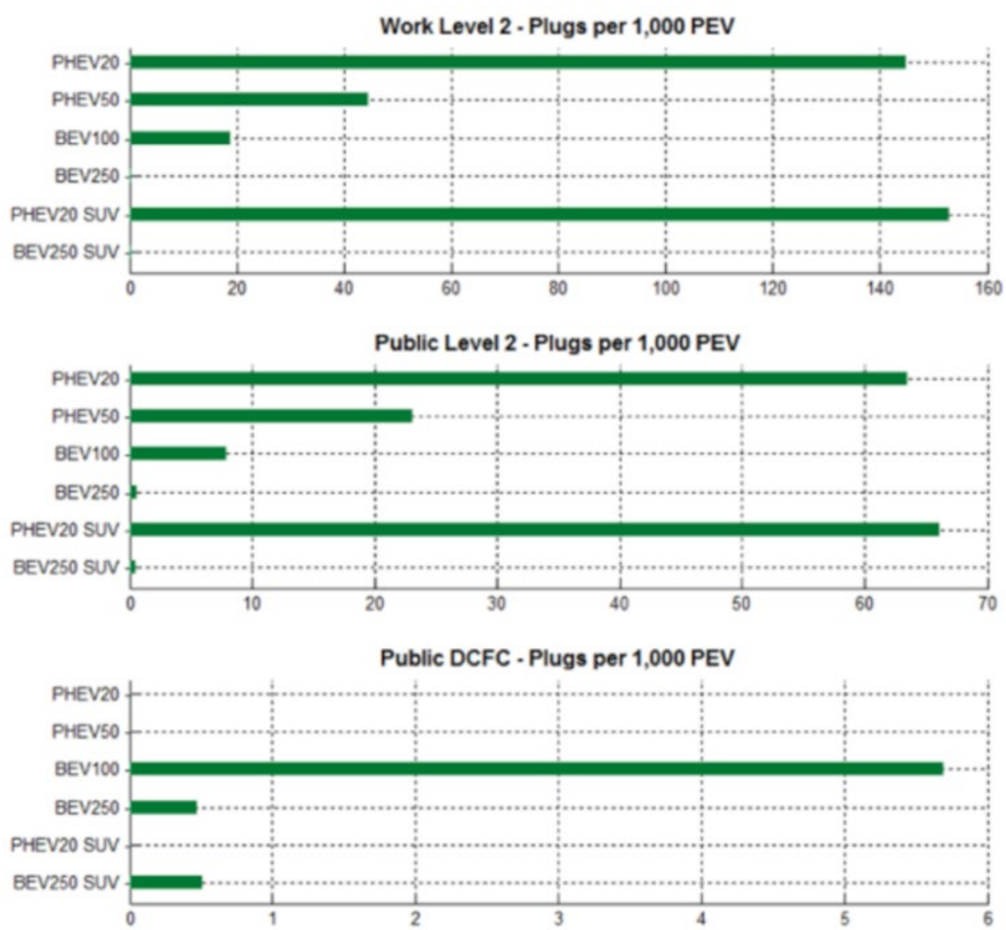

Projected Light-Duty PEV Registrations in Florida
BEV
PHEV
TOTAL
Thousands
140
120
100
80
60
40
20
0
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030


Share of Total PEV Registrations in Florida
Historical and Projected
BEV
PHEV
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2013*
2014*
2015*
2016*
2017*
2018*
2019*
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030

CHARGING INFRASTRUCTURE FORECAST: 2020-2030

As the number of EVs on the road increases, so will the need for additional charging infrastructure. A reliable public charging network is crucial to meet the needs of existing drivers and encourage prospective buyers. However, installing too much charging infrastructure without strong demand will lead to underutilization. To achieve balance between supply and demand, charging infrastructure needs should be estimated using EV sales forecasts.

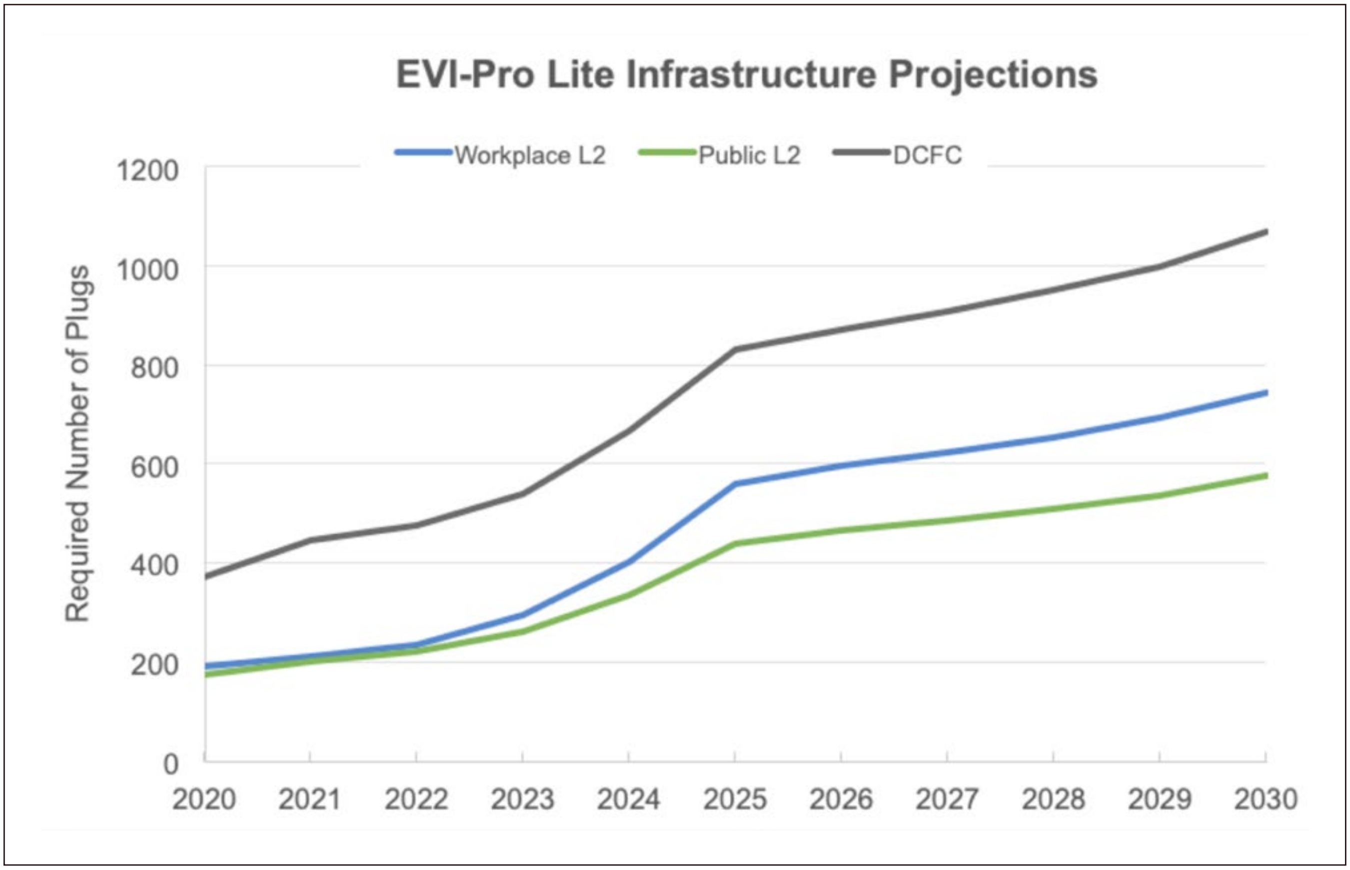
For this analysis, the NREL's EVI-Pro Lite tool was utilized to estimate future infrastructure needs based on projected charging demand. EVI-Pro Lite is an online tool that estimates the number of public Level 2, workplace Level 2, and DCFC stations required to support the input number of EVs.



Nominal non-residential EVSE/PEV ratios (home dominant charging behavior).

The EVI-Pro Lite tool allows the user to alter a few different inputs, including the number of vehicles to support, the vehicle share for different ranges, the amount of support for PHEVs, and the percent of drivers with access to home charging. The tool was executed for each year in the analysis timeline. Variables that remained constant for each iteration were support for PHEVs" and, "85 percent of drivers have access to home charging", which was based on the survey responses. The number of vehicles and vehicle share percentage were derived from the AEO and varied for each run.

The tool's output contains the projected number of workplace Level 2, public Level 2, and public DCFC plugs required to support the specified vehicle demand. The figure below displays Florida's infrastructure estimates for 2020-2030.



At the time of this report, there are 3,907 Level 2 charging plugs and 844 DCFC plugs located in Florida. A quick comparison between the current and projected needs reveals that Florida currently has enough Level 2 chargers throughout the state to meet infrastructure needs for the next ten years. With the planned DCFCs on Florida's interstates along with the existing DCFC network, there will be enough DCFC to meet projected charging demand until 2025. Following 2025, additional DCFC stations will need to be installed each year.

The EVI-Pro Lite model only accommodates analyses within a state or major city. NREL plans to release an update including county areas soon, the tool fails to offer a direct method for performing county-level analyses at this time. As a workaround, the infrastructure demands per county were calculated by scaling down the statewide estimates in proportion to each county's 2019 share of EVs and LDVs. To verify its accuracy, this approach was first approved by one of the EVI-Pro developers. The county-level infrastructure requirements for the year 2030 are shown below.

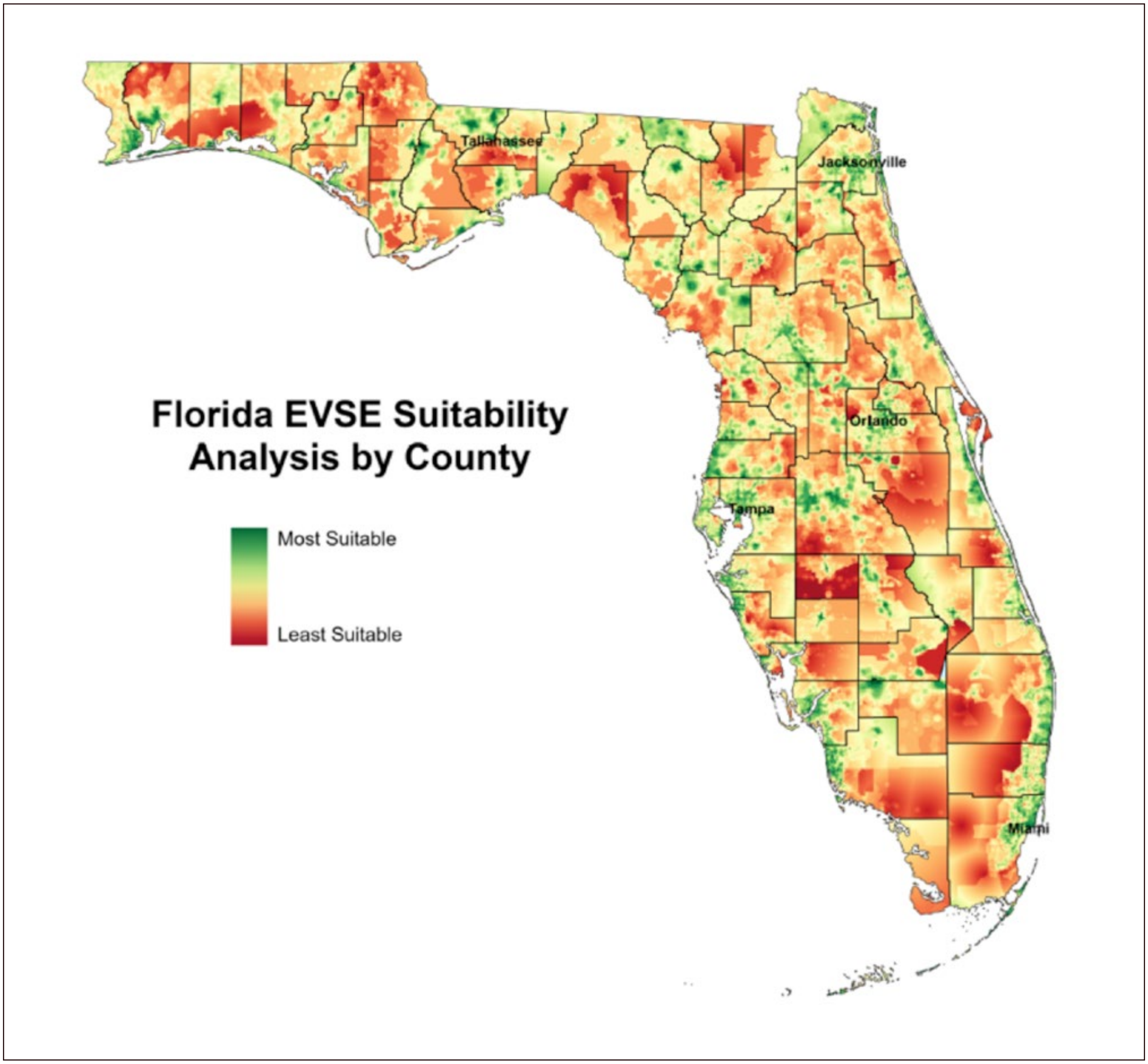
Using Geographic Information Systems (GIS), a suitability analysis was performed on each county to identify optimal areas to place these charging stations. The model looks at six different variables related to EV charging behavior: commercial land use, places of employment, high-density residential land use, population counts, registered EV counts, and existing station placement. Ideally, a charging station will be in a well-populated area near high commercial and economic activity, accessible to residents in multi-unit dwellings, and not too close to existing EVSE.

Before starting the model, the entire state was overlaid with a raster grid containing 0.5 mi x 0.5 mi cells. Each cell represents a 0.25 sq. mi. area of land. Then, all the input datasets were added to the model (blue ovals). Different geo-processing tools (yellow squares) were run on the datasets depending on the desired output. For instance, the "Kernel Density" tool was used on the commercial land use, employment, and high-density residential data to create a raster grid illustrating areas of high concentration. The "Euclidean Distance" tool was used on the existing charging station data, which created a distance raster that displays the distance from each cell to the nearest charging station. Finally, since the population and registered EV Shapefiles were already distributed among census tracts and zip code areas, respectively, they were simply converted to rasters.

Running the geo-processing tools, all six input variables were converted into the same raster grid made earlier. Each 0.25 sq. mi. grid cell contains six different values – one for each variable. However, the values were not yet useful because each dataset had a different scale. Thus, the "Reclassify" and "Rescale by Function" tools were run on each raster to convert the cell values into a common scale of 1-5. Before running the tool, each variable was classified into five quantiles, creating a class interval with the same frequency of observations per class. The "Reclassify" tool can then be used, allocating a value of 1-5 for each quantile class. After doing so, each cell contains six different values ranging from 1-5, where 1 is the least suitable, and 5 is the most suitable.

Finally, the six variable rasters were combined to create one suitability surface using the "Weighted Sum" tool. Different weights were assigned to each variable based on its significance to EVSE placement (Commercial=15%, Employment=10%, MUD=15%, Population=10%, Registered EVs=15%, Existing EVSE=35%), and the weighted values were summed together. The output of this analysis (shown below) is a suitability heat map for Florida that illustrates high priority locations.

The suitability heat map, along with commercial land use, major roadways, and average annual daily traffic (AADT) Shapefiles were used to determine the best charger locations to meet the charging infrastructure needs for the next three years



The following tables show EVI-Pro Lite infrastructure projections for each county and charging level from 2021-2030. The values in the table correspond to the projected number of plugs that will be needed to meet infrastructure demand in any given year.

PUBLIC LEVEL 2 INFRASTRUCTURE PROJECTIONS BY COUNTY
Based on EVI-Pro Lite Infrastructure Projections

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Alachua	2	3	3	4	5	6	6	6	6	7
Baker	0	0	0	0	0	0	0	0	0	0
Bay	1	1	2	2	3	3	3	3	3	4
Bradford	0	0	0	0	0	0	0	0	0	0
Brevard	6	7	8	10	13	14	15	15	16	17
Broward	23	25	29	37	49	52	54	57	60	64
Calhoun	0	0	0	0	0	0	0	0	0	0
Charlotte	2	2	2	3	4	4	4	4	4	5
Citrus	1	1	1	2	2	2	3	3	3	3
Clay	2	2	2	3	3	4	4	4	4	4
Collier	5	5	6	8	10	11	11	12	12	13
Columbia	0	0	0	1	1	1	1	1	1	1
Dade	26	29	34	44	57	61	63	66	70	75
Desoto	0	0	0	0	0	0	0	0	0	0
Dixie	0	0	0	0	0	0	0	0	0	0
Duval	8	8	10	13	17	18	18	19	20	22
Escambia	2	2	3	4	5	5	5	5	6	6
Flagler	1	1	1	2	2	2	3	3	3	3
Franklin	0	0	0	0	0	0	0	0	0	0
Gadsden	0	0	0	0	1	1	1	1	1	1
Gilchrist	0	0	0	0	0	0	0	0	0	0
Glades	0	0	0	0	0	0	0	0	0	0
Gulf	0	0	0	0	0	0	0	0	0	0

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hamilton	0	0	0	0	0	0	0	0	0	0
Hardee	0	0	0	0	0	0	0	0	0	0
Hendry	0	0	0	0	0	1	1	1	1	1
Hernando	1	1	2	2	3	3	3	3	4	4
Highlands	1	1	1	1	1	2	2	2	2	2
Hillsborough	14	15	17	22	29	31	32	34	36	38
Holmes	0	0	0	0	0	0	0	0	0	0
Indian River	1	2	2	2	3	3	3	4	4	4
Jackson	0	0	0	0	1	1	1	1	1	1
Jefferson	0	0	0	0	0	0	0	0	0	0
Lake	3	4	4	5	7	8	8	8	9	9
Lee	6	7	8	11	14	15	15	16	17	18
Leon	2	3	3	4	5	5	6	6	6	7
Levy	0	0	0	0	1	1	1	1	1	1
Liberty	0	0	0	0	0	0	0	0	0	0
Madison	0	0	0	0	0	0	0	0	0	0
Manatee	4	4	5	7	9	9	9	10	10	11
Marion	3	3	3	4	6	6	6	7	7	7
Martin	2	2	2	3	4	4	5	5	5	5
Monroe	1	1	1	2	2	2	2	2	3	3
Nassau	1	1	1	1	2	2	2	2	2	2
Okaloosa	2	2	2	3	4	4	4	4	4	5
Okeechobee	0	0	0	0	0	0	0	0	1	1
Orange	16	17	21	27	35	37	38	40	42	46
Osceola	3	3	4	5	6	7	7	7	8	8
Palm Beach	18	20	24	31	40	42	44	46	49	52
Pasco	5	5	6	8	10	11	11	12	12	13
Pinellas	10	11	13	17	22	24	25	26	27	29
Polk	5	5	6	8	10	11	11	12	12	13
Putnam	0	0	1	1	1	1	1	1	1	1

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Santa Rosa	1	1	2	2	3	3	3	3	4	4
Sarasota	5	6	7	9	12	12	13	13	14	15
Seminole	5	6	7	9	11	12	12	13	14	15
St. Johns	3	3	4	5	7	7	8	8	8	9
St. Lucie	3	3	3	4	5	6	6	6	7	7
Sumter	1	1	1	2	2	2	3	3	3	3
Suwannee	0	0	0	0	0	1	1	1	1	1
Taylor	0	0	0	0	0	0	0	0	0	0
Union	0	0	0	0	0	0	0	0	0	0
Volusia	4	5	6	7	10	10	10	11	12	12
Wakulla	0	0	0	0	0	0	0	0	1	1
Walton	1	1	1	1	2	2	2	2	2	2
Washington	0	0	0	0	0	0	0	0	0	0
TOTAL	204	222	263	339	443	468	489	512	540	579

WORKPLACE LEVEL 2 INFRASTRUCTURE PROJECTIONS BY COUNTY
Based on EVI-Pro Lite Infrastructure Projections

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Alachua	3	3	4	5	7	7	7	8	8	9
Baker	0	0	0	0	0	0	0	0	0	1
Bay	1	2	2	3	4	4	4	4	4	5
Bradford	0	0	0	0	0	0	0	0	0	0
Brevard	6	7	9	12	17	18	19	20	21	22
Broward	23	26	33	45	62	66	69	72	77	82
Calhoun	0	0	0	0	0	0	0	0	0	0
Charlotte	2	2	2	3	4	5	5	5	6	6
Citrus	1	1	2	2	3	3	3	3	4	4
Clay	2	2	2	3	4	5	5	5	5	6
Collier	5	5	7	9	13	13	14	15	16	17
Columbia	0	0	1	1	1	1	1	1	1	1
Dade	27	31	38	52	72	77	81	85	90	96
Desoto	0	0	0	0	0	0	1	1	1	1
Dixie	0	0	0	0	0	0	0	0	0	0
Duval	8	9	11	15	21	22	23	25	26	28
Escambia	2	3	3	4	6	6	7	7	7	8
Flagler	1	1	2	2	3	3	3	3	4	4
Franklin	0	0	0	0	0	0	0	0	0	0
Gadsden	0	0	0	1	1	1	1	1	1	1
Gilchrist	0	0	0	0	0	0	0	0	0	0
Glades	0	0	0	0	0	0	0	0	0	0
Gulf	0	0	0	0	0	0	0	0	0	0
Hamilton	0	0	0	0	0	0	0	0	0	0
Hardee	0	0	0	0	0	0	0	0	0	0

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hendry	0	0	0	0	1	1	1	1	1	1
Hernando	1	2	2	3	4	4	4	4	5	5
Highlands	1	1	1	1	2	2	2	2	2	2
Hillsborough	14	16	20	27	37	39	41	43	46	49
Holmes	0	0	0	0	0	0	0	0	0	0
Indian River	1	2	2	3	4	4	4	5	5	5
Jackson	0	0	0	0	1	1	1	1	1	1
Jefferson	0	0	0	0	0	0	0	0	0	0
Lake	3	4	5	7	9	10	10	11	11	12
Lee	7	7	9	13	17	19	20	20	22	23
Leon	2	3	3	5	6	7	7	7	8	8
Levy	0	0	0	0	1	1	1	1	1	1
Liberty	0	0	0	0	0	0	0	0	0	0
Madison	0	0	0	0	0	0	0	0	0	0
Manatee	4	5	6	8	11	12	12	13	13	14
Marion	3	3	4	5	7	8	8	8	9	10
Martin	2	2	3	4	5	6	6	6	7	7
Monroe	1	1	1	2	3	3	3	3	3	4
Nassau	1	1	1	2	2	2	2	2	3	3
Okaloosa	2	2	2	3	5	5	5	5	6	6
Okeechobee	0	0	0	0	1	1	1	1	1	1
Orange	17	19	23	32	44	47	49	51	54	59
Osceola	3	3	4	6	8	9	9	9	10	11
Palm Beach	19	21	27	36	50	54	56	59	63	67
Pasco	5	5	7	9	13	14	14	15	16	17
Pinellas	11	12	15	20	28	30	31	33	35	37
Polk	5	5	7	9	13	14	14	15	16	17
Putnam	0	0	1	1	1	1	1	1	1	1
Santa Rosa	1	2	2	3	4	4	4	4	5	5

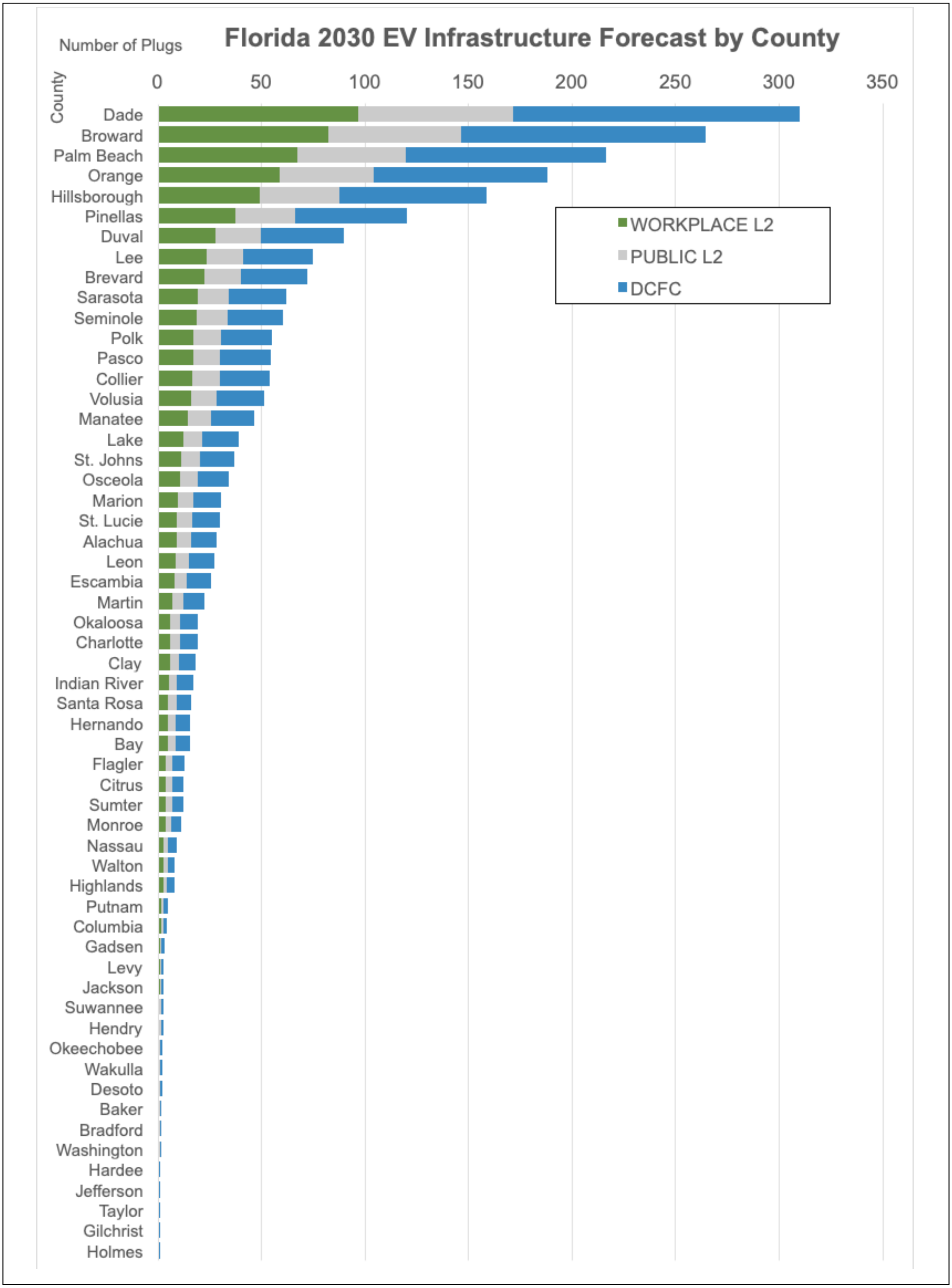
COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sarasota	5	6	8	10	15	15	16	17	18	19
Seminole	5	6	7	10	14	15	16	17	18	19
St. Johns	3	4	5	6	9	9	10	10	11	11
St. Lucie	3	3	4	5	7	7	8	8	9	9
Sumter	1	1	2	2	3	3	3	3	4	4
Suwannee	0	0	0	0	1	1	1	1	1	1
Taylor	0	0	0	0	0	0	0	0	0	0
Union	0	0	0	0	0	0	0	0	0	0
Volusia	5	5	6	9	12	13	13	14	15	16
Wakulla	0	0	0	0	1	1	1	1	1	1
Walton	1	1	1	1	2	2	2	2	2	3
Washington	0	0	0	0	0	0	0	0	0	0
TOTAL	210	236	296	404	559	596	625	655	693	745

DCFC INFRASTRUCTURE PROJECTIONS BY COUNTY
Based on EVI-Pro Lite Infrastructure Projections

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Alachua	5	6	6	8	10	10	11	11	12	13
Baker	0	0	0	0	1	1	1	1	1	1
Bay	3	3	3	4	5	6	6	6	6	7
Bradford	0	0	0	0	1	1	1	1	1	1
Brevard	13	14	16	20	25	26	27	29	30	32
Broward	49	52	60	74	92	96	100	105	111	118
Calhoun	0	0	0	0	0	0	0	0	0	0
Charlotte	4	4	4	5	7	7	7	8	8	9
Citrus	2	2	3	3	4	5	5	5	5	6
Clay	3	4	4	5	6	7	7	7	8	8
Collier	10	11	12	15	19	20	21	21	23	24
Columbia	1	1	1	1	2	2	2	2	2	2
Dade	58	62	70	86	108	113	118	123	130	139
Desoto	0	0	0	1	1	1	1	1	1	1
Dixie	0	0	0	0	0	0	0	0	0	0
Duval	17	18	20	25	31	33	34	36	37	40
Escambia	5	5	6	7	9	9	10	10	11	11
Flagler	2	3	3	4	4	5	5	5	5	6
Franklin	0	0	0	0	0	0	0	0	0	0
Gadsden	1	1	1	1	1	1	1	1	1	1
Gilchrist	0	0	0	0	0	0	0	0	0	1
Glades	0	0	0	0	0	0	0	0	0	0
Gulf	0	0	0	0	0	0	0	0	0	0
Hamilton	0	0	0	0	0	0	0	0	0	0
Hardee	0	0	0	0	0	0	0	1	1	1

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hendry	0	1	1	1	1	1	1	1	1	1
Hernando	3	3	4	4	5	6	6	6	7	7
Highlands	1	2	2	2	3	3	3	3	3	3
Hillsborough	29	31	36	44	55	58	60	63	66	71
Holmes	0	0	0	0	0	0	0	0	0	1
Indian River	3	3	4	5	6	6	6	7	7	8
Jackson	1	1	1	1	1	1	1	1	1	1
Jefferson	0	0	0	0	0	0	0	1	1	1
Lake	7	8	9	11	13	14	15	15	16	17
Lee	14	15	17	21	26	27	28	30	31	33
Leon	5	5	6	8	9	10	10	11	11	12
Levy	1	1	1	1	1	1	1	1	1	1
Liberty	0	0	0	0	0	0	0	0	0	0
Madison	0	0	0	0	0	0	0	0	0	0
Manatee	9	9	10	13	16	17	18	18	19	21
Marion	6	6	7	9	11	11	12	12	13	14
Martin	4	4	5	6	8	8	9	9	9	10
Monroe	2	2	3	3	4	4	4	5	5	5
Nassau	2	2	2	2	3	3	3	4	4	4
Okaloosa	4	4	4	5	7	7	7	8	8	9
Okeechobee	0	0	1	1	1	1	1	1	1	1
Orange	35	37	43	52	65	69	72	75	79	84
Osceola	6	7	8	10	12	13	13	14	14	15
Palm Beach	40	43	49	60	75	79	82	86	90	97
Pasco	10	11	12	15	19	20	21	22	23	24
Pinellas	22	24	27	33	42	44	46	48	50	54
Polk	10	11	12	15	19	20	21	22	23	25
Putnam	1	1	1	1	2	2	2	2	2	2
Santa Rosa	3	3	4	4	6	6	6	6	7	7
Sarasota	12	12	14	17	22	23	24	25	26	28

COUNTY	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Seminole	11	12	14	17	21	22	23	24	25	27
St. Johns	7	7	8	10	13	13	14	15	15	16
St. Lucie	6	6	7	8	10	11	11	12	12	13
Sumter	2	2	3	3	4	5	5	5	5	6
Suwannee	0	1	1	1	1	1	1	1	1	1
Taylor	0	0	0	0	0	0	0	0	0	1
Union	0	0	0	0	0	0	0	0	0	0
Volusia	10	10	12	14	18	19	20	20	21	23
Wakulla	0	0	1	1	1	1	1	1	1	1
Walton	2	2	2	2	3	3	3	3	3	4
Washington	0	0	0	0	1	1	1	1	1	1
TOTAL	445	475	541	666	832	873	910	951	1001	1070


Florida 2030 EV Infrastructure Forecast by County
Number of Plugs
County
0
50
100
150
200
250
300
350
WORKPLACE L2
PUBLIC L2
DCFC
Dade
Broward
Palm Beach
Orange
Hillsborough
Pinellas
Duval
Lee
Brevard
Sarasota
Seminole
Polk
Pasco
Collier
Volusia
Manatee
Lake
St. Johns
Osceola
Marion
St. Lucie
Alachua
Leon
Escambia
Martin
Okaloosa
Charlotte
Clay
Indian River
Santa Rosa
Hernando
Bay
Flagler
Citrus
Sumter
Monroe
Nassau
Walton
Highlands
Putnam
Columbia
Gadsden
Levy
Jackson
Suwannee
Hendry
Okeechobee
Wakulla
Desoto
Baker
Bradford
Washington
Hardee
Jefferson
Taylor
Gilchrist
Holmes

CHARGING INFRASTRUCTURE LOCATIONS: 2021-2023

While Florida's existing charging infrastructure meets the projected infrastructure need at the state level for the next three years, the charging stations are not evenly distributed, so some counties require additional infrastructure and other counties have more infrastructure installed than is required to meet charging needs.

The number of existing EVSE plugs and planned plugs for each county were subtracted from EVI-Pro Lite's projected EV infrastructure needs to determine if additional stations will be necessary in the next three years. Additional infrastructure needs are highlighted in red in the table below. The negative numbers indicate the number of installed EVSE over the projected EV infrastructure needs in a county.

ADDITIONAL DCFC INFRASTRUCTURE REQUIREMENTS
Based on EVI-Pro Lite Infrastructure Projections

COUNTY	EXISTING DCFC PLUG COUNT	PLANNED FDEP PLUG COUNT	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED
Alachua	14	2	5	-11	6	-10	6	-10
Bradford	0		0	0	0	0	0	0
Citrus	0		2	2	2	2	3	3
Gilchrist	0		0	0	0	0	0	0
Lake	17		7	-10	8	-9	9	-8
Hernando	0	2	3	1	3	1	4	2
Levy	0		1	1	1	1	1	1
Marion	9		6	-3	6	-3	7	-2
Sumter	8	2	2	-8	2	-8	3	-7
Brevard	31	4	13	-22	14	-21	16	-19
Indian River	9	2	3	-8	3	-8	4	-7
Martin	1		4	3	4	3	5	4
Okeechobee	18		0	-18	0	-18	1	-17
Orange	45	8	35	-18	37	-16	43	-10
Osceola	30		6	-24	7	-23	8	-22
Seminole	13		11	-2	12	-1	14	1
St. Lucie	19	2	6	-15	6	-15	7	-14
Desoto	0		0	0	0	0	0	0
Hardee	0		0	0	0	0	0	0
Highlands	5		1	-4	2	-3	2	-3

COUNTY	EXISTING DCFC PLUG COUNT	PLANNED FDEP PLUG COUNT	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED
Hillsborough	51	4	29	-26	31	-24	36	-19
Manatee	0		9	9	9	9	10	10
Pasco	9		10	1	11	2	12	3
Pinellas	35	2	22	-15	24	-13	27	-10
Polk	21		10	-11	11	-10	12	-9
Sarasota	22	4	12	-14	12	-14	14	-12
Baker	0		0	0	0	0	0	0
Columbia	10	2	1	-11	1	-11	1	-11
Dixie	0		0	0	0	0	0	0
Franklin	2		0	-2	0	-2	0	-2
Gadsen	0		1	1	1	1	1	1
Hamilton	0	2	0	-2	0	-2	0	-2
Jefferson	0		0	0	0	0	0	0
Leon	13		5	-8	5	-8	6	-7
Liberty	0		0	0	0	0	0	0
Madison	0		0	0	0	0	0	0
Suwannee	12		0	-12	1	-11	1	-11
Taylor	4		0	-4	0	-4	0	-4
Union	0		0	0	0	0	0	0
Wakulla	0		0	0	0	0	1	1
Bay	9		3	-6	3	-6	3	-6
Calhoun	0		0	0	0	0	0	0
Escambia	4		5	1	5	1	6	2
Gulf	0		0	0	0	0	0	0
Holmes	0		0	0	0	0	0	0
Jackson	0		1	1	1	1	1	1
Okaloosa	0		4	4	4	4	4	4
Santa Rosa	0		3	3	3	3	4	4
Walton	5		2	-3	2	-3	2	-3
Washington	4		0	-4	0	-4	0	-4
Clay	0		3	3	4	4	4	4
Duval	32	6	17	-21	18	-20	20	-18
Flagler	0	2	2	0	3	1	3	1

COUNTY	EXISTING DCFC PLUG COUNT	PLANNED FDEP PLUG COUNT	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED	PROJECTED DCFC PLUG COUNT	ADDITIONAL PLUGS TO BE PLACED
Nassau	0	2	2	0	2	0	2	0
Putnam	1		1	0	1	0	1	0
St. Johns	19	4	7	-16	7	-16	8	-15
Volusia	41	8	10	-39	10	-39	12	-37
Charlotte	6		4	-2	4	-2	4	-2
Collier	15	2	10	-7	11	-6	12	-5
Glades	0		0	0	0	0	0	0
Hendry	0		0	0	1	1	1	1
Lee	24	2	14	-12	15	-11	17	-9
Broward	81	8	49	-40	52	-37	60	-29
Dade	134		58	-76	62	-72	70	-64
Monroe	9		2	-7	2	-7	3	-6
Palm Beach	45	4	40	-9	43	-6	49	0

EMERGENCY EVACUATION OF FLORIDA'S EVS

Florida has a unique geography that makes it exceptionally susceptible to impacts from tropical storms and hurricanes, with a total of 11 hurricane strength cyclones impacting the state in 2019.[9] The frequency and strength of these storms is expected to increase in the future, along with the population of Florida. For the purposes of this analysis, a hurricane scenario has been assumed.

This analysis is considering DCFC charging infrastructure only; Level 2 and Level 1 charging are adequate for the charge needed to leave the home, but do not have the charging speed to support a large-scale rapid evacuation. EV infrastructure problems discussed in this report are not unique to Florida, they are shared by every other state; in fact, Florida is seen a leader in addressing these issues.

The owners of EVs in Florida face several challenges when needing to evacuate during an emergency, beginning the moment they know an evacuation is eminent. Their first orders of business will be to review their evacuation path and start charging their car. Like most vehicle owners, EV owners are closely tied to the refueling infrastructure. There is charging infrastructure in major metropolitan areas, infrastructure in other parts of the state is limited.

There are approximately 186 publicly accessible high-speed chargers in Florida from a variety of providers, and Tesla currently has 327 fast chargers in the state.[10] The ratio of Tesla vehicles to fast chargers is 96 vehicles per fast charger, the ratio of all other EV vehicles in the state to publicly available fast chargers is 138 vehicles per charging station.

Currently there is little infrastructure in the interior of the state to support evacuation, significant portions of I-75, and I-10 in the panhandle have very little fast charging. There are over 60,000 light-duty EVs registered in Florida, and most of them are within a few miles from one of our coasts.

The light-duty EV population grew by an average of 1,600 vehicles per month in 2019, an adoption rate 32 percent higher than 2018, and more than four times the monthly adoption rate of 2017; the rate of adoption will continue to increase, bringing more urgency to addressing evacuation issues. The acceptance and growth of EVs continues to accelerate in Florida, and reliable, high-speed EV charging facilities are needed to support the evacuation of owners during an emergency.

[9] https://en.wikipedia.org/wiki/List_of_Florida_hurricanes_(2000%E2%80%93present).

[10] https://afdc.energy.gov/stations/#/analyze?region=US-FL&country=US&fuel=ELEC&status=E&status=T&ev_levels=dc_fast

CONSIDERATIONS SPECIFIC TO EVS

Light duty EVs are required to have all the safety features of conventionally fueled vehicles. EVs have fail-safe mechanisms to shut down their electrical systems very rapidly, and their sealed battery systems are impervious to water intrusion. EVs also have a low center of gravity, due to the batteries being carried in the chassis; rollovers during accidents is much less likely to occur.

Range anxiety, the fear of not having enough battery energy to complete a trip, limited the EV adoption rate for years; however, electric vehicle technology and efficiencies have consistently improved. The average range of yearly models has shifted from approximately 75 miles, to 250 miles in the past decade. The standard 2019 Chevy Bolt has a range of 259 miles; Tesla Model 3s can be upgraded to 322 miles of range. EV manufacturers have announced near-term production models with over 400 miles of range, equal to, and greater than, most models of conventionally fueled vehicles.

The 2020 Battery Electric Vehicle lineup features all-electric ranges between 123 and 402 miles, many older models have ranges under 100, which is not as practical for long distance highway travel. Despite the travel range increases, adequate infrastructure is still an issue, especially for those with EVs that have shorter travel ranges; a problem that seriously complicates planning for an evacuation.

With the threat of a hurricane, EV drivers cannot spare much time to stop and charge their vehicles. Level 1 and 2 charging stations, which take hours to fully charge an EV's battery, are not adequate for evacuation travel. Alternatively, DCFC stations can charge many batteries to 80 percent capacity in a half hour or less. EV charging lengths vary depending on the model and charger type, but even the quickest chargers take over three times the amount of time it takes to fuel a gasoline vehicle.

DCFC has various power levels, most current installments charge at a maximum rate of 50 (kW, but higher output stations are being deployed by infrastructure providers. Soon, stations with speeds of 150 to 350 kW can cut charge times to10 minutes or less. Eventually, a robust network of high output DCFC stations will make EV charging times comparable to conventional fueling methods. Higher output DCFC stations will facilitate hurricane evacuations and daily long-distance travel.

Charger wait times may lead to more delays. During evacuations, thousands of drivers travel along the same roads around the same time. The heightened traffic flow leads to escalated fuel demands along major corridors, often to the point of depletion. It is common to see gas stations lines extending to five cars or more, but since it only takes a few minutes to fill up, the lines move relatively quickly. Drivers also have the option of finding another station nearby if wait times become too long.

EV drivers do not have the same convenience. DCFC locations can only accommodate one or two vehicles at a time, and a fast charge takes about a half-hour. An expected charge time of a half hour can potentially turn into one or two hours due to high wait times. EV chargers are limited and not as widespread as gas stations, so drivers probably will not have the freedom of finding another station in the area.

Real-time data is a simple way to check charger availability before driving to the station. Most EV charging network providers have apps that display information such as availability and remaining charge time. Some providers offer ways to reserve chargers before arriving. This can help warn drivers ahead of time but might not provide much benefit in cases where that charger is their only option. A better way to reduce wait times, and prepare for more EVs on the road, is to install more charging outlets at each station. Tesla's proprietary fast charging stations have an average of 10 outlets per station, and drivers rarely complain about long wait times. Having more charging points will increase turnover, allowing more drivers to charge with less waiting. A station with 10 charging ports can service up to 240 vehicles during a 24-hour period, which can make a big difference during evacuations.

MOVING FORWARD

EVs are a small but a rapidly growing segment of the light-duty vehicle market, if only half of EV owners evacuate Palm Beach, Broward, and Dade County evacuate, it would result in an exodus of over 10,000 vehicles, transporting 15-20,000 Florida residents. The current rate of EV adoption averages about 1,600 units per month, if the adoption rate and evacuation rate remained constant for ten years, over 96,000 EVs with over 144,000 passengers would need to be accommodated. These numbers are based on a linear adoption rate. However, EV sales are expected to increase exponentially over the next 10-20 years.

Power outages caused from major weather events are problematic and likely. Weather is the largest cause of electric disturbance events in the United States. A hurricane can produce widespread power outages that last for days. In 2017, Hurricane Irma left 60 percent of the state without power at its peak, and over 300,000 customers were still without power a week later.[11] Without electrical supply at charging stations, EV drivers who evacuated have no means to make it back home, and those drivers may be stranded without transportation for days.

[11] https://www.eia.gov/todayinenergy/detail.php?id=32992

Several methods of temporary charging have been developed, including small self-contained portable battery systems, larger scale battery systems on heavy duty trucks, and stand-alone, transportable, temporary charging installations.

All these solutions have drawbacks, but some offer capabilities beyond charging EVs. Portable, self-contained systems are now available that can be used to charge EVs and provide clean power for emergency installations such as field medical facilities and shelters. The systems can be tied to the electrical grid or installed as stand-alone systems that use solar photovoltaic (PV) and battery storage to provide power for vehicle and equipment. These systems could also be deployed to determine the charging utilization potential, prior to an investment in a permanent installation.

Optionally Equipped with Emergency Power Panel Access

- Total continuous power - 25A @ 240VAC max
- Breakers
  - 1x 30A main 240V breaker
  - 2x 20A push to reset 120V breakers
    - Outlets (refer to NEMA Guide for outlet graphics
      - 240V (not GFCI protected)
      - 1x NEMA L14-30 (twist lock)
  - 120V (GFCI protected)
    - 2x Duplex NEMA 5-20
    - 2x NEMA L5-20 (twist lock)
- Protection
  - All outlets and breakers equipped with waterproof covers and boots
  - Lockable metal cover plate assembly when stowed and not in use
    - Comes standard with generic padlock and key – can be swapped out for local standard emergency lock
    - Cover plate assembly unfolds to double as weather shield while system is in use
- Other features
  - Low battery red light
  - White night light
  - Manual visible labeling and decals
  - Highly visible labeling and decals

Panels comes fully assembled and factory tested with power and control connector whips for rapid installation (mating harnesses required in ARC.

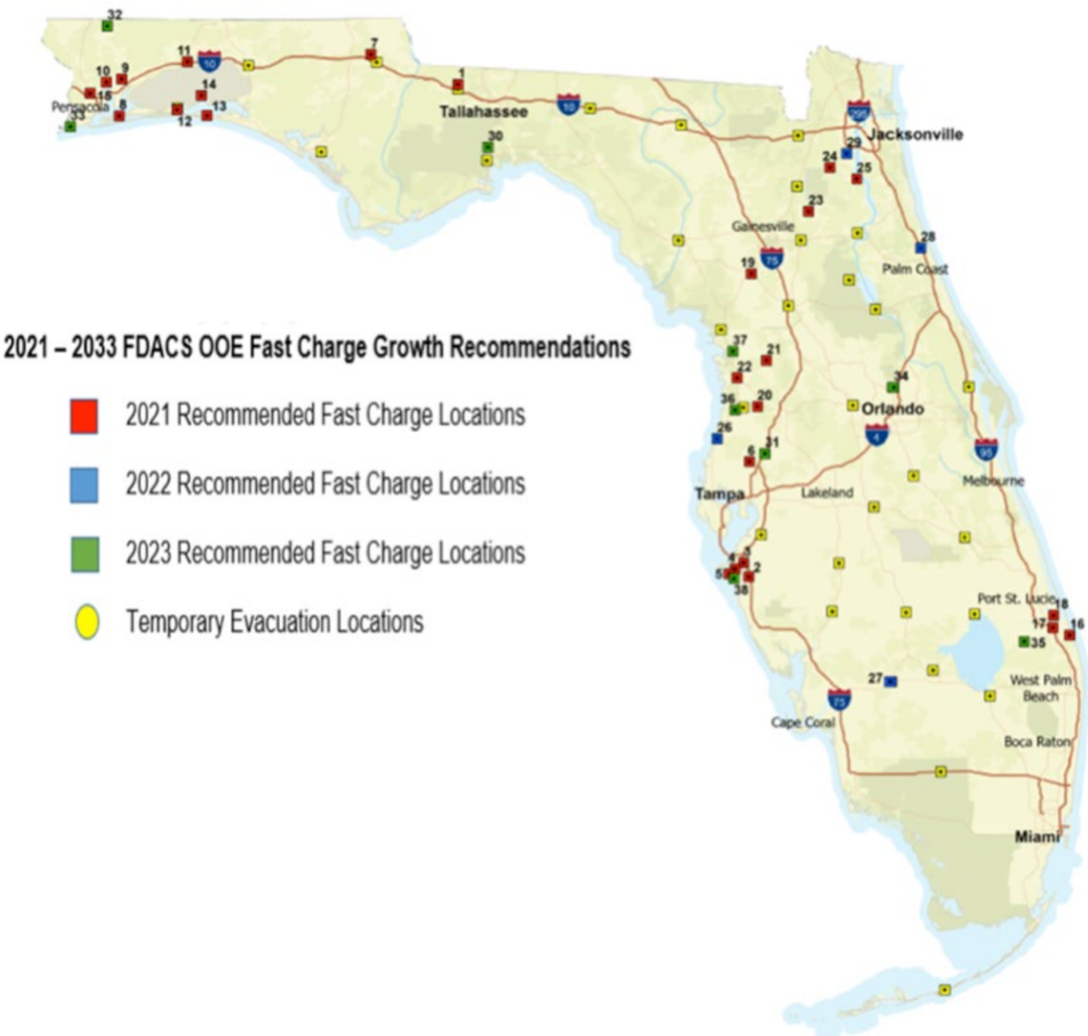
Photo: Envision Solar

The state of Florida and infrastructure providers investing in our state have been diligent in preparing for the increasing adoption of EVs. Several processes and procedures addressing evacuations need to be understood more thoroughly; such as, staffing and restoration priorities of infrastructure providers, provisioning of spare equipment, security, notifications, and other critical factors need to be better understood.

A possible short-term solution is the acquisition of portable charging, as has been previously described. If these portable charging systems would be deployed to either the north, central or southern part of the state in response to a particular hurricane, it is estimated that 12 of these units could provide significant capacity for EV owners in each particular region of the state. Based on current retail pricing, the estimated cost for 12 units is $ $840,000.

Below is a map illustrating recommended locations for installing temporary charging, they are largely in the underserved rural areas. Periodically, these locations also serve as a bridge between I-75 and I-4, providing alternative routes with less congestion and more opportunities to charge. The availability of commercial power has been confirmed, any required make-ready for the site has not been determined. A tie to the grid is not required since these are self-contained, solar powered units; a grid tie would be desirable to trickle charge the battery storage and provide backup power. These units also have emergency power to support other hurricane relief efforts.

FL MAP WITH FDACS OOE SITE RECOMMENDATIONS



Given the probability of hurricanes in Florida, and the accompanying power outages, it is recommended that solar power with battery backup and storage be considered for critical installations. Solar power and battery storage are expensive add-ons to a charger; given the vulnerability of the rapidly growing population of EV owners, some methodology needs to be developed to support these ancillary systems. Moreover, there is and environmental benefit in EVs charging with renewable power.

There are several other future opportunities for EVs in addressing hurricane impacts, including home emergency power from the EV. As EV battery systems continue to grow in power capacity, the use of their stored energy capabilities will increase. The battery systems in the vehicles can provide emergency power to the owner's home for a significant period of time; combining residential solar photovoltaics (PV) with an EV battery system extends and increases the emergency power capabilities. The increase in storage capacity for vehicles is particularly useful when heavy-duty electric vehicles are considered. Electric school buses configured to output their stored power could be very valuable in an emergency. Florida currently has 46 schools with solar PV installed that provides power to the emergency shelter using 10kW arrays. An electric school bus with its 160kW of stored energy would be a dramatic improvement for the school shelters, extended care facilities, etc.

The broad availability of both light-duty and heavy-duty vehicles should be aggressively investigated by governmental agencies, most of whom have no requirement for the consideration of EVs. Many EV applications have been developed, from pickup trucks with exportable power, to garbage trucks and street sweepers; all using clean fuel, a lower cost of ownership and other potential benefits.

EV OWNER SURVEY ANALYSIS

As a follow-up to the public webinars, an online survey was conducted to solicit feedback from one of the largest stakeholder groups, the end-users. The survey's objective was to gain a better understanding of Florida's current charging infrastructure from those with first-hand experience. It served as a platform for Florida EV drivers to communicate their specific needs and concerns. We believe this is the first survey of this nature to be conducted in Florida.

The online survey consisted of sixteen multiple-choice questions and was open to the public from August 11, 2020 to August 25, 2020. FDACS OOE hosted the survey for advocacy groups, local governments, and other relevant stakeholders. Questions were focused on the user's environment, behavior, or opinions about Florida EV infrastructure. Several questions were rephrased and asked a second time to validate consistency. Not all participants answered every question.

There were 663 total responses. Respondents needed to meet two conditions: own a PHEV/BEV and live in Florida. The first two questions served as a screening process, and if respondents did not meet either requirement, they were unable to continue. Excluding this group, the survey received a total of 532 responses from eligible participants.

The survey response data was comparatively analyzed to gain a better understanding of the relationships between responses to different questions. For example, how does vehicle range impact the respondent's feelings towards public charging infrastructure, how does type of residence relate to charging behavior, etc. Comparing inter-related questions helped identify several patterns.

The EV Owner Survey Analysis outlines the methodology, results, conclusions, and key takeaways from the survey. The full report is available as an addendum to this report.

EV INFRASTRUCTURE DEPLOYMENT RECOMMENDATIONS

Sound policy for EVs and EV infrastructure is crucial for their adoption and success in our state. Therefore, we have included recommendations for areas in need of policy development.

PLANNING

EV infrastructure planning continues to advance in its sophistication and application. The planning is largely carried out by four major entities, the providers of network-based infrastructure, municipalities, counties, and power service providers. Additional planning, on a smaller scale, takes place at airports and destination locations, such as Florida's theme parks.

EVs are mechanically much simpler than traditional internal combustion engines that use gasoline. EVs do not require radiators, belts, or engine and transmission overhauls, or the petroleum products needed for these devices. Auto manufacturers are fully committed to electric transportation, and customers such as Amazon and UPS are prepared to purchase over 100,000 electric delivery vehicles as soon as they can be manufactured.

There are now EVs for every imaginable transportation need, from street sweepers to heavy duty delivery vehicles and police motorcycles. Regional short-haul trucking firms are converting to electric, and long-haul carriers are also committing to the EV segment, powered by hydrogen fuel cells.

The lower total cost of ownership and longer life of these vehicles will have profound positive impacts on all segments of transportation, especially disadvantaged and mobility starved communities as these communities are affected more by transportation-related pollution and spend a disproportionate amount of their income on gas and public transit costs. As the EV population and technology advance, additional attention and coordination will be needed for infrastructure development.

INSTALLATION PERMITTING

Webinar participants, and others, noted that installation permitting requirements are subject to local jurisdictional requirements that vary from jurisdiction to jurisdiction. Significant amounts of time can be required to educate authorities about EV infrastructure technology, resulting in delays to deployment. The development of EV ordinances addressing requirements and considerations by local jurisdictions for EV infrastructure would benefit the jurisdiction, the infrastructure developer, and the general public.

Although there is a healthy infrastructure development environment in Florida, there has been little coordination of efforts and no established standards for performance and availability.

TRANSPORTATION NETWORK COMPANIES (TNCS), TAXIS AND SHUTTLES

Florida businesses providing transportation services are beginning to convert to electric transportation using vehicles designed to address their needs. Services such as Lyft and Uber have already impacted parking, and arrival and departure services at airports, convention centers, hotels and other high transit areas. The shift to more electric taxis and shuttles will accelerate as prices for these vehicles decrease and the lower total cost of ownership becomes clearer.

These services are fuel intensive operations, regardless of what fuel is use. Demand for high-powered EV charging in close proximity to previously mentioned travel destinations will increase substantially. There are significant health and environmental advantages that can be realized by investing in these high-traffic environments.

Many hotels and vacation destinations now offer some level of EV charging for their guest, typically Level 2. Direct current fast chargers (DCFC) in the urban core and at convention and hotel clusters will be required to support business and vacation travel. Additional Level 2 charging in parking garages and lots will be required to support multi-day business and vacation travel.

DISADVANTAGED COMMUNITIES

Historically economically disadvantaged communities, which include low-income communities and communities of people of color, are areas which have been disproportionately impacted from a combination of economic, health, and energy related burdens.

Disadvantaged communities are disproportionately harmed because of their proximity to multiple sources of pollution, including industrial facilities, bus depots, and truck corridors. They have been an unwilling victim of transportation planning, typically through permanent disruption of their neighborhoods. As well as adverse health and occupational impacts related to transportation disproportionally affecting these communities.

Low-income communities and communities of people of color bear disproportionate climate change and pollution burdens, and therefore, these communities must be among the first to receive investment relating to new technologies and infrastructure that address the climate crisis and mitigate localized environmental pollution.

Electric transportation's significantly lower total cost of ownership presents a real opportunity to improve disadvantaged communities transportation access, allowing them to commute to better jobs, health care and other services that cannot be accessed through public transportation; all while enjoying a quieter and cleaner community.

RURAL COMMUNITIES

Drivers in rural communities have different travel behaviors and vehicle preferences than their urban counterparts. It is precisely these differences that give drivers in rural communities the greatest economic potential for gain by purchasing an EV. Drivers living outside of urban areas often have farther to travel to work, shop, and visit a doctor. They have to repair their vehicles more frequently, they produce more carbon emissions per capita, and they spend more money on gasoline.

There are three main barriers preventing rural drivers from switching to EVs: vehicle range, limited vehicle choices, and lack of charging infrastructure. EVs manufacturers are addressing the first two concerns by providing vehicles with travel ranges in excess of 100 miles as well as promising to provide more vehicle choices including pickup trucks. However, more EV charging infrastructure is needed to address the third concern.

One reason EV charging infrastructure is not prevalent in rural communities is because it more difficult to find optimal areas for public charging infrastructure as these areas are more remote with a low population density. Collaboration between local and regional transportation agencies along with the local electric utility provider will guarantee a connected network with higher utilization. Placed appropriately, EV charging infrastructure in rural areas would also ensure evacuation routes are complete for EV drivers when a natural or man-made disaster occurs.

FINANCING AND INCENTIVES

Securing financing for EV infrastructure is particularly challenging, due largely in part to the low return on investment and lack of supporting policy decisions. The business case for capital intensive infrastructure is not particularly attractive, owing to the relatively low adoption rate for EVs and the revenue they generate. Fortunately, private companies are providing infrastructure, accepting the risk, and counting on the rapidly growing EV population.

There are several methods of financing the installation of EV infrastructure in Florida. Established providers can access private financing from financial institutions, internal sources, and grants and awards provided by federal sources such as the U.S. Departments of Energy, Transportation, and Environmental Protection. Philanthropic foundations can also be a source of funding. Counties, municipalities, and other governmental or quasi-governmental agencies largely depended on federal grants to support the installation of infrastructure.

STATE OF FLORIDA

The state of Florida currently provides funding for the installation of EV infrastructure through funding from Florida's Volkswagen Settlement. Florida Department of Environmental Protection (FDEP) manages the state's share of the EPA's lawsuit against Volkswagen for actively falsifying emissions test results for their diesel vehicles. The state allocated the maximum amount allowable for EV infrastructure under the $167 Settlement, $25 million (15 percent). The settlement funds for infrastructure are largely targeted for the installation of DCFC units to close existing charging gaps on Florida's Interstates and other major roads.

Volkswagen funding for infrastructure purchased with electric school busses, as well as funding to support infrastructure for electric medium and heavy-duty vehicles is also available through the FDEP, under the federal Diesel Emissions Reduction Act (DERA). See the FDEP's Volkswagen Settlement website for details.

FEDERAL HIGHWAY ADMINISTRATION (FHWA)/USDOT

Under the Congestion Mitigation and Air Quality Improvement Program a state may obligate funds a project or program to establish electric vehicle charging stations or natural gas vehicle refueling stations for the use of battery powered or natural gas fueled trucks or other motor vehicles at any location in the State except that such stations may not be established or supported where commercial establishments serving motor vehicle users are prohibited by section 111 of title 23, United States Code.

Highway Infrastructure Program funds may be used to provide necessary charging infrastructure along corridor-ready or corridor-pending alternative fuel corridors designated pursuant to 23 U.S.C. 151

ADDITIONAL INCENTIVES

Several Florida power service providers offer incentives and programs for businesses and individuals; they are almost exclusively for the installation of home charging and workplace charging.

EV ADOPTION AND FORECASTING INFRASTRUCTURE NEEDS

The rate of EV adoption is key to determining the required infrastructure, the ability to do so has been difficult but is improving. Additional elements that contributed to an understanding of infrastructure need, such as user behavior, are also becoming better understood. The introduction of temporary, solar powered charging stations can be a valuable tool to confirm the analytical analysis of a potential location. The independently powered units can be easily deployed to measure actual utilization of a proposed site.

Determining actual EV sales in Florida has also been difficult for a variety of reasons, including low initial sales and difficulty in interpreting data provided by Florida's Department of Motor Vehicles (FDMV). A significant amount of filtering, cross checking and other efforts are currently needed to arrive at accurate data. The data has become more visible and accurate, but there appears to be a need to refocus on data input; specifically, the criteria used, input accuracy, its usability, and available reporting. Improvements in these areas will provide a better understanding of the impact of these transportation technologies in our state.

Several Florida power service providers continue to invest the time in this process and share very accurate and valuable information. Information provide by Florida Power & Light has been instrumental in developing this report.

Working directly with EIA, NREL and several others will allow us to develop forecasts that reflect Florida's specific needs. These forecasts will be based on the latest Florida specific data, and the growth rate projections used by several leading organizations for their individual forecasts. We will blend growth rates provided by these organizations to produce customized estimates of Florida's infrastructure needs.

INFRASTRUCTURE INTEROPERABILITY, PERFORMANCE AND MONITORING

Transportation is undergoing profound changes driven by new technologies in propulsion, fuels, engineering, planning, and many other segments. Near-term expectations for autonomous vehicles and connected infrastructure are revolutionizing transportation planning. There is promise in how these technologies will provided cleaner, more efficient transportation that can serve a disadvantaged and aging population, while expanding the capabilities of vehicles and infrastructure.

INTEROPERABILITY

"Smart Technologies" have the ability to analyze data from devices in near real-time and make adjustments to the device or support infrastructure to improve efficiency and throughput. Data networks have thrived in an environment of standards that allow connections and hand-offs between devices, back-offices, and networks. An example of data network interoperability is the Open Systems Interconnection model (OSI), adopted as a standard by International Organization for Standards (ISO 7498) and the International Telecommunications Union (ITU-T X.200). OSI is based on a seven-layer Reference Model and a set of specific protocols.[12] The development and adoption of data network standards has allowed the ubiquitous availability of high-speed data and video, dramatic reductions in equipment cost, and the development of specialized applications and tools.

Work continues on the development of standards for EV charging, generally recognized as the Open Charge Point Protocol (OCPP). OCPP is an application protocol enabling communications between EV charging stations and central management systems; it has not been widely adopted and is currently available as OCPP 2.0. The latest version has the following use cases.

The U.S. Department of Energy is involved in the development of standards and technologies for EV charging and EV to-Grid interface at its Argonne National Laboratory. Argonne provides research to support the EV industry and electric utilities. The goals of the EV-Smart Grid Interoperability Center are:[13]

- Enabling technology development to support EV-Grid integration,
- Enabling communication to manage vehicle charging loads,
- Reducing the cost of electric vehicle charging infrastructure,
- Enhancing the viability of fast/consumer-friendly charging
- Harmonization of global connectivity standards.

Adoption of standards could also provide more uniform reporting on network performance and utilization, allow faster restoration, and provide user information on availability. Many infrastructure providers have developed smartphone apps that provide availability information directly to their users; these apps could be a source of information on charging network performance and other metrics during the formal development of standards and metrics.

[12] https://electricalacademia.com/computer/osi-model-layers-functions/
[13] https://www.anl.gov/es/evsmart-grid-interoperability-center

NETWORK MONITORING AND PERFORMANCE

EV charging availability and reliability is becoming more important as the use, reliance and range of these vehicles increases. Conventionally fueled vehicles and the refueling network they rely on have had over a century to develop into robust and reliable systems. Standards have been developed, and requirements have been put in place to support the availability of liquid fuels. Additional requirements are also in place to require availability during emergencies.

The need for similar standards and requirements to support electric transportation are needed. EV charging infrastructure is growing rapidly, and both the users and owners of these systems would benefit from the establishment of performance standards and requirements. New infrastructure providers are introducing their systems and equipment in Florida, the current absence of standards and performance provides a very low bar for the deployment of this critical infrastructure.

The availability and reliability of EV charging is an important consideration, but so are the resources to support that availability. Consideration needs to be given to the support and field staff that provides network maintenance and restoration, as well as the inventory and availability of spare equipment. Emergency restoration plans also need to be periodically reviewed.

Finally, adequate network monitoring can document infrastructure utilization and provide a basis for forecasting infrastructure growth, the needed replacement of obsolete and defective equipment and the performance of software and network upgrades. More sophisticated monitoring in the future could provide additional enhancements for notifications of network elements degradation and predictive failures.

INFRASTRUCTURE SIGNAGE AND INFORMATION

Signage requirements for Florida's road system is a combination of FHWA requirements, FDOT requirements, and local jurisdictional requirements. Highway signage to support electric transportation is currently being reviewed by Clean Cities Coalitions, DOTs and the FHWA in the southeast region of the U.S. The goal of the discussions is to bring as much consistency to signage use in the Southeast as possible. FDOT also has an initiative to develop signage requirements for Florida.

TRAINING AND SAFETY

There is an ongoing need for safety training of first and second responders in alternative fuel vehicles and their infrastructure. CFCCC has facilitated this type of training for firefighters and tow operators, primarily on the topic of vehicles. Due to the dynamic growth of EVs and their charging infrastructure, training updates and resources must be readily available. Coordinating these efforts with established first responder training organizations like the National Fire Protection Association should be continued.

RECOMMENDED GUIDANCE FOR EV INFRASTRUCTURE DEVELOPMENT

Based on information from our webinars, interim reports, the EV Owner Survey Analysis as well as feedback from stakeholders, the following recommendations are offered for consideration.

Legislative funding to support the investigation and development these recommendations is critical to supporting the deployment of clean transportation and realizing the inherent benefits. Action on these recommendations should be undertaken in conjunction with industry and stakeholder representation.

PLANNING

1. Information regarding EV sales in Florida is difficult to collect, analyze and report; it is recommended that the Florida Department of Motor Vehicles develop and publish quarterly standardized reporting for all classes of electric vehicles.
2. Permitting requirements for EV infrastructure installation is highly variable in Florida; it is recommended that the Florida Building Commission develop a standardized process for reviewing and permitting infrastructure installations.
3. Multi-family developments represent an untapped source for the expansion of EV use and infrastructure, they also present unique challenges to deployment; it is recommended that the Florida Building Commission develop guidance, policies and incentives to maximize this opportunity.
4. Florida municipalities, county governments and state agencies purchase products and services from vendors included on the State Contract and Agreements List; it is recommended that FDMS encourage vendors to provide more EVs options under the state term contract.
5. Florida Statutes require state agencies to select the vehicle with the greatest fuel efficiency within a given class; it is recommended that the Florida Legislature remove this outdated language and instead require agencies to perform an analysis on the total cost of ownership of a vehicle prior to its purchase.
6. Florida has critical gaps in charging infrastructure as it relates to emergency evacuation; it is recommended that the State purchase portable, solar powered EV chargers with battery storage as a means of addressing this immediate need.
7. EVs and the associated infrastructure offer substantial advantages in mitigating impacts from fossil fuels; it is recommended that the use of solar power and battery storage be investigated by FDACS OOE as a means of extending these benefits and reducing operating expense.

FINANCING AND INCENTIVES

1. Florida has allocated the maximum allowable funding under the Volkswagen Settlement for in frastructure installation, which will be used primarily for the installation of capital intensive DCFC; it is recommended that existing federal funding be reviewed by the FDOT to support EV infrastructure installation by local governments, underserved communities, and rural areas.
2. Workplace charging has been proven to increase EV adoption and expand its benefits; it is recommended that the FDACS OOE develop state incentives that can be made available to support workplace charging.
3. The Florida Legislature previously provided incentives that supported the deployment of alternative fuel vehicles that use natural gas; it is recommended that the Florida Legislature authorize similar incentives for the deployment of electric transportation and infrastructure with priority given to disadvantaged and rural communities.

EDUCATION

1. Lack of education is one of the biggest barriers to EV adoption; it is recommendation the Florida Legislature provide funding to the FDACS OOE to develop a statewide EV educational campaign that can be rebranded locally.

FORECASTING EV ADOPTION AND INFRASTRUCTURE NEEDS

1. The rate of EV adoption is key to determining the required infrastructure, the ability to do so has been difficult; it is recommended that that the FDACS OOE, the FDOT and the FPSC develop methodologies to track and forecast EV sales and infrastructure requirements.

INFRASTRUCTURE INTEROPERABILITY, PERFORMANCE, AND MONITORING

1. State standards for EV infrastructure interoperability, monitoring, availability, reliability and reporting have not been established; it is recommended that the FDACS OOE, the FDOT, and the FPSC develop these standards.
2. State standards for emergency response to restore EV infrastructure have not been established; it is recommended that the FDACS OOE, the FDOT, the FPSC, and the FDEM develop standards for restoration of this critical infrastructure, in conjunction with industry and stakeholder input. Standards should include provider staffing and spares inventory.

ADDENDA

Future EV Infrastructure and Infrastructure Models Interim Report

Emergency Evacuation of Florida Electric Vehicles Interim Report

Electric Vehicle Infrastructure Deployment Recommendations Interim Report

Argonne National Laboratory Summary Statistics for Light-Duty Plug-in Electric Vehicles in Florida

Electric Vehicle Owner Survey Analysis

Florida's Future EV Infrastructure
&
Infrastructure Models
Interim Report
For The
Florida Electric Vehicle Roadmap

June 30, 2020

Florida Department of Agriculture and Consumer Services
Office of Energy

Central Florida Clean Cities Coalition

Florida’s Future EV Infrastructure
&
Infrastructure Models
Interim Report

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Introduction

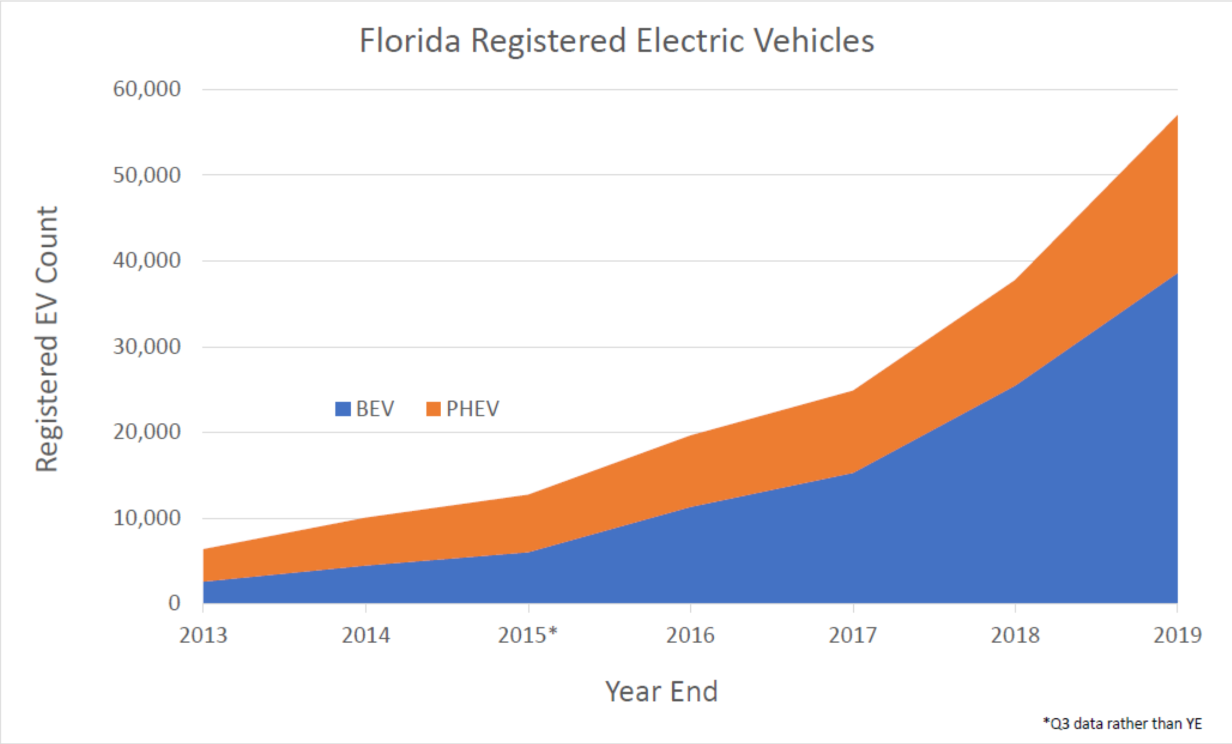
This is the first interim report to be submitted for the Florida Department of Agriculture and Consumer Services, Office of Energy’s *Florida Electric Vehicle Roadmap* (FEVR) project. The project and these reports address the Electric Vehicle Supply Equipment (EVSE) infrastructure that is specific to light-duty electric passenger vehicles. Workplace charging and infrastructure to support heavy-duty vehicles and fleets is typically specific to their needs and is not included in the analysis. The need for particular policy or regulatory attention will be noted but not addressed in these reports. These are “Business-as-Usual” evaluations, impacts from the COVID-19 virus have not been considered.

The domestic transportation landscape is being reshaped by technologies that will dramatically improve the efficiency and safety of the way we travel and transport goods. Electric vehicles (EVs) are poised to assume a significant role in transportation over the next five to ten years. EV battery prices continue to decline and electric passenger vehicle cost are expected to reach price parity with conventionally fueled vehicles across the passenger vehicle segment by 2025.[1]

EV adoption in Florida continues to accelerate, and adoption is expected to dramatically increase as price parity is achieved and consumers begin to understand the Total Cost of Ownership (TCO) concept and the savings to be realized when compared to internal combustion engine (ICE) vehicles. There is the very real possibility that growth in EV sales will outpace the deployment of charging infrastructure. The lack of adequate infrastructure will result in a frustrating barrier to the consumer’s full use of their EVs as well as complications with emergency incidents. The deployment of autonomous

[1] https://www.greencarreports.com/news/1111144_electric-cars-will-cost-less-to-buy-than-regular-cars-by-2025-analysis).

vehicles, electric taxis and shuttles, and startup Transportation Network Companies (TNC) such as Lyft and Uber will also be impacted.



Source: Florida Power & Light

Stakeholder Webinars

FDACS OOE and its partner, the Central Florida Clean Cities Coalition, conducted six webinars between April 28th and June 16th to discuss future infrastructure considerations with stakeholders. Individual webinars addressed the considerations with stakeholders representing power service providers, infrastructure network providers, advocacy groups, planners, and state agencies. A total of 15 industry representatives from all of the stakeholder groups participated as facilitators for the webinars. More than 500 stakeholders attended over eight hours of webinars. Discussions during the webinars were very productive and useful. Feedback from participants was very positive. Recordings of the webinars and other information is available on the project website at, https://www.fdacs.gov/Energy/Florida-Electric-Vehicle-Roadmap.

Topics of discussion during the webinars included:

- Increase in battery efficiency, resulting in 400+ mile range
- Increase in electric vehicle supply equipment (EVSE) output of 600kW+
- Requirements for thermal management of higher EVSE outputs
- Increased grid demands at EVSE locations

- Broad introduction of EV passenger shuttles, taxis, and Transportation Network Companies (TNCs)
- Initial deployment of autonomous vehicles
- Inductive charging
- Networking and internetworking of EVSE
- Siting and upgrade capabilities
- Uptime, Resiliency, Backup Power
- Obsolescence and upgrade of EVSE
- Social equity and underserved communities
- Outreach, education, and training
- Energy consumption
- Environmental
- Site Safety
- Zoning, building codes, and permitting
- Signage

Survey of General Public and Enthusiasts

Gathering information from end users is crucial to understanding the performance of the existing infrastructure, and the planning needed for future infrastructure. FDACS OOE and Clean Cities will be conducting an online survey of what stakeholders think Florida's future charging infrastructure should look like. The survey, which will begin in late July, and will collect information on EV ownership, currently available infrastructure, availability and uptime, residence type, individual charging behavior, charging location priorities, EV fees, and other detailed information.

Research Underway

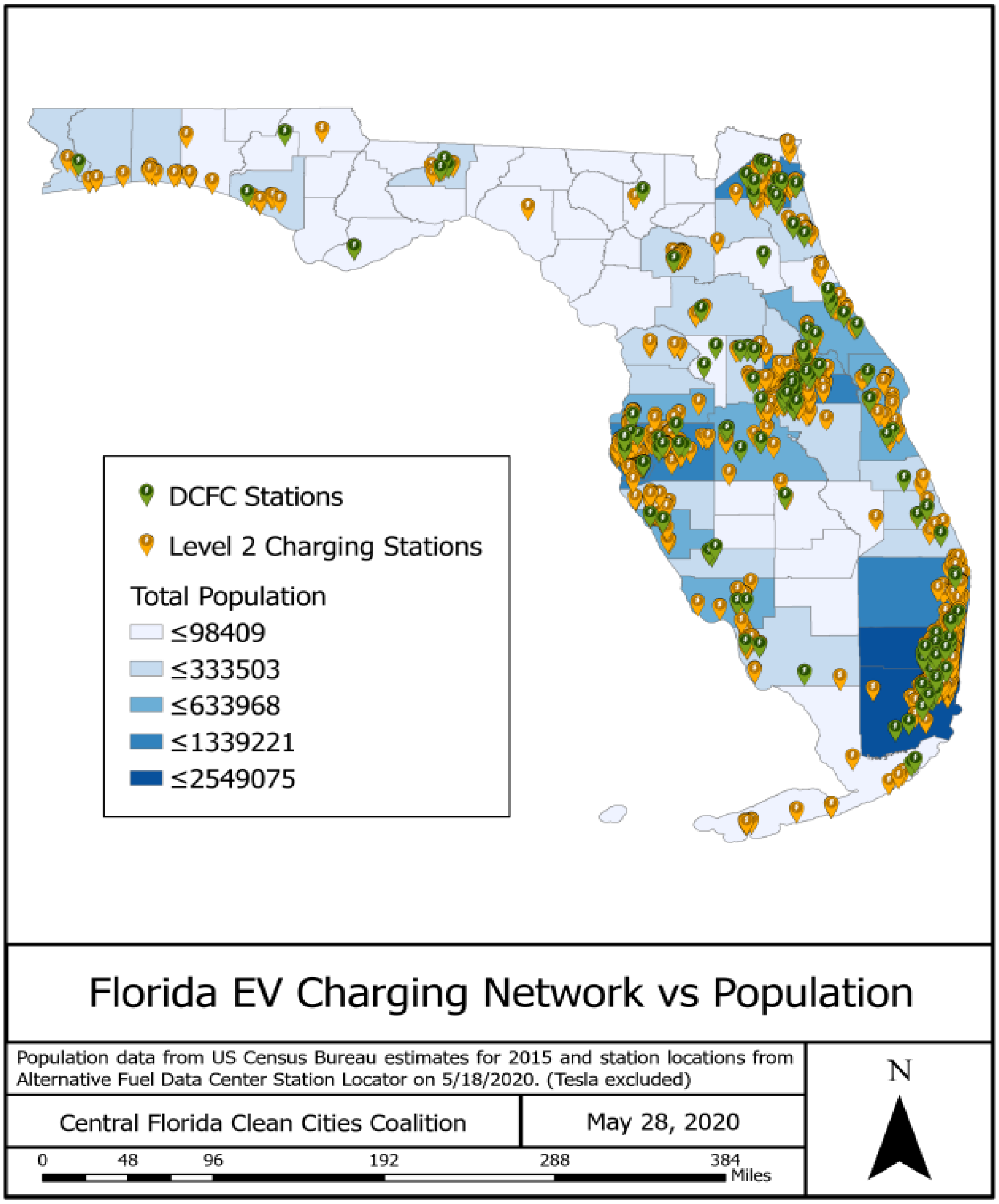
Additional efforts outside of the webinars and the survey includes, gathering data on travel and evacuation, discussions with Florida Department of Transportation (FDOT), Tesla, UL, EVgo and others, review of White Papers and other research, and participation on FDOT's M-CORE panels for considerations associated with new transportation corridors being built in Florida.

The development of Geographic Information Systems (GIS) maps to illustrate existing and recommended infrastructure has begun, the maps will contain the following layers:

1. Layer for all Interstates and State Roads
2. Layer of all DCFC in Florida, including Tesla
3. Layer of all DCFC in Florida, minus Tesla
4. Layer for Volkswagen Settlement (VW) funded Interstate sections
5. Layer for pending, permitting, under construction (PPC)
6. Layer for recommendations
7. Layer for Evac routes with DCFC now

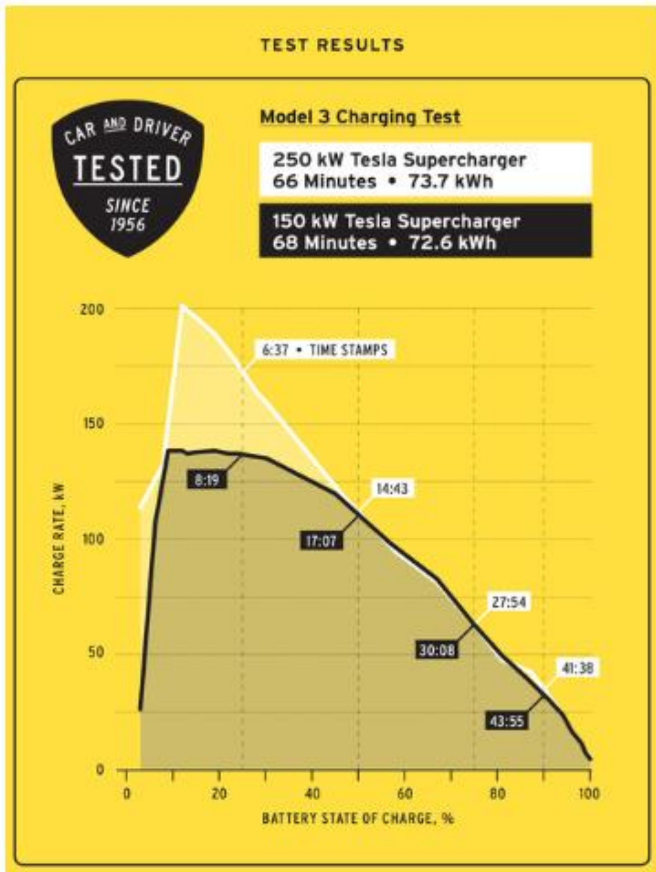
8. Layer for evac routes with VW
9. Layer for evac routes with: Direct Current Fast Charger (DCFC) now, VW, PPC

<u>Infrastructure Technology</u>



First, it should be understood that there are no special requirements for the installation of charging infrastructure, when compared to other electrical appurtenances installed in similar fashion; and in many instances the installations are less complex than a standard traffic control device. Permits and other approvals are required for installation, but generally no more so that other devices installed in similar fashion.

EV infrastructure technology is advancing at a rapid pace in an effort to meet the requirements of longer range EVs, and support the increasing capability of these vehicles to manage much higher recharge power levels. The conventional 50kW DCFC is giving way to DCFCs of 100-350 kW that are currently being installed. Future output capacities are expected to exceed 650 kW. A 50kW DCFC can restore about 120 miles of travel per hour, a 150-350 kW DCFC can provide 800-1000 miles of travel in the same amount of time.[2]



CAR AND DRIVER

Increased EVSE power outputs require increased grid inputs and other considerations. The placement of the higher power EVSE becomes more difficult and demanding in finding a suitable location that can accommodate the needed grid requirements, additional requirements for the thermal cooling of the supply cables, and data network availability to support monitoring, billing and other back office requirements.

EVSE installations in Florida continue at a strong pace. However, a significant portion of the installations were for Level 2 EVSE with a maximum output of 40kW, 10kW below the 50kW common output of a conventional DCFC. Level 2 installations are adequate

[2] https://www.caranddriver.com/news/a32132062/tesla-250-kw-vs-150-kw-supercharger-tested/

for short duration recharges for minimum travel requirements, these installations will not adequately support the rapid charge requirements of long distance EVs on destination travel.

Battery technology and consumer needs will strongly influence infrastructure needs. There are intrinsic incentives for choosing both long and short range EVs. Longer range EVs will provide the most travel flexibility. However, a shorter range EV with less battery capacity can be manufactured and sold at a much lower cost than an ICE vehicle.

EVSE Technology[3]

EVSE delivers electrical energy from an electricity source to charge an EV's battery. The EVSE communicates with the EV to ensure that an appropriate and safe flow of electricity is supplied. EVSE units are commonly referred to as charging stations.

Basic EVSE Components

The following is a fundamental description of the EVSE technology; these technologies can vary; for safety, please review and understand the technology of the specific vehicle and EVSE you use.

EVSE: The equipment, connected to an electrical power source, that provides the alternating current (AC) or the direct current (DC) supply to the electric vehicle that is needed to charge the vehicle's traction batteries. EVSE charging capacity options are an important consideration as they have a direct bearing on how fast the batteries can be recharged. As an example, Level 2 EVSE is available in 20, 30 and 40 amp capacities and higher amperage equates to faster recharge times. However, the EV's onboard charger must have the ability to match the full output of the EV to realize the fastest recharge times.

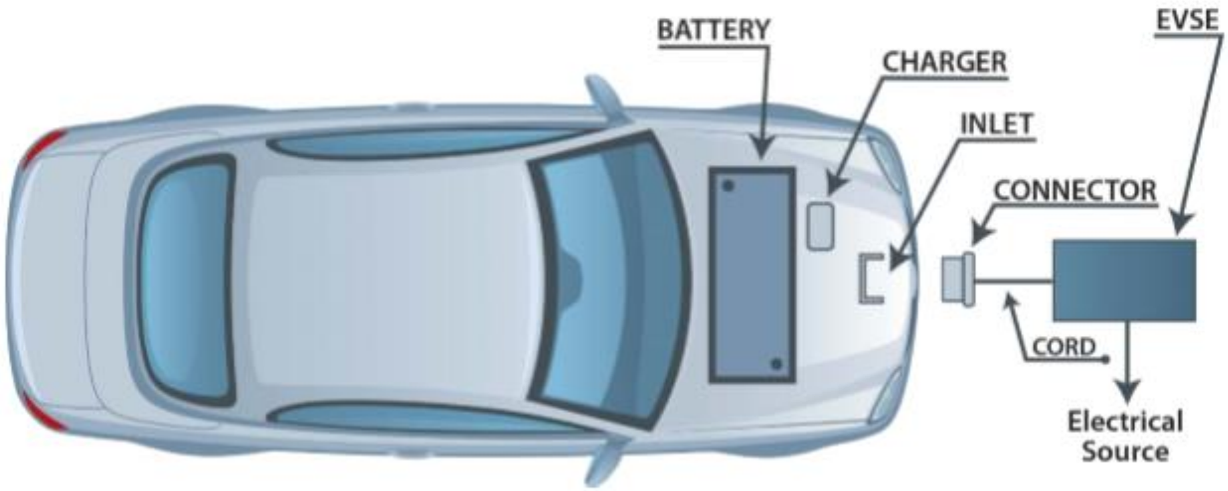
Electric Vehicle Connector: The device attached to the EVSE cable that provides the physical connection between the EVSE and the EV. There are three predominant connectors in use today: the SAE J1772 based connector (developed by the U.S. auto standards development organization SAE), the CHAdeMO connector (developed by the Japanese auto standards development organization), and the Tesla developed Supercharger connector that is used exclusively for charging Tesla electric automobiles.

Electric Vehicle Inlet: The device on the electric vehicle that provides the physical connection between the EV and the EVSE connector. Some EVs have more than one inlet port and locations vary from vehicle to vehicle.

Battery Charger: Level 1 and 2 charging uses the EV's internal battery charger to convert the EVSE alternating current (AC) supply to the direct current (DC) needed to charge the car's traction batteries. DC Fast Chargers (DCFC) supply high-current DC

[3] http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1996-15.pdf

electricity directly to the EV's traction batteries; the onboard charger conversion of AC to DC is not required, and this function of the on-board charger is by-passed when a DCFC is used. On-board battery charger options are an important consideration when purchasing a EV as they have a direct bearing on how fast the batteries can be recharged. There are several options available, some of which do not provide an option for DCFC.



EVSE Charger Classifications

EVSE is normally classified as Level 1, Level 2 or DC Fast Charge (DCFC). In general terms, EVSE classification pertains to the power level that the equipment provides to recharge an EV's batteries. The use of higher charge levels can significantly reduce the time required to recharge batteries.

Levels 1, 2 and DCFC are the most widely deployed classes of chargers, but there are two other classes of lesser known, high-powered EVSE specifications, AC Level 2 and DC Level 2; information on AC Level 2 and DC Level 2 can be found at, http://standards.sae.org/j2836/2_201109/

Level 1 Charging Cord
Source: Roperld

Level 2 Charging Station
Source: ClipperCreek

DC Fast Charging (DCFC)
Source: Evcaro

<u>AC Level 1 Charging</u>

Level 1 provides charging from a standard residential 120-volt AC outlet, its power consumption is approximately equal to that of a toaster. Most EV manufacturers include a Level 1 EVSE cord set so that no additional charging equipment is required. As a general rule, Level 1 recharging will add approximately four miles of travel per hour. Level 1 charging is the most common form of battery recharging and can typically recharge a EV’s batteries overnight; however, a completely depleted EV battery could take up to 20 hours to completely recharge.

<u>AC Level 2 Charging</u>

Level 2 equipment provides charging using 220-volt residential or 208-volt commercial AC electrical service, its power consumption is approximately equal to that of a residential clothes dryer. As a general rule, Level 2 recharging will supply up to approximately 15 miles of travel for one hour of charging to vehicles with a 3.3 kW onboard charger, or 30 miles of travel for one hour of charging for vehicles with a 6.6kWh on-board charger. Level 2 EVSE utilizes equipment specifically designed to provide accelerated recharging and requires professional electrical installation using a dedicated electrical circuit. Level 2 equipment is available for purchase online or from retailers that sell other residential appliances. A completely depleted EV battery could be recharged in approximately seven hours using a Level 2 charger.

<u>DC Fast Charging (DCFC)</u>

DCFC equipment requires commercial grade 480-volt AC power service and its power requirements are approximately equal to 15 average size residential central air conditioning units. As a general rule, DCFC recharging will add approximately 80-100 miles of travel with 20-30 minutes of charging. The DCFC EVSE converts AC to DC within the EVSE equipment, bypassing the car’s charger to provide high-power DC directly to the EV’s traction batteries through the charging inlet on the vehicle. DCFCs are deployed across the United States, typically in public or commercial settings. While the power supplied to EVs by all DCFCs is standardized, there is not uniform agreement on the connector that is used to connect the charger to the vehicle. There are two competing standards for the vehicle connectors used with DCFCs; one standard is the SAE J1772 Combo developed by the U.S. auto standards development organization SAE and the other is the CHAdeMO connector developed by a Japanese auto standards organization. As a practical matter, both connectors work very well and many (but not all) EVs are equipped to utilize either connector. DCFC's high-power capabilities can restore a depleted EV battery in approximately 30 minutes.

EVSE General Characteristics (Completely depleted battery)

	Charge Time	Voltage/Amps	Power Equivalent	Installation
Level 1	Up to 20 hrs.	120/15	Toaster	Self
Level 2	Up to 7 hrs.	240/40	Clothes dryer	Professional
DC Fast Charge	Up to 30 min.	480/125	15 Central A.C.	Professional

EV Battery Systems

EVs actually have two battery systems, the larger "traction" batteries that provide propulsion for the vehicle, and a smaller, conventional 12-volt battery that provides auxiliary power for on-board systems such as the entertainment system, dash lights, etc. The traction batteries come in a wide variety of power ratings that are designed to meet the specific needs of the particular model of EV. Traction batteries are also becoming known by the more technical designation of Rechargeable Energy Storage System (RESS), a reference to their ability to store energy for purposes other than propelling the EV. Most of today's EVs use lithium-ion batteries, which are much larger versions of the battery technology used in cell phones and other personal electronics.

EVSE/EV Signaling and Communications

EVSE and EV interaction during the battery recharging process can be an interactive and dynamic process that requires communications between both elements. Multiple, ongoing communications exchanges occur during charging, one of the primary purposes of these communications is to regulate the amount of current provided to charge the vehicle. The EVSE informs the vehicle of the maximum current available, allowing the EV to manage current flow within the EVSE's service breaker capacity. Additional primary communications and interactions take place that monitor the State-of-Charge (SOC) of the batteries and also allow the EV to bypass the on-board charger and use the EVSE charger if a DCFC station is being used.

SAE Recommended Practice SAE J2847/2 establishes requirements and specifications for communication between EVs and the DC Off-board charger. Where relevant, this SAE document notes, but does not formally specify, interactions between the vehicle and vehicle operator. This document applies to the off-board DC charger for conductive charging, which supplies DC current to the batteries of the electric vehicle through a SAE J1772™ coupler. Communications will be on the J1772 Pilot line for Power Line Communication (PLC). The details of PLC communications are found in SAE J2931/4.

The specification supports DC energy transfer via Forward Power Flow (FPF) from source to vehicle.

SAE J2847/2 provides messages for DC energy transfer. The updated version in August, 2012 was aligned with the DIN SPEC 70121 and additions to J1772™ for DC charging, published October, 2012. This revision includes results from implementation and changes not included in the previous version. This revision also includes effects from DC discharging or Reverse Power Flow to off-board equipment that expands on J2847/3 for AC energy flow from the vehicle, and other Distributed Energy Resource functions that are being developed from the use cases in J2836/3™, published January, 2013. [3] SAE International, Communication between Plug-in Vehicles and Off-Board DC Chargers.[4]

Networking and Interoperability

Most new EVSE includes back-end software developed and maintained by a network service provider. Networked charging stations are connected to the Internet which allows them to communicate with a central control system. Through the network, the station sends important information to the service provider and site host and, in turn, they can control the station remotely.

Networked EVSE allow the hosts to accept payment from EV drivers via credit card, smartphone, or radio-frequency identification (RFID) card. Without the networked connection, chargers are unable to accept any payment. Additionally, the host or network service provider can access stored data from the station to analyze electricity usage, total charge time, frequency of use, or other relevant information. With real-time data, providers can share information about charger availability and functionality with its user apps.

Charging networks need to be able to communicate with each other, and many network service providers use proprietary programming language that can only communicate with their own branded charging stations and networks. The Open Charge Point Protocol (OCPP), while not yet fully adopted as a standard, has been gaining popularity as a method of standardizing charger communications. Standardized protocols allow communications and enable data sharing among providers, which can facilitate network "roaming". Like a cell phone roaming across networks while traveling, roaming allows EV drivers to charge at stations outside of their provider network without creating a new membership. EV drivers in much of Europe can use a single RFID card to access all public stations being operated by different network providers. Many US network companies, such as ChargePoint, Electrify America, EVgo, EVBox, and EV Connect, have begun bilateral agreements that allow users to charge at any of their stations.

Networked charging stations offer several benefits compared to their non-networked counterparts, while the lack of standardization in the U.S. is a significant barrier. There

[4] http://standards.sae.org/wip/j2847/2/

are already over 20 EVSE network service providers throughout the country, most of which require a membership for access to their stations; drivers have a difficult time keeping up with their accounts and finding a station they can use. The success of the electric vehicle market depends on drivers having access to charging infrastructure whenever necessary, so networks must have interoperability. Interoperability allows chargers to communicate allowing drivers to charge at a station with a single identification or payment method.

OCPP is a standardized communications protocol that allows the site owner to switch network providers. This increases competition among vendors, encouraging them to constantly improve their service.

Battery Technology

The capacity and efficiency of EV batteries continue to increase as the price for the batteries continues to decline. The primary factors for lower battery pricing are the increase in manufacturing scale and efficiency, advancements in battery technology, and the increased adoption of EVs. Automobile manufacturers continue their commitment to EVs through the acquisition of battery technology companies and their ongoing investment in new large-scale battery manufacturing facilities.

The convergence of factors in battery technology can be seen in Tesla's Model 3 EV. The Model 3 has an average range of 250 miles and cost of approximately $40,000; the combination of range and price resulted in the sale of over 16,000 vehicles in 2019 alone, or 28 percent of a total sales and a huge contributor to an overall increase of 33 percent.[5]

Researchers and vehicle manufacturers expect a shift from the current lithium-ion chemistry to solid state-batteries within the next five years. Solid-state batteries:

- Are inherently safer that lithium-ion
- Can recharge faster, with a longer useful life.
- Use more common elements like sodium, a few rare-earth minerals
- Significantly less expensive to manufacture
- Potential to more than double the range of EVs

All of the advantages of solid-state batteries will further reduce the cost of EVs and spur additional adoption; which will, in turn, increase infrastructure demand.

Inductive and Resonant Charging Technologies

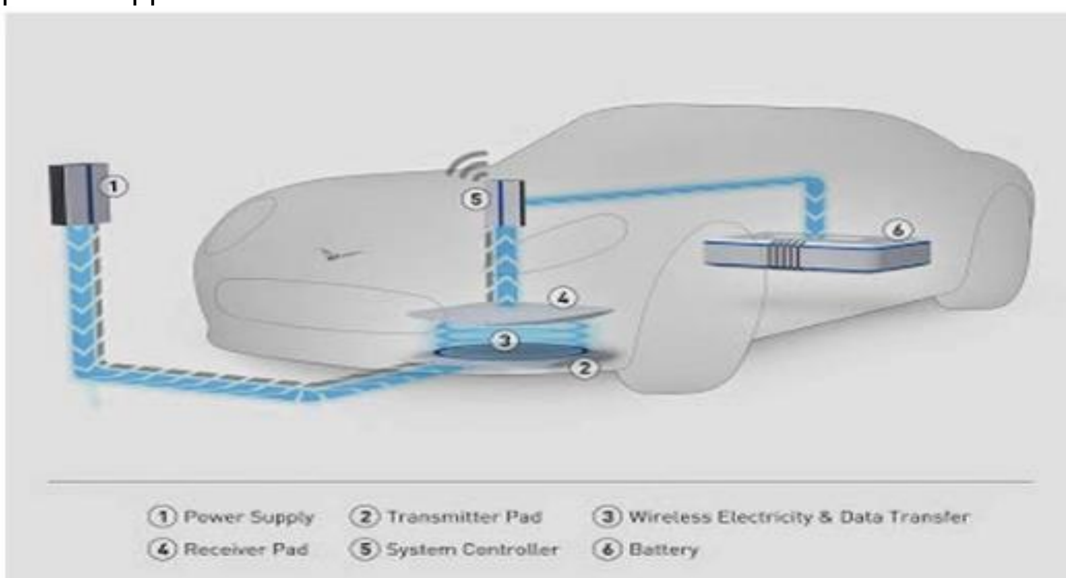
Inductive charging, also known as Wireless Power Transfer (WPT), is an emerging technology that allows EV recharging without the use of a cabled connection. The most common application uses a charging pad installed on or in the pavement and a receiving pad installed underneath the EV. Electrical current is passed through the

[5] FPL, EV sales 2019

pavement pad, which creates an inductive electrical field that is captured by the EV's receiving pad to charge the vehicle's batteries.

The successful development and deployment of wireless technology presents the promise of having the convenience of pulling into your garage or a parking spot and having your car recharge without the need to connect and disconnect a cable. Some researchers are also exploring the possibility of embedding wireless charging in the roadway as a method of continuously recharging the vehicle while in motion; this system would dramatically reduce battery size requirements and extend the travel range of EVs. Wireless charging is now offered as an upgrade on some luxury model cars, it is also being actively used by transit agencies to provide on-demand charging of their buses.

Induction chargers typically use an induction coil to create an alternating electromagnetic field from within a charging base station, and a second induction coil in the portable device (i.e., EV) that takes power from the electromagnetic field and converts it back into electrical current to charge the battery. Greater distances between sender and receiver coils can be achieved when the inductive charging system uses resonant inductive coupling. Recent improvements to this resonant system include using a movable transmission coil, and the use of materials for the receiver coil made of silver plated copper or aluminum.



Source: Electric Vehicle News

A significant effort in research and development is underway by academic, governmental and private industry to help realize the promise of the untethered charging of EV batteries. The Massachusetts Institute of Technology (MIT) has marketed a patented WPT technology that applies magnetic resonance to an inductive electrical field.

This technology provides impressive power transfer efficiencies over larger air gaps between the charging transmitter and the EV's charging receiver. MIT's WPT has been licensed to several large automobile manufacturers.

Utah State University is also involved in wireless charging research and has a new research facility that includes an oval track to test technology for recharging electric vehicles while moving.

The Society of Automotive Engineers and the International Electrotechnical Commission develop standards for wireless technology and there is limited commercial availability. The standards reference for SAE is SAE J2954; the IEC reference is IEC 61851-1.

Obsolescence, Upgrade, Futureproofing

A significant portion of the existing EV infrastructure has been installed for more than six years, or approximately two-thirds of its useful life. Many of these installations are not networked, employ older technology, have proprietary operating and billing systems, and are typically a lower power Level 2 installation.

As the industry grows and adapts, preparing for future demand will become increasingly necessary. Sites can be "future-proofed" by installing additional conduit and addressing other make-ready needs to support future growth. With a few small adjustments, the station can be upgraded to meet future demand without incurring substantial additional costs.

Provisioning the electrical capacity for upgrades during the initial charger construction can help support future demand changes. This includes laying extra conduit that can accommodate future power requirements and leaving space for additional transformers. When it is time to upgrade, installation costs will be significantly lower.

Future-proofing can also be achieved by installing a high-powered charging station upfront and then limiting its output power until necessary. For example, a site host may install a 350 kW charger but limit its output to 50 kW or 150 kW to save money until fast charging demand increases. As more power is needed, a software change and module exchange/additions allow the station to produce more power.

Uptime, Resiliency and Backup Power

Many of the new EVSE installations include data network connectivity that allows the status monitoring of the installation, including whether the unit is online, how many ports are available, and other metrics.

Unfortunately, there are few established criteria for the performance of installations; it is not unusual for EVSE to be off-line for long periods of time. The cause for these issues can be traced to:

- Support abandonment by a manufacturer who is out of business,
- Low utilization

- No performance goals have been established
- No maintenance and support mechanism has been established

Fortunately, the availability and reliability of these installations is improving, due in large part to the entry of national-scale infrastructure providers that realize the need for monitoring and uptime.

EVSE are critical installations that serve a life-line purpose, and should be maintained as such. Backup power for EVSE installations is virtually non-existent, but should be investigated as it provides critical uptime support for the installation. There is the very real possibility that backup batteries could also help mitigate demand charges for electrical power. *Given the critical nature of these installations, requirements for uptime and availability of these installations needs to be addressed.*

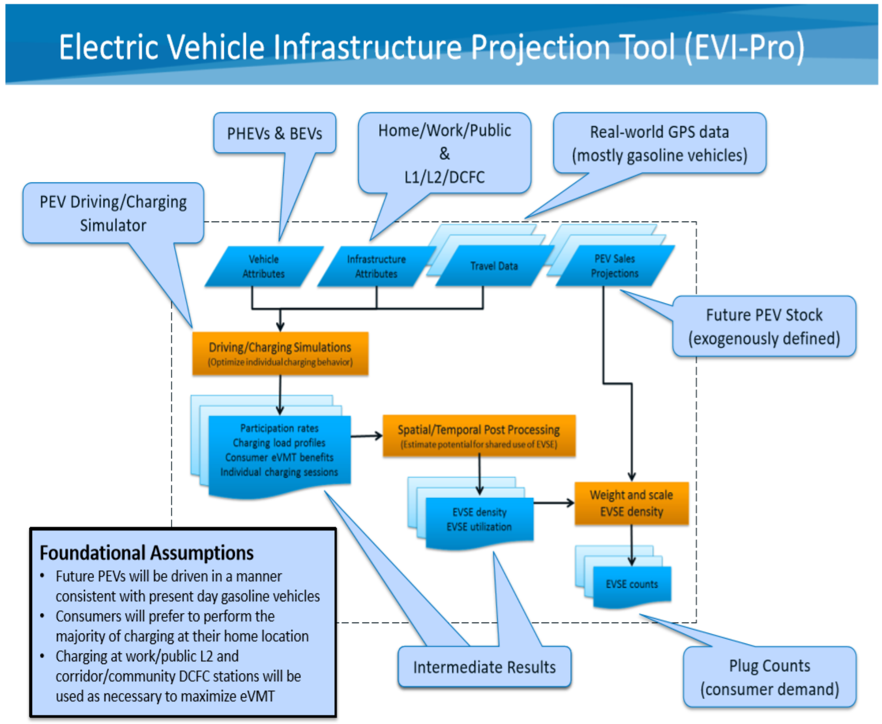
EV Infrastructure Models

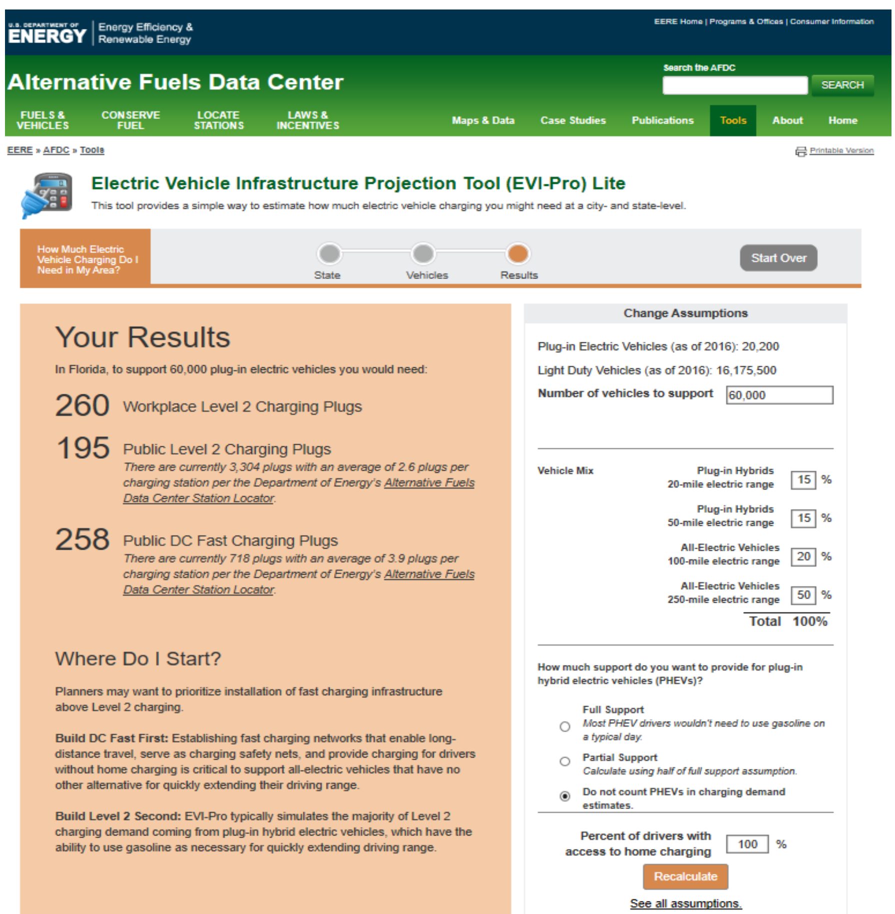
From a planning perspective, Florida's EV infrastructure is entering its second generation, a generation that includes interoperability, managed charging, improved efficiency, and modular power upgrades; all significant improvements over the installations from just a decade ago. Planners have also been improving their tools.

There are several approaches to modeling charging infrastructure, some treat geographic areas as a "cluster" and perform an analysis on a specific geographic area and its constituency. An example would be multi-modal transit center at an airport, or a downtown entertainment/shopping center. Tools, such as NREL's EVI-Lite, take a more "blanketed" approach which encompass larger geographic areas and estimates the number of chargers that should be needed.

There are many models for evaluating the need for EVSE infrastructure and evaluation of these models is just beginning. Tools from the National Renewable Energy Laboratory (NREL), the Florida Department of Transportation (FDOT), UL, and several others are being evaluated. Additional consultation is being sought from industry and academia. Among the best known is NREL's EV infrastructure projection tools, EVI Pro-Lite.[6] These tools calculate the need for infrastructure base on the input of local data, real world travel documentation and EV adoption projections. Below are illustrations that present the architecture and output of the tool.

[6] https://cleancities.energy.gov/files/u/news_events/document/document_url/361/nrel-evi-pro.pdf





[Electric Vehicle Infrastructure Projection Tool (EV Pro) Lite]

EVs have been largely concentrated in metropolitan areas, due in large part to not having long range travel capabilities, and the existence of recharging infrastructure. The now common availability of EVs with a range of over 200 miles has opened up this market segment and changed the considerations when planning EV infrastructure. As an example, public EV charging for rural and underserved communities has been largely considered as economically infeasible, especially for expensive DCFC installations. Support for the home charging environment for those EV owners must be augmented with publically available infrastructure to support long-range round trips. As an alternative to DCFC, high-powered Level 2 infrastructure could be installed; a $5-8k 40-60 amp charger would provide a charging profile and time similar to $10-40k DCFC for thousands of dollars less than a DCFC unit and its accompanying grid make-ready.[7]

EV charging networking companies have expanded their footprint and continue to invest in Florida, $25 million in funding from the State's share of the Volkswagen Settlement is allocated to support the installation of charging infrastructure, and investments from local governments continue to expand charging opportunities in our state. Overall, there is a significant amount of momentum in preparing for an ever increasing number of EVs on the road. All of these elements will be accounted for in the final report.

While the technology associated with charging infrastructure has made significant advancements in the last decade; there has not been much progress in deciding how much infrastructure will be needed. There is not much validated data available, a review of past studies and projections will largely show that assumptions were incorrect, resulting in projections with ranges of variability of 150-200 percent. Accurate historical data of EV sales in Florida is now available, the diversity and detail will allow for more accurate projections of both EV sales and the supporting infrastructure.

EV infrastructure technology has been progressing rapidly over the last several years, largely to accommodate longer range, but also to provide an increased level of reliability and network visibility. The challenge is to understand what technologies will also prove to be viable 10-20 years from now.

This report provides a preliminary high-level technical and operational review of the current and future EVSE infrastructure. Discussions are continuing with the manufacturers, vendors, and others involved with EV infrastructure; information from these discussions will be included in future reports.

[7] https://afdc.energy.gov/files/u/publication/EV_Charger_Selection_Guide_2018-01-112.pdf

Interim Report

Emergency Evacuation of Florida Electric Vehicles

For the
Florida Electric Vehicle Roadmap

Date: July 30, 2020

Interim Report – Emergency Evacuation of Florida Electric Vehicles

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Introduction

This is the second interim report to be submitted for the Florida Department of Agriculture and Consumer Services, Office of Energy (FDACS OOE)'s *Florida Electric Vehicle Roadmap* (FEVR) project. The project and these reports address the Electric Vehicle Charger (EVC) infrastructure that is specific to light-duty electric passenger vehicles. Workplace charging and infrastructure to support heavy-duty vehicles and fleets is typically specific to their needs and is not included in the analysis. The need for particular policy or regulatory attention will be noted but not addressed in these reports. These are "Business-as-Usual" evaluations, impacts from the COVID-19 virus have not been considered.

FDACS OOE and its partner, the Central Florida Clean Cities Coalition, conducted six webinar's between April 28th and June 16th to discuss future infrastructure considerations with stakeholders. Individual webinars addressed the considerations with stakeholders representing power service providers, infrastructure network providers, advocacy groups, planners, and state agencies. A total of 15 industry representatives from all of the stakeholder groups participated as facilitators for the webinars. More than 500 stakeholders attended over eight hours of webinars. Discussions during the webinars were very productive and useful. Feedback from participants was very positive. Recordings of the webinars and other information is available on the project website at, https://www.fdacs.gov/Energy/Florida-Electric-Vehicle-Roadmap.

The FDACS OOE and Clean Cities will make a survey available to EV owners and the general public in early August. The survey is intended to solicited direct responses from stakeholders on questions such as, "How would you rank the availability of public charging?", "Do you live in a single-family residence or a multiple dwelling unit?", "What EV power charge level do you use most often?". The results of the survey and webinars will be included in subsequent reports.

Background

The FDACS OOE staff provides support for Emergency Support Function, ESF-12 Fuels, at the Florida Department of Emergency Management State Emergency Operations Center during all emergencies. Responsibilities for ESF-12 Fuels includes activities such as helping to procure fuel and propane for governments, utility crews, first responders and mass care kitchens. In addition, FDACS OOE staff facilitates the daily reporting of bulk fuel data for each port from private fuel vendors and reports on the fuel to be delivered in three to nine days.

This report primarily addresses the Direct Current Fast Charge network (also known as, DCFC, Fast Charge, Level 3); Level 2 and Level 1 charging are adequate for the charge needed to leave the home, but do not have the charging speed to support a large-scale large scale rapid evacuation. EV infrastructure problems discussed in this report are not unique to Florida, they are shared by every other state; in fact, Florida is seen a leader in addressing these issues.

Florida has a unique geography that makes it exceptionally susceptible to impacts from tropical storms and hurricanes, with a total of 18 named storms developing in the Atlantic Basin in 2019. Dorian, a Category 5 hurricane that inflicted severe damage in the Bahamas, also threatened Florida for several days and eventually passed less than 100 miles from our coast.[1] The frequency and strength of these storms is expected to increase in the future, along with the population of Florida. For the purposes of this report, a hurricane scenario has been assumed.

The owners of EVs in Florida face several challenges when needing to evacuate during an emergency, beginning the moment they know an evacuation is eminent. Their first orders of business will be to review their evacuation path, and start charging their car. Like most vehicle owners, EV owners are closely tied to refueling infrastructure. There is charging infrastructure in major metropolitan areas, infrastructure in other parts of the state is limited.

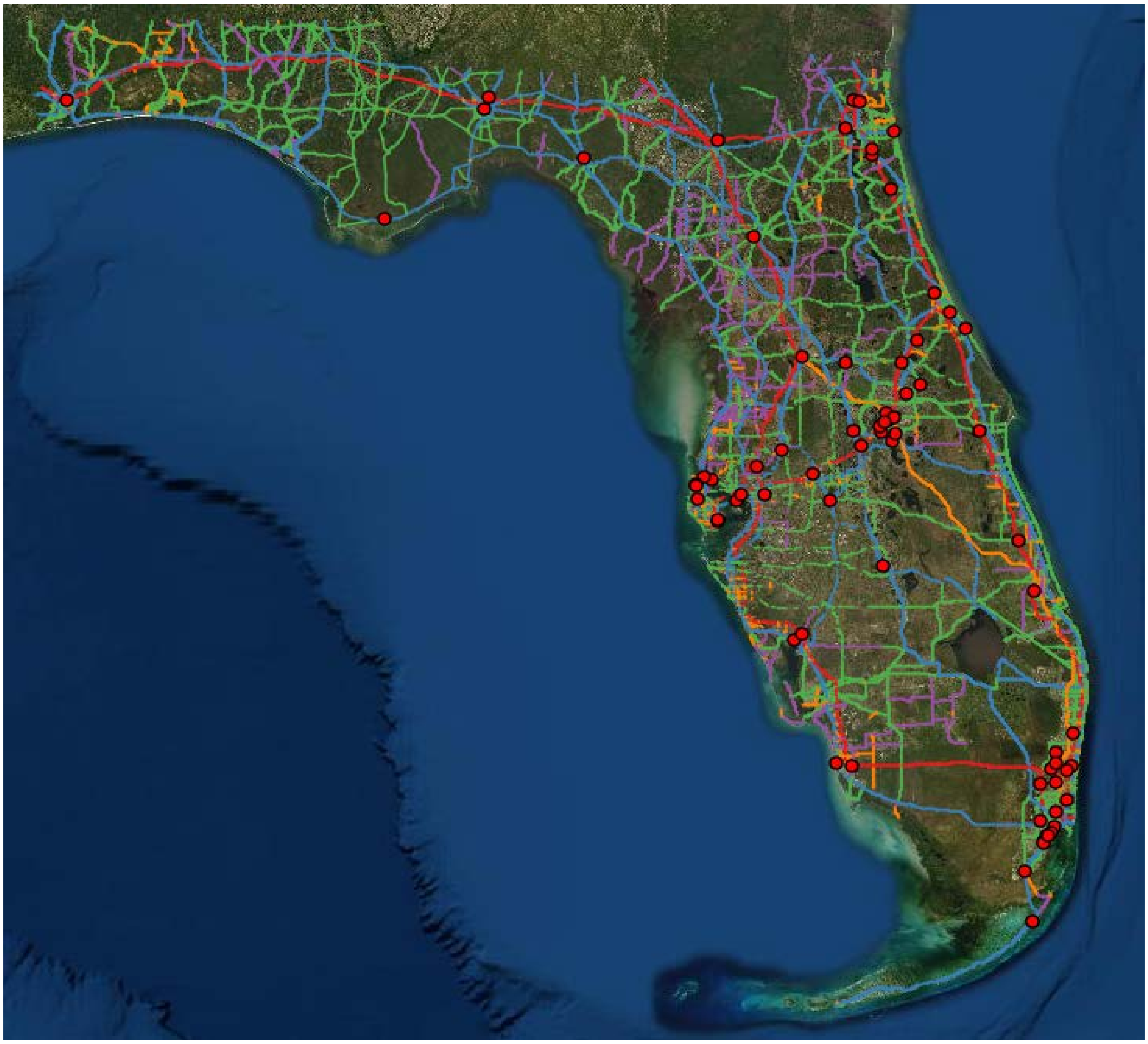
There are approximately 186 publically accessible high-speed chargers in Florida from a variety of providers, and Tesla currently has 327 fast chargers in the state.[2] The ratio of Tesla vehicles to fast chargers is 96 vehicles per fast charger, the ratio of all other EV vehicles in the state to publically available fast chargers is 138 vehicles per charging station.

[1] https://floridastorms.org/2019/12/01/florida-spared-a-significant-strike-during-the-2019-hurricane-seaso/
[2] https://afdc.energy.gov/stations/#/analyze?region=US-FL&country=US&fuel=ELEC&status=E&status=T&ev_levels=dc_fast

Currently there is little infrastructure in the interior of the state to support evacuation, significant portions of I-75, and I-10 in the panhandle have very little fast charging. The table below details the need for DCFC charging times during emergency evacuations.[3]

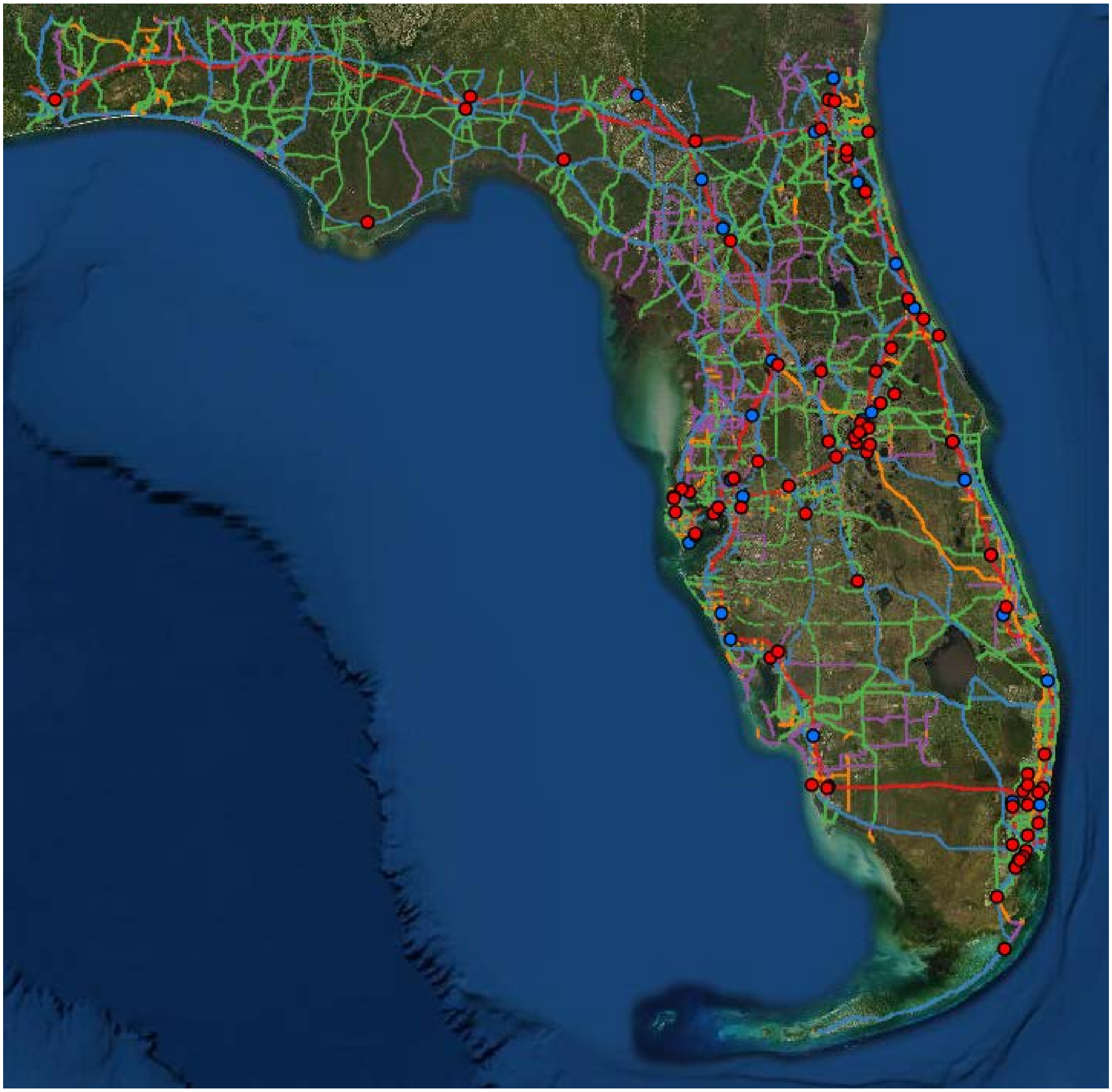
EVSE General Characteristics (Completely depleted battery)

	Charge Time	Voltage/Amps	Power Equivalent	Installation
Level 1	Up to 20 hrs.	120/15	Toaster	Self
Level 2	Up to 7 hrs.	240/40	Clothes dryer	Professional
DC Fast Charge	Up to 30 min.	480/125	15 Central A.C.	Professional

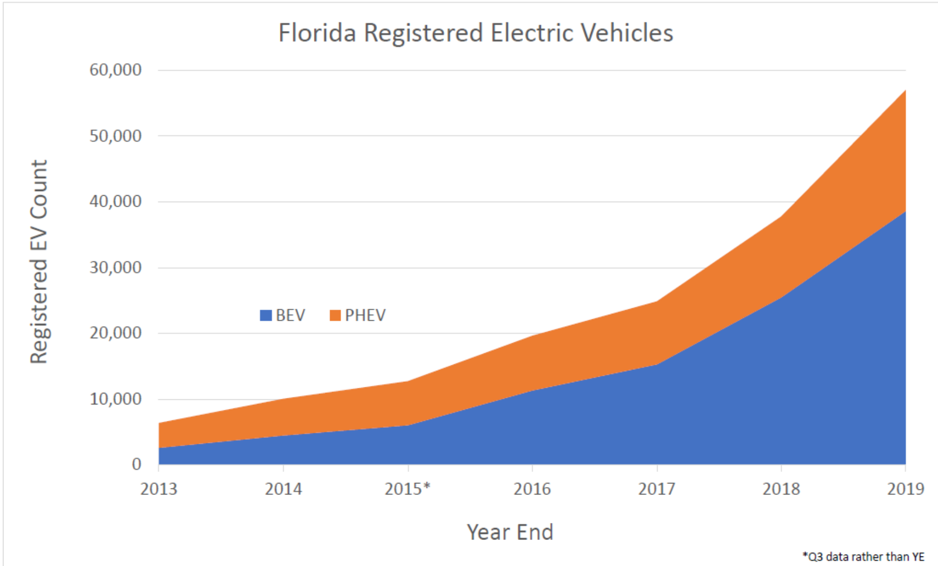


Current fast charge network, June 2020 Source: AFDC/CFLCCC

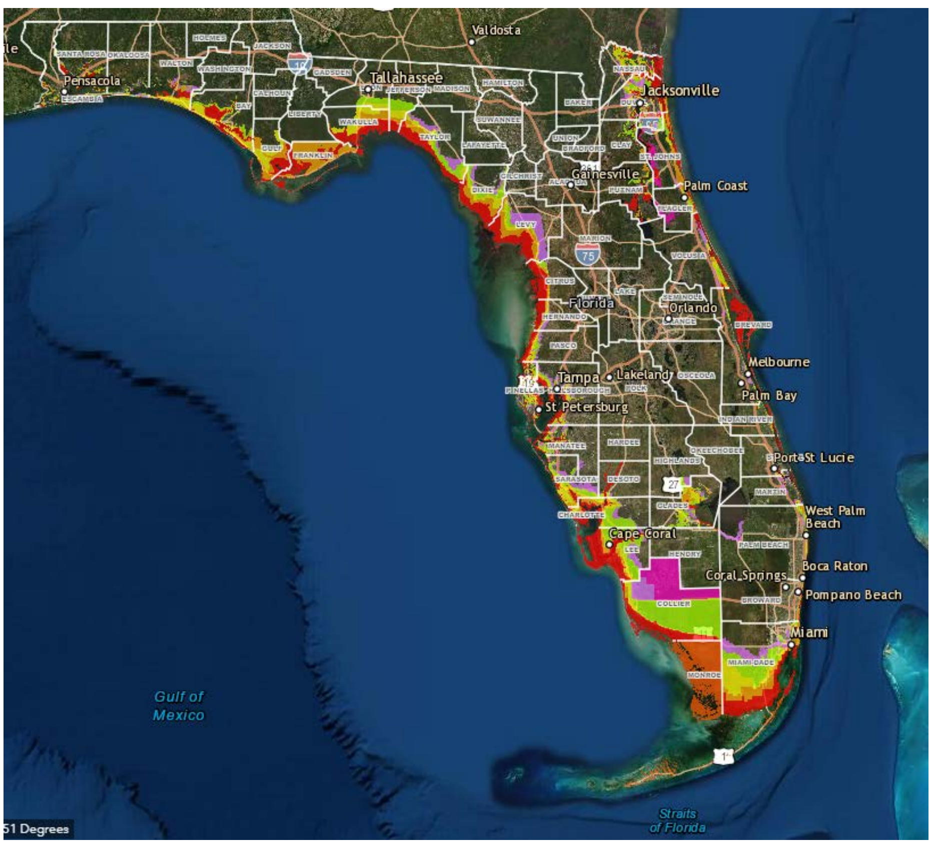
[3] http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1996-15.pdf


Current fast charge network, with VW funded chargers (blue), June 2020   Source: FDEP/AFDC/CFLCCC

There are over 60,000 light-duty EVs registered in Florida, and most of them are within a few miles from one of our coasts. The light-duty EV population grew by an average of 1600 vehicles per month in 2019, an adoption rate 32 percent higher than 2018, and more than four times the monthly adoption rate of 2017; the rate of adoption will continue to increase, bringing more urgency to addressing these issues. The acceptance and growth of electric vehicles continues to accelerate in Florida, and reliable, high-speed EV charging facilities are needed to support the evacuation of owners during an emergency.



Source: Florida Power & Light



Source: https://floridadisaster.maps.arcgis.com

Assuming only half of current EV owners evacuate Palm Beach, Broward and Dade Counties would result in an exodus of over 10,000 vehicles, transporting 15-20,000 Florida residents.[4]

[4] Alternative Fuel Data Center, June 2020

Considerations Specific to EVs

Safety

Light duty EVs are required to have all of the safety features of conventionally fueled vehicles. EVs have fail-safe mechanisms to shut down their electrical systems very rapidly, and their sealed battery systems are impervious to water intrusion. EVs also have a low center of gravity, due to the batteries being carried in the chassis; roll overs during accidents is much less likely to occur.

Driving Range

Range anxiety, the fear of not having enough battery energy to complete a trip, limited the EV adoption rate for years; however, electric vehicle technology and efficiencies have consistently improved. The average range of yearly models has shifted from approximately 75 miles, to 250 miles in the past decade (Figure 3). The standard 2019 Chevy Bolt has a range of 259 miles, Tesla Model 3s can be upgraded to 322 miles of range. EV manufacturers have announced near-term production models with over 400 miles of range, equal to, and greater, than most models of conventionally fueled vehicles.

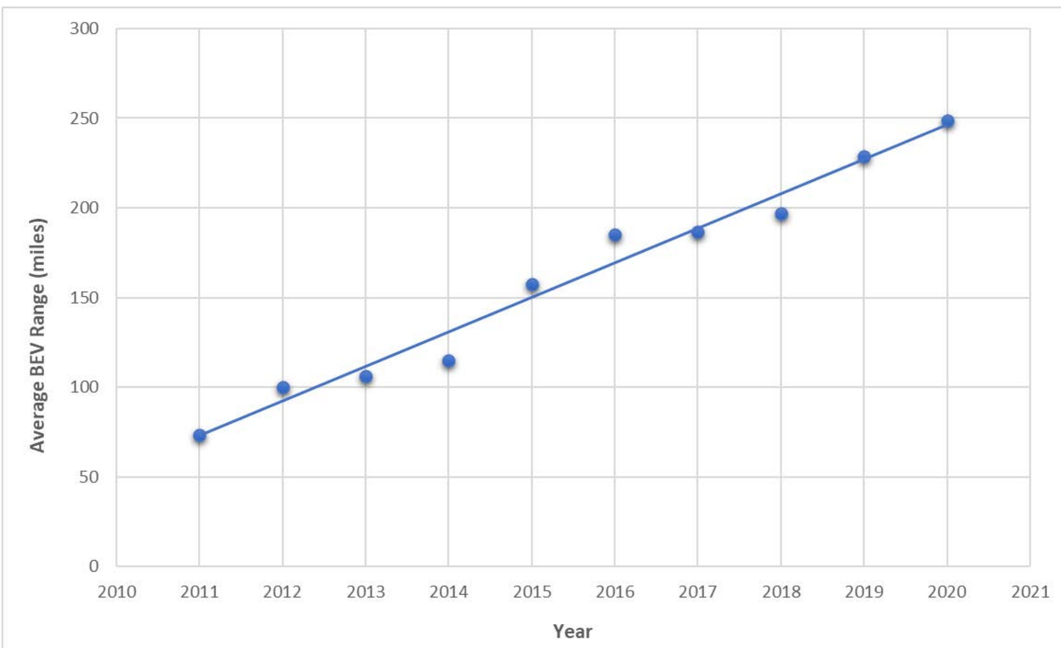


Figure 3. Average BEV Range

The 2020 Battery Electric Vehicle lineup features all-electric ranges between 123 and 402 miles, many older models have ranges under 100, which is not as practical for long distance highway travel. Despite the travel range increases, adequate infrastructure is still an issue, especially for those with EVs that have shorter travel ranges; a problem that seriously complicates planning for an evacuation.

Charging Speed

With the threat of a hurricane, EV drivers cannot spare much time to stop and charge their vehicles. Level 1 and 2 charging stations, which take hours to fully charge an EV's battery, are not adequate for evacuation travel. Alternatively, DCFC stations can charge many batteries to 80 percent capacity in a half hour or less. EV charging lengths vary depending on the model and charger type, but even the quickest chargers take over three times the amount of time it takes to fuel a gasoline vehicle.

DCFC has various power levels, most current installments charge at a maximum rate of 50 kilowatt (kW), but higher output stations are being deployed by infrastructure providers. In the near future, stations with speeds of 150 to 350 kW, can cut charge times to10 minutes or less. Eventually, a robust network of high output DCFC stations will make EV charging times comparable to conventional fueling methods. Higher output DCFC stations will facilitate hurricane evacuations and daily long-distance travel.

Wait Times

Charger wait times may lead to more delays. During evacuations, thousands of drivers travel along the same roads around the same time. The heightened traffic flow leads to escalated fuel demands along major corridors, often to the point of depletion. It is common to see gas stations lines extending to five cars or more, but since it only takes a few minutes to fill up, the lines move relatively quickly. Drivers also have the option of finding another station nearby if wait times become too long.

Figure 2. Gas Station Demand during Hurricane Evacuation. Source: https://floridapolitics.com/archives/223590-evacuations-underway-2-florida-counties

EV drivers do not have the same convenience. DCFC locations can only accommodate one or two vehicles at a time, and a fast charge takes about a half-hour. An expected charge time of a half hour can potentially turn into one or two hours due to high wait times. EV chargers are limited and not as widespread as gas stations, so drivers probably will not have the freedom of finding another station in the area.

Real-time data is a simple way to check charger availability before driving to the station. Most EV charging network providers have apps that display information such as availability and remaining charge time. Some providers offer ways to reserve chargers before arriving. This can help warn drivers ahead of time but might not provide much benefit in cases where that charger is their only option. A better way to reduce wait times, and prepare for more EVs on the road, is to install more charging outlets at each station. Tesla's proprietary fast charging stations have an average of 10 outlets per station, and drivers rarely complain about long wait times. Having more charging points will increase turnover, allowing more drivers to charge with less waiting. A station with

10 charging ports can service up to 240 vehicles during a 24-hour period, which can make a big difference during evacuations.

Moving Forward

EVs are a small but rapidly growing segment of the light-duty vehicle market, if only half of EV owners evacuate Palm Beach, Broward and Dade County evacuate, it would result in an exodus of over 10,000 vehicles, transporting 15-20,000 Florida residents. The current rate of EV adoption averages about 1600 units/month, if the adoption rate and evacuation rate remained constant for ten years, over 96,000 EVs with over 144,000 passengers would need to be accommodated. These numbers are based on a linear adoption rate. However, EV sales are expected to increase exponentially over the next 10-20 years.

Temporary EV Charging Installations

Power outages caused from major weather events are problematic and likely. Weather is the largest cause of electric disturbance events in the United States. A hurricane, can produce widespread power outages that last for days. In 2017, Hurricane Irma left 60 percent of the state without power at its peak, and over 300,000 customers were still without power a week later.[5] Without electrical supply at charging stations, EV drivers who evacuated have no means to make it back home, and those drivers may be stranded without transportation for days.

Several methods of temporary charging have been developed, including small self-contained portable battery systems, larger scale battery systems on heavy duty trucks, and stand-alone, transportable, temporary charging installations.

All of these solutions have drawbacks, but some offer capabilities beyond charging EVs. Portable, self-contained systems are now available that can be used to charge EVs, and provide clean power for emergency installations such as field medical facilities and shelters. The systems can be tied to the electrical grid, or installed as stand-alone systems that use solar photovoltaic (PV) and battery storage to provide power for vehicle and equipment. These systems could also be deployed to determine the charging utilization potential, prior to an investment in a permanent installation.

[5] https://www.eia.gov/todayinenergy/detail.php?id=32992

Optionally equipped with Emergency Power Panel Access

- Total continuous power - 25A @ 240VAC max
- Breakers
  - 1x 30A main 240V breaker
  - 2x 20A push to reset 120V breakers
  - Outlets (refer to NEMA Guide for outlet graphics)
    - 240V (not GFCI protected)
      - § 1x NEMA L14-30 (twist lock)
  - 120V (GFCI protected)
    - § 2x Duplex NEMA 5-20
    - § 2x NEMA L5-20 (twist lock)
- Protection
  - All outlets and breakers equipped with waterproof covers and boots
  - Lockable metal cover plate assembly when stowed and not in use
    - § Comes standard with generic padlock and key – can be swapped out for local standard emergency lock.
    - § Cover plate assembly unfolds to double as weather shield while system is in use
- Other features
  - Low battery red light
  - White night light
  - Manual on/off to disable EV charging if needed
  - Highly visible labeling and decals

Panel comes fully assembled and factory tested with power and control connector whips for rapid installation (mating harnesses required in ARC).

Photo: Envision Solar

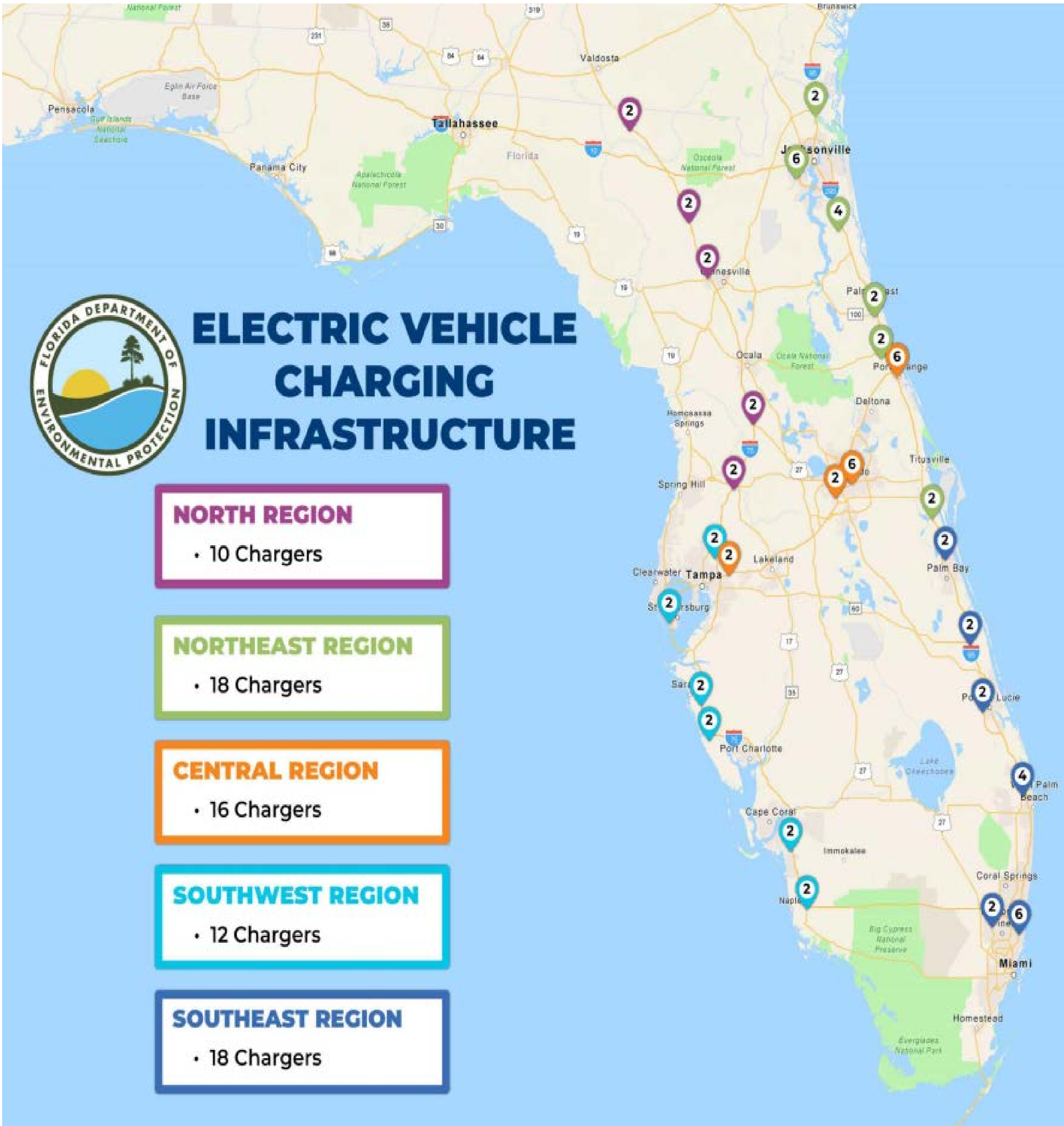
Infrastructure Provider Response

The state of Florida and infrastructure providers investing in our state have been diligent in preparing for the increasing adoption of EVs. Several processes and procedures addressing evacuations need to be understood more thoroughly; such as, staffing and restoration priorities of infrastructure providers, provisioning of spare equipment, security, notifications, and other critical factors need to be better understood.

Volkswagen Settlement (VW Settlement)

Florida is eligible for up to $167 million in VW Settlement funds and has allocated $25 million of those funds to installing EV infrastructure. The first, of three rounds of awards, was announced earlier this month, providing up to $6.8 million for the installation of 74 new fast chargers. Awardees have up to two years to complete their installations. Another award cycle is expected late 2020 or early 2021. Additional information on the awards can be found on the FDEP VW website, floridadep.gov/air/air-director/documents/evci-phase-1-table-awarded-applicants-segment.

The first round of awards will do much to close charging location gaps on Interstates 4, 75, and 95, Interstate 10 was not included in the in the first round of awards but is expected to be addressed in the next award cycle.



VW - First round DCFC award locations

Planning

EV infrastructure is slowly being incorporated into planning processes. The Florida Department of Transportation has been very involved in new vehicle technologies, including autonomous and electric. They recently included discussion about new technologies and infrastructure in their taskforce webinars for M-CORES, a planning project for three new transportation corridors in Florida.

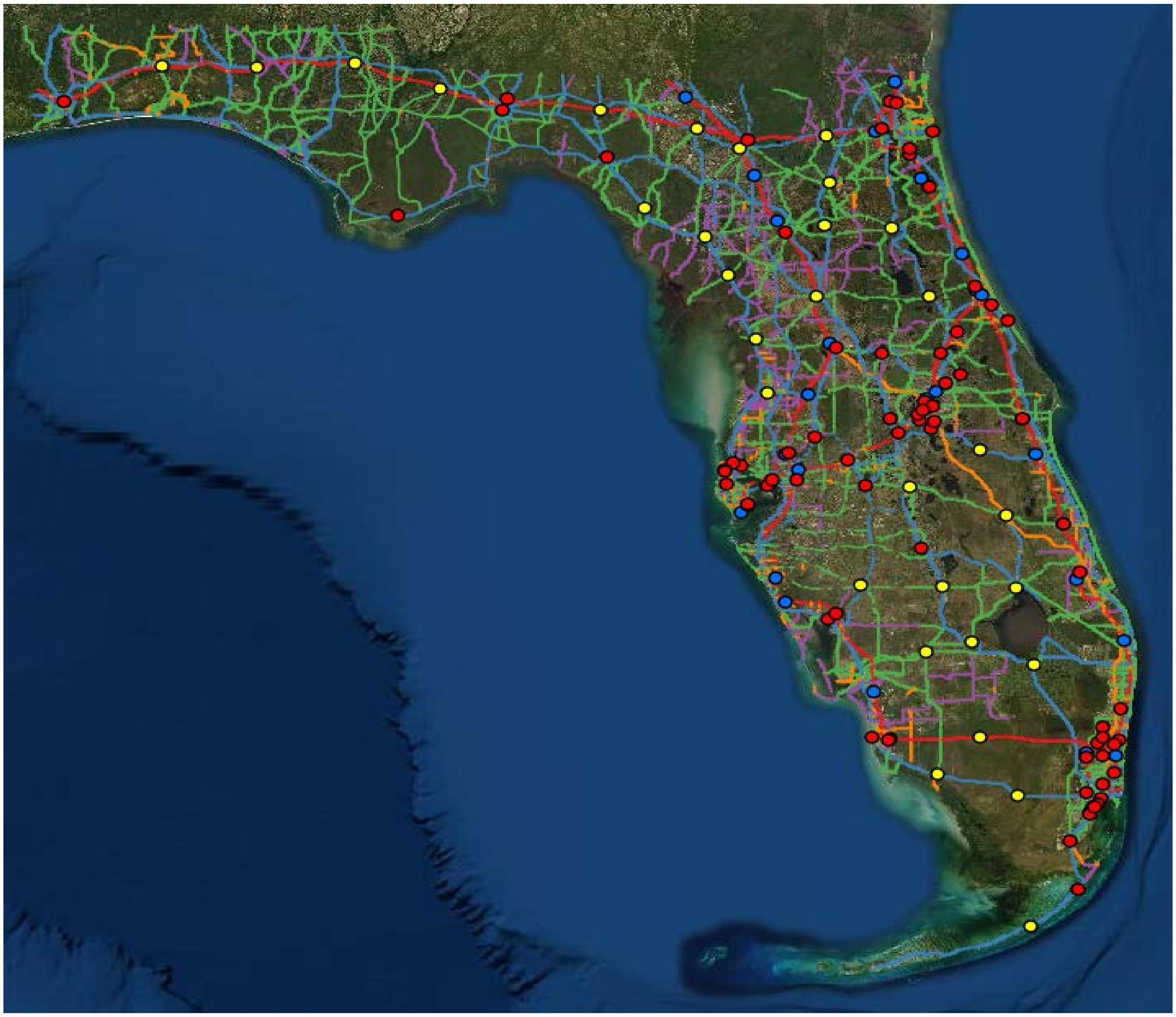
EV infrastructure planning is a difficult task under the best of circumstances, and especially so for private business. Return on investment (ROI) is complicated by the fact that capital is being invested today in a business that should produce revenue in the future; how much revenue depends on EV adoption, which is itself, a moving target. Funding from sources like the VW settlement is an enormous help in improving ROIs.

As has been mentioned, VW settlement will help close the charging gaps on our state's interstates; and it is assumed that some of the funding will be awarded to provide charging to less populated and rural areas of the state. Based on the latest round of Requests for Proposals, final installation of these chargers will not be completed for another three to four years.

Temporary Charging Installations

A possible short-term solution is the acquisition of portable charging, as has been previously described. Assuming that these portable charging systems would be deployed to either the north, central or southern part of the state in response to a particular hurricane, it is estimated that 12 of these units could provide significant capacity for EV owners in each particular region of the state. Based on current retail pricing, the estimated cost for 12 units is $ $840,000.

Below is a map illustrating recommended locations for installing temporary charging, they are largely in the underserved rural areas. Periodically, these locations also serve as a bridge between I-75 and I-4, providing alternative routes with less congestion and more opportunities to charge. The availability of commercial power has been confirmed, any required make-ready for the site has not been determined. A tie to the grid is not required since these are self-contained, solar powered units; a grid tie would be desirable to trickle charge the battery storage and provide grid power. These units can also provide emergency power to support other hurricane relief efforts.



Existing DCFC VW Awards Temporary DCFC

Renewable Energy and Storage

Given the probability of hurricanes in Florida, and the accompanying power outages, it is recommended that solar power with battery backup and storage be considered for critical installations. Solar power and battery storage are expensive add-ons to a charger; given the vulnerability of the rapidly growing population of EV owners, some methodology needs to be developed to support these ancillary systems. And, the environmental upside of EVs charging with renewable power is a win for the environment.

EVs as Emergency Power

There are several other future opportunities for EVs in addressing hurricane impacts, including home emergency power from the EV. As EV battery systems continue to grow in power capacity, the use of their stored energy capabilities will increase. The battery systems in the vehicles can provide emergency power to the owner’s home for a significant period of time; combing residential solar photovoltaics (PV) with an EV battery systems extends and increases the emergency power capabilities. The increase in storage capacity for vehicles is particularly useful when heavy-duty electric vehicles are considered; electric school buses, configured to output their stored power could be very valuable in an emergency situation. Florida currently has 46 schools with solar PV installed that provide power to the emergency shelter using 10kW arrays. An electric school bus with its 160kW of stored energy would be a dramatic improvement for the school shelters, extended care facilities, etc.

The broad availability of both light-duty and heavy-duty vehicles should be aggressively investigated by governmental agencies, most of whom have no requirement for the consideration of EVs. Many EV applications have been developed, from pickup trucks with exportable power, to garbage trucks and street sweepers; all using clean fuel, a lower cost of ownership and other potential benefits.

Conclusion

This report has explored the opportunities and obligations our state has in supporting the evacuation and safety of a rapidly growing population of EV owners. The opportunities are associated with the technology of electric transportation, including the use of the vehicles themselves as sources of clean, portable emergency power; and expanding the use of solar as a renewable energy source to charge EVs, and storage batteries to reduce operational costs. The obligation comes in the form of support for these owners as they realize the benefits of a lower cost of ownership, improved energy efficiency, and contributing to improved air quality in Florida.

Electric Vehicle Infrastructure Deployment Recommendations

Florida Electric Vehicle Roadmap

October 6, 2020

Electric Vehicle Infrastructure Deployment Recommendations

Prepared by:

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Introduction

This is the third report to be submitted for FDACS OOE's *Florida Electric Vehicle Roadmap* (FEVR) project. The project and these reports address the Electric Vehicle (EV) infrastructure that is specific to light-duty electric passenger vehicles. Workplace charging and infrastructure to support heavy-duty vehicles and fleets is typically specific to their needs and is not included in the analysis. The need for particular policy or regulatory attention will be noted but not addressed in these reports. These are "Business-as-Usual" evaluations; impacts from COVID-19 have not been considered.

This report is a compilation of previously reported information, new research, and additional input from stakeholders. A series of webinars and a state-wide survey conducted by FDACS OOE and CFLCCC were used to collect valuable input from a broad range of interested parties.

Stakeholder Input

Gathering information from end users is crucial to understanding the performance of the existing infrastructure, and the planning needed for future infrastructure. FDACS OOE and CFLCCC conducted six webinar's between April 28 and June 16 to discuss future infrastructure considerations with stakeholders. Individual webinars addressed the considerations with stakeholders representing power service providers, infrastructure network providers, advocacy groups, planners, and state agencies. A total of 15 industry representatives from all of the stakeholder groups participated as facilitators for the webinars. More than 500 stakeholders attended over eight hours of webinars. Discussions during the webinars were very productive and useful. Feedback from participants was very positive. Recordings of the webinars and other information is available on the project website at, fdacs.gov/Energy/Florida-Electric-Vehicle-Roadmap

Topics of discussion during the webinars included:

- Increase in battery efficiency, resulting in 400+ mile range
- Increase in EVSE output of 600kW+
- Requirements for thermal management of higher EVESE outputs
- Increased grid demands at EVSE locations
- Broad introduction of EV passenger shuttles, taxis, and Transportation Network Companies (TNCs)
- Initial deployment of autonomous vehicles
- Inductive charging
- Networking and internetworking of EVSE
- Siting and upgrade capabilities
- Uptime, Resiliency, Backup Power
- Obsolescence and upgrade of EVSE
- Social equity and underserved communities
- Outreach, education, and training
- Energy consumption
- Environmental
- Site Safety
- Zoning, building codes, and permitting
- Signage

Following the webinars, FDACS OOE and CFLCCC decided to conduct a survey of interested parties as an additional means of gathering stakeholder input through an online questionnaire addressing Florida's EV infrastructure. Conducted in August of 2020, the survey sought feedback on the existing infrastructure, but it also posed other questions about reliability and availability, as well as equitable EV fees in-lieu-of gasoline taxes. The results of this survey are discussed in the recommendations section of this report.

Policy
Specific policy recommendations are outside the scope of this report. However, sound policy for EVs and EV infrastructure are crucial for their adoption and success in our state. Therefore, we have included recommendations for areas in need of policy development in the Recommendations Section.

Planning
EV infrastructure planning continues to advance in its sophistication and application. The planning is largely carried out by four major entities, the providers of network-based infrastructure, municipalities, counties, and power service providers. Additional planning, on a smaller scale, takes place at airports and destination locations, such as Florida's theme parks. As the EV population and technology advance, additional attention and coordination will be needed for infrastructure development.
EVs are mechanically much simpler than traditional internal combustion engines that use gasoline. EVs do not require radiators, belts, or engine and transmission overhauls,

or the petroleum products needed for these devices. Auto manufacturers are fully committed to electric transportation, and customers such as Amazon and UPS are prepared to purchase over 100,000 electric delivery vehicles as soon as they can be manufactured.

There are now EVs for every imaginable transportation need, from street sweepers to heavy duty delivery vehicles and police motorcycles. Regional short-haul trucking firms are converting to electric, and long-haul carriers are also committing to the EV segment, powered by hydrogen fuel cells.

The lower Total Cost of Ownership (TCO) and longer life of these vehicles will have profound positive impacts on all segments of transportation, especially disadvantaged and mobility starved communities as these communities are effected more by transportation-related pollution and spend a disproportionate amount of their income on gas and public transit costs.

Florida’s Department of Environment Protection (FDEP) administers the state’s share of the EPA’s law suit against Volkswagen for actively falsifying emissions test results for their diesel vehicles.

The first round of awards will do much to close charging location gaps on Interstates 4, 75, and 95. Interstate 10 was not included in the in the first round of awards, but it is expected to be addressed in the next award cycle.

Installation Permitting

Webinar participants, and others, noted that installation permitting requirements are subject to local jurisdictional requirements that vary from jurisdiction to jurisdiction. Significant amounts of time can be required to educate authorities about EV infrastructure technology, resulting in delays to deployment. The development of EV ordinances addressing requirements and considerations by local jurisdictions for EV infrastructure would benefit the jurisdiction, the infrastructure developer, and the general public.

Although there is a healthy infrastructure development environment in Florida, there has been little coordination of efforts and no established standards for performance and availability.

Transportation Network Companies (TNCs), Taxis and Shuttles

Florida businesses providing transportation services are beginning to convert to electric transportation using vehicles designed to address their needs. Services such as Lyft and Uber have already impacted parking, and arrival and departure services at airports, convention centers, hotels and other high transit areas. The shift to more electric taxis and shuttles will accelerate as prices for these vehicles decrease and the lower TCO becomes clearer.

These services are fuel intensive operations, regardless of what fuel is use. Demand for high-powered EV charging in close proximity to previously mentioned travel destinations will increase substantially. There are significant health and environmental advantages that can be realized by investing in these high-traffic environments.

Many hotels and vacation destinations now offer some level of EV charging for their guest, typically Level 2. Direct current fast chargers (DCFC) in the urban core and at convention and hotel clusters will be required to support business and vacation travel. Additional Level 2 charging in parking garages and lots will be required to support multi-day business and vacation travel.

Disadvantaged Communities

Historically economically disadvantaged communities are areas which have been disproportionately impacted from a combination of economic, health, and energy related burdens. These burdens include high energy costs, poverty, high unemployment, air and water pollution, presence of hazardous wastes as well as high incidence of asthma and heart disease. These areas include low-income communities and communities of people of color.

Disadvantaged communities are disproportionately harmed because of their proximity to multiple sources of pollution, including industrial facilities, bus depots, and truck corridors. They have been an unwilling victim of transportation planning, typically through permanent disruption of their neighborhoods. As well as adverse health and occupational impacts related to transportation disproportionally affecting these communities.

Low-income communities and communities of people of color bear disproportionate climate change and pollution burdens, and therefore, these communities must be among the first to receive investment relating to new technologies and infrastructure that address the climate crisis and mitigate localized environmental pollution.

Electric transportation's significantly lower TCO present a real opportunity to improve disadvantaged communities transportation access, allowing them to commute to better jobs, health care and other services that cannot be accessed through public transportation; all while enjoying a quieter and cleaner community.

Rural Communities

Drivers in rural communities have different travel behaviors and vehicle preferences than their urban counterparts. It is precisely these differences that give drivers in rural communities the greatest economic potential for gain by purchasing an EV. Drivers living outside of urban areas often have farther to travel to work, shop, and visit a doctor. They have to repair their vehicles more frequently, they produce more carbon emissions per capita, and they spend more money on gasoline.

There are three main barriers preventing rural drivers from switching to EVs: vehicle range, limited vehicle choices, and lack of charging infrastructure. EVs manufacturers are addressing the first two concerns by providing vehicles with travel ranges in excess of 100 miles as well as promising to provide more vehicle choices including pickup trucks. However, more EV charging infrastructure is needed to address the third concern.

One reason EV charging infrastructure is not prevalent in rural communities is because it more difficult to find optimal areas for public charging infrastructure as these areas are more remote with a low population density. Collaboration between local and regional transportation agencies along with the local electric utility provider will guarantee a connected network with higher utilization. Placed appropriately, EV charging infrastructure in rural areas would also ensure evacuation routes are complete for EV drivers when a natural or man-made disaster occurs.

Financing and Incentives
Securing financing for EV infrastructure is particularly challenging, due largely in part to the low return on investment and lack of supporting policy decisions. The business case for capital intensive infrastructure is not particularly attractive, owing to the relatively low adoption rate for EVs and the revenue they generate. Fortunately, private companies are providing infrastructure, accepting the risk, and counting on the rapidly growing EV population.

Counties, municipalities and other governmental or quasi-governmental agencies largely depended on federal grants to support the installation of infrastructure.
There are several methods of financing the installation of EV infrastructure in Florida. Established providers can access private financing from financial institutions, internal sources, and grants and awards provided by federal sources such as the US Departments of Energy, Transportation, and Environmental Protection. Philanthropic foundations can also be a source of funding.

State of Florida
The State of Florida currently provides funding for the installation of EV infrastructure through funding from Florida's Volkswagen Settlement. FDEP manages the state's share of the EPA's law suit against Volkswagen for actively falsifying emissions test results for their diesel vehicles. The State allocated the maximum amount allowable for EV infrastructure under the $167 Settlement, $25 million (15 percent). The Settlement funds for infrastructure are largely targeted for the installation of DCFC units to close existing charging gaps on Florida's Interstates and other major roads.

Volkswagen funding for infrastructure purchased with *electric school busses* is available under a program managed by FDEP. Volkswagen funding supporting infrastructure for *electric medium and heavy-duty vehicles* is also available through the FDEP, under the federal Diesel Emissions Reduction Act (DERA). See the FDEP's Volkswagen Settlement website for details.

The first, of three rounds of awards, was in July, providing up to $6.8 million for the installation of 74 new DCFC units. Awardees have up to two years to complete their installations. Another award cycle is expected late 2020 or early 2021. Information on the awards can also be found at on FDEP's Volkswagen Settlement website.

Federal Highway Administration (FHWA)/USDOT

Congestion Mitigation and Air Quality Improvement (CMAQ) Program

A State may obligate funds apportioned under section 104(b)(4) for a project or program to establish electric vehicle charging stations or natural gas vehicle refueling stations for the use of battery powered or natural gas fueled trucks or other motor vehicles at any location in the State except that such stations may not be established or supported where commercial establishments serving motor vehicle users are prohibited by section 111 of title 23, United States Code. https://www.fhwa.dot.gov/map21/docs/title23usc.pdf

Highway Infrastructure Program (HIP)

A recent apportionment memo issued by FHWA as part of the FY20 US Department of Transportation Appropriations Act. The memo apportions FY20 Highway Infrastructure Program (HIP) funding, and includes a ***new*** eligibility **"to provide necessary charging infrastructure along corridor-ready or corridor-pending alternative fuel corridors designated pursuant to 23 U.S.C. 151."**

The HIP funds are sub-allocated in the same manner as the Surface Transportation Block Grant (STBG) Program funds, which is explained here.

The funding is sub-allocated to areas based on their relative share of the total State 2010 Census population (Table 1) of apportionment memo. The sub-allocated funds are divided into three categories and must be used in the areas described below by the following categories:

1. Areas with a population of 5,000 or fewer.
2. Urban areas with a population of 5,001 to 200,000.
3. Urbanized areas with a population over 200,000.

The percentage to be sub-allocated is 55 percent in FY 20. The remaining percentage (45 percent) of the State's apportionment is available for use in any area of the State.

For Urbanized areas with a population over 200,000 (category #3 above), FHWA provides an additional level of sub-allocation, by specific urban areas – see (Table 2) of the apportionment memo. The other categories (1 and 2) are only sub-allocated at the State level.

"Corridor funding" is another eligible activity among many for HIP funding; this funding can be used for EV infrastructure along designated corridors, but it is a state/local decision to do so.

Additional Incentives

Several Florida power service providers provide incentives and programs for businesses and individuals, they are almost exclusively for the installation of home charging and workplace charging.

For more information on incentives and programs, contact your local government or power service provider. Additional information specific to Florida (outlined below) can be found at on the USDOE's Alternative Fuels Data Center.

State Incentives

- Electric Vehicle Supply Equipment (EVSE) Financing Authorization
- Excise Tax Exemption for Biodiesel Produced by Schools
- Idle Reduction and Natural Gas Vehicle (NGV) Weight Exemption
- Ethanol Production Credit

Utility/Private Incentives

- Plug-in Electric Vehicle (PEV) Rebate - JEA
- All-Electric Vehicle (EV) and Electric Vehicle Supply Equipment (EVSE) Rebates - KUA
- Plug-In Electric Vehicle (PEV) Rebate - OUC
- Electric Vehicle Supply Equipment (EVSE) Incentives - Brickell Energy
- Electric Vehicle Supply Equipment (EVSE) Pilot Program - Duke Energy

Laws and Regulations

- State Highway Electrification Plan added 7/13/2020
- State Highway Transportation Plan
- Autonomous Vehicle (AV) Testing and Operation
- Charging Electric Vehicle Supply Equipment (EVSE) Regulation Exemption
- Electric Vehicle Supply Equipment (EVSE) Policies for Condominiums
- Electric Vehicle Supply Equipment (EVSE) Rules
- Authorization for Alternative Fuel Infrastructure Incentives
- Electric Vehicle (EV) Insurance Regulation
- Alternative Fuel Economic Development
- Fuel-Efficient Vehicle Acquisition and Alternative Fuel Use Requirements
- Provision for Renewable Fuels Investment

EV Adoption, and Forecasting Infrastructure Needs

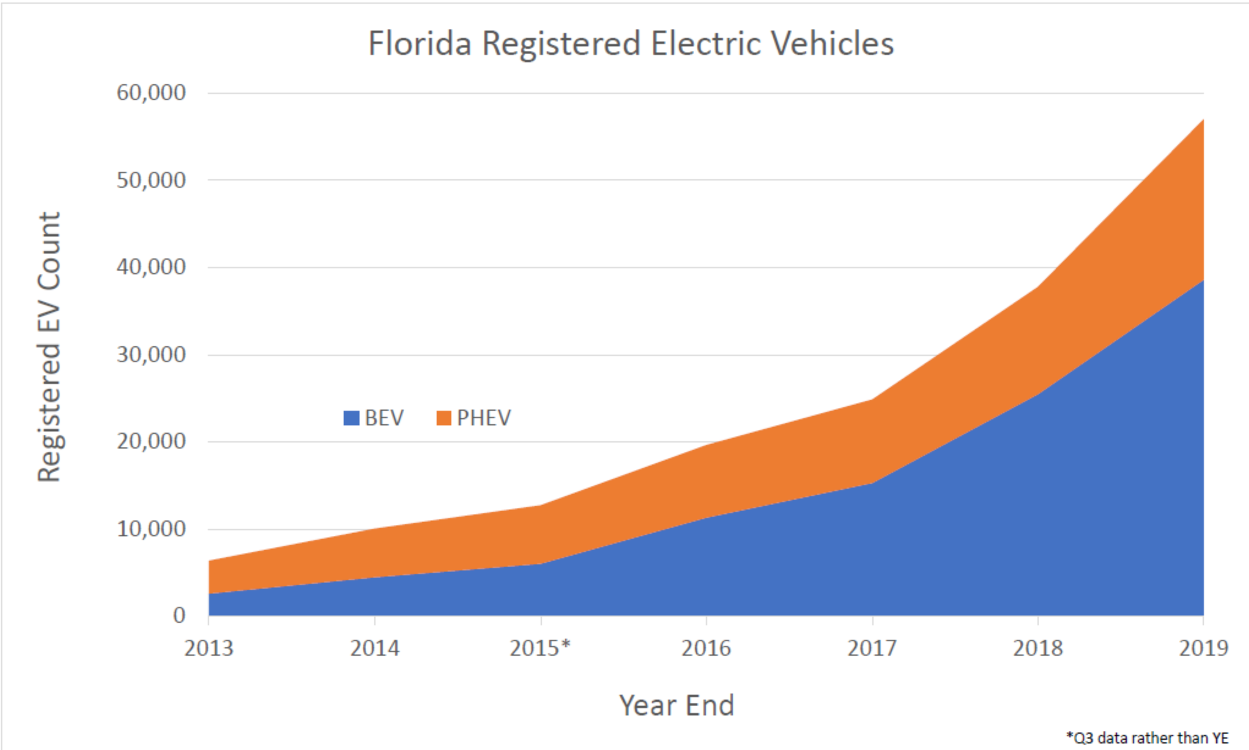
The rate of EV adoption is key to determining the required infrastructure, the ability to do so has been difficult but is improving. Additional elements that contributed to an understanding of infrastructure need, such as user behavior, are also becoming better understood. The introduction of temporary, solar powered charging stations can be a valuable tool to confirm the analytical analysis of a potential location. The independently powered units can be easily deployed to measure actual utilization of a proposed site.

Determining actual EV sales in Florida has also been difficult for a variety of reasons, including low initial sales and difficulty in interpreting data provided by Florida's Department of Motor Vehicles (FDMV). A significant amount of filtering, cross checking and other efforts are currently needed to arrive at accurate data. The data has become more visible and accurate, but there appears to be a need to refocus on data input; specifically, the criteria used, input accuracy, its usability, and available reporting. Improvements in these areas will provide a better understanding of the impact of these transportation technologies in our state.

Several Florida power service providers continue to invest the time in this process and share very accurate and valuable information. Information provide by Florida Power & Light has been instrumental in developing this report.

<u>EV Adoption</u>
The growth of the Florida EV population has been steadily accelerating over the last decade, there are over 60,000 light-duty EVs registered in Florida in 2020. The light-duty EV population grew by an average of 1600 vehicles per month in 2019, an adoption rate 32 percent higher than 2018, and more than four times the monthly adoption rate of 2017.[1] The rate of adoption will increase rapidly as the prices for EVs continue to decline. This report will include data and information for all EV manufacturer's and infrastructure providers currently doing business in the state.

[1] Florida Power & Light, Q2 2020 Analysis



Source: Florida Power & Light

Registered BEV and PHEV Drivers State of Florida	
Year	Vehicles
Q2 2020	63,750
YE 2019	56,980
YE 2018	37,776
YE 2017	24,852
YE 2016	19,627
Q3 2015	12,749
YE 2014	10,068
YE 2013	6,377

Source: Florida Power & Light

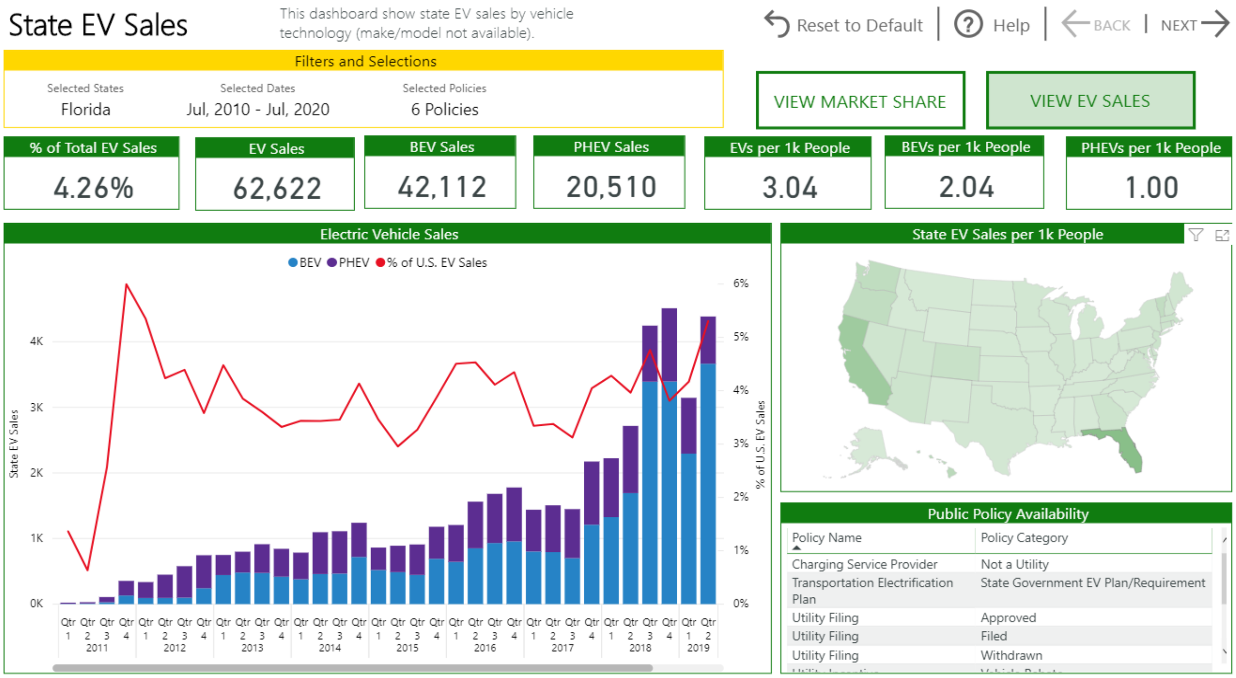
The CFLCCC recently worked with our partners at Argonne National Laboratory to produce a report specific to Florida. The report[2], based on the data above, provides timely information for our state. Conclusions from the report are excerpted below, a full copy of the report is included as an appendix. The nation-wide assessment contains additional valuable information on driver behavior, energy efficiency and other topics, it can be found at, https://publications.anl.gov/anlpubs/2020/06/158307.pdf

Conclusions: "Since the latest generation of light-duty plug-in electric vehicles have been available in the United States, nearly 60,000 PEVs have been registered in Florida, driving nearly 1.5 billion miles on electricity. These 1.5 billion eVMT consumed more than 500 gigawatt-hours of electricity while reducing gasoline consumption statewide by nearly 60 million gallons. From 2011 to 2019, mileage driven by PEVs and electricity consumption has grown, which has offset gasoline consumption and CO_2 *emissions from ICE vehicles. Further information about assumptions and calculation methodology can be found in a previous report (Gohlke and Zhou, 2020)."*

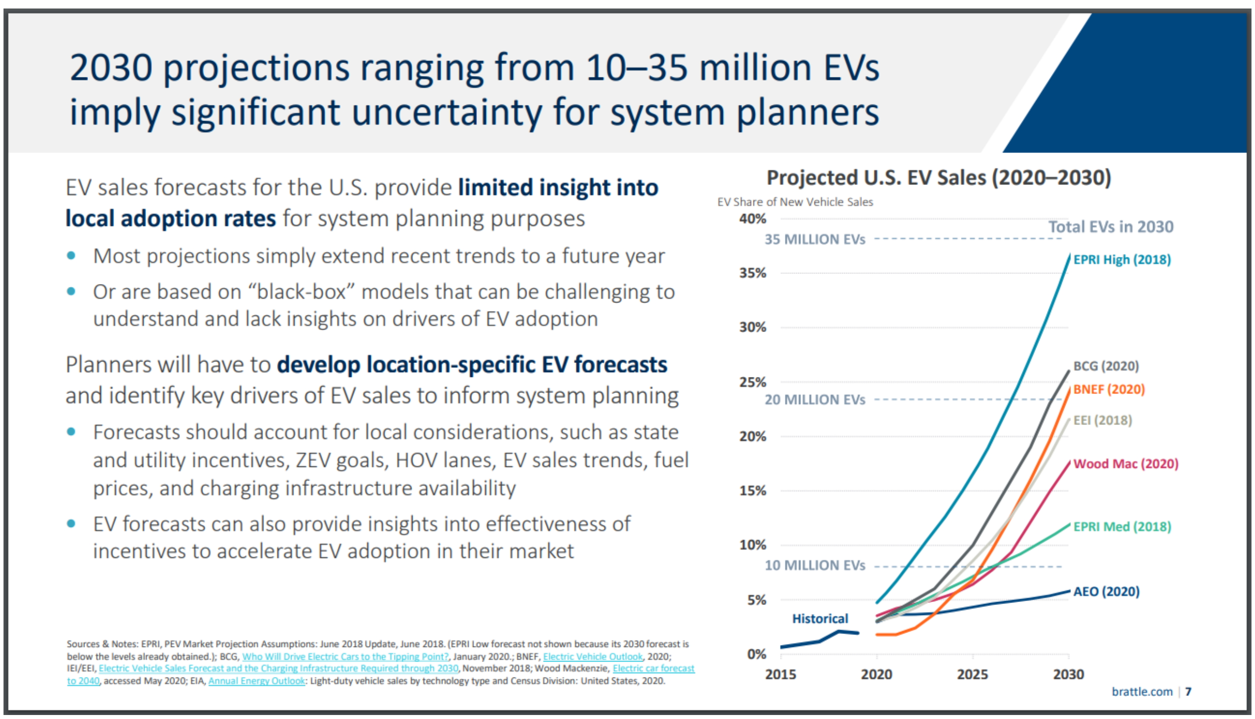
Time has allowed for the development of methodologies that provide more accurate accounting for EV adoption in Florida, how to apply that information as a forecast becomes more complex and impactful over the ten-year horizon of this project.

There are several agencies, and private organizations that routinely forecast the adoption of electric vehicles, among them are the International Energy Commission, Bloomberg, L.P., and private consultation groups. Most of these forecasts are on a national scale, which is insightful but not very useful at the state level. Below are excerpts from reports from Atlas EV Hub, a Clean Cities national partner, and the Brattle Group's June 2020 report, Getting to 20 million EVs by 2030.

[2] *Summary Statistics for Light-Duty Plug-in Electric Vehicles in Florida, 2011 – 2019,* David Gohlke, Argonne National Laboratory, Energy Systems Division, Systems Assessment Group, August 6, 2020



Source: Atlas EV Hub

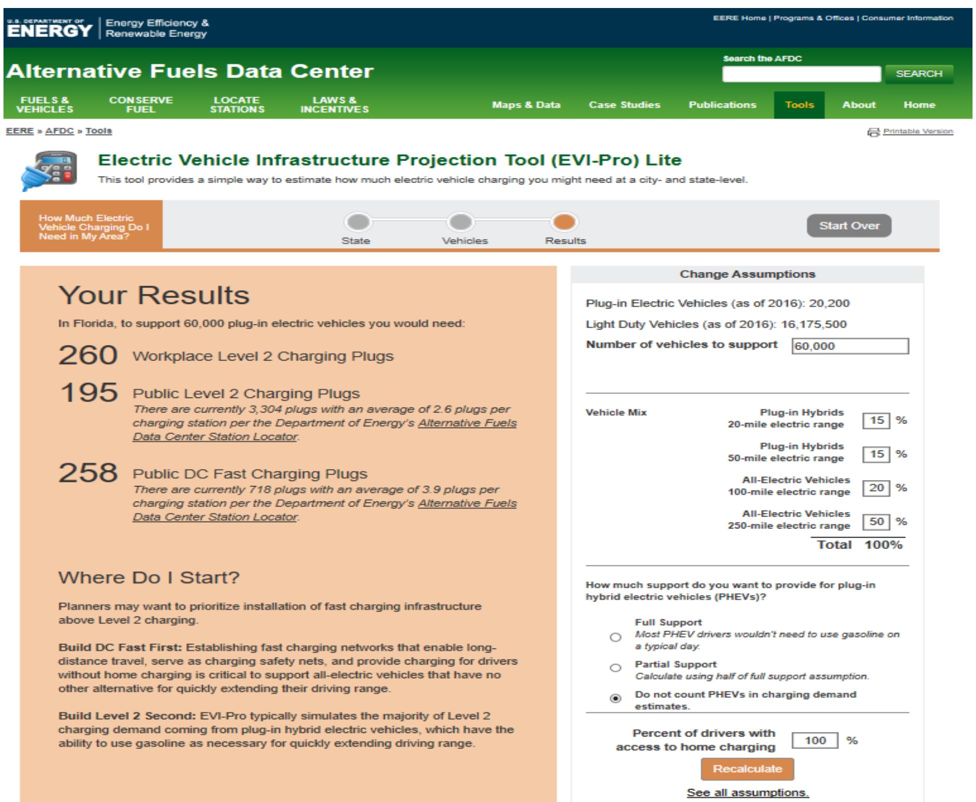


Source: The Brattle Group, Inc.

EVI Tool

The U.S. Department of Energy's National Renewable Energy Laboratory's (NREL) EVI-Pro Lite[3] tool will be used to calculate estimated infrastructure demand. The tool allows projections based on geographic area, using the region's current and anticipated EV population. There are other methodologies for estimating required infrastructure; however, this tool provides backend support from NREL and other national labs, and a more accurate ability to compare results with other leading EV states, such as California and New York.

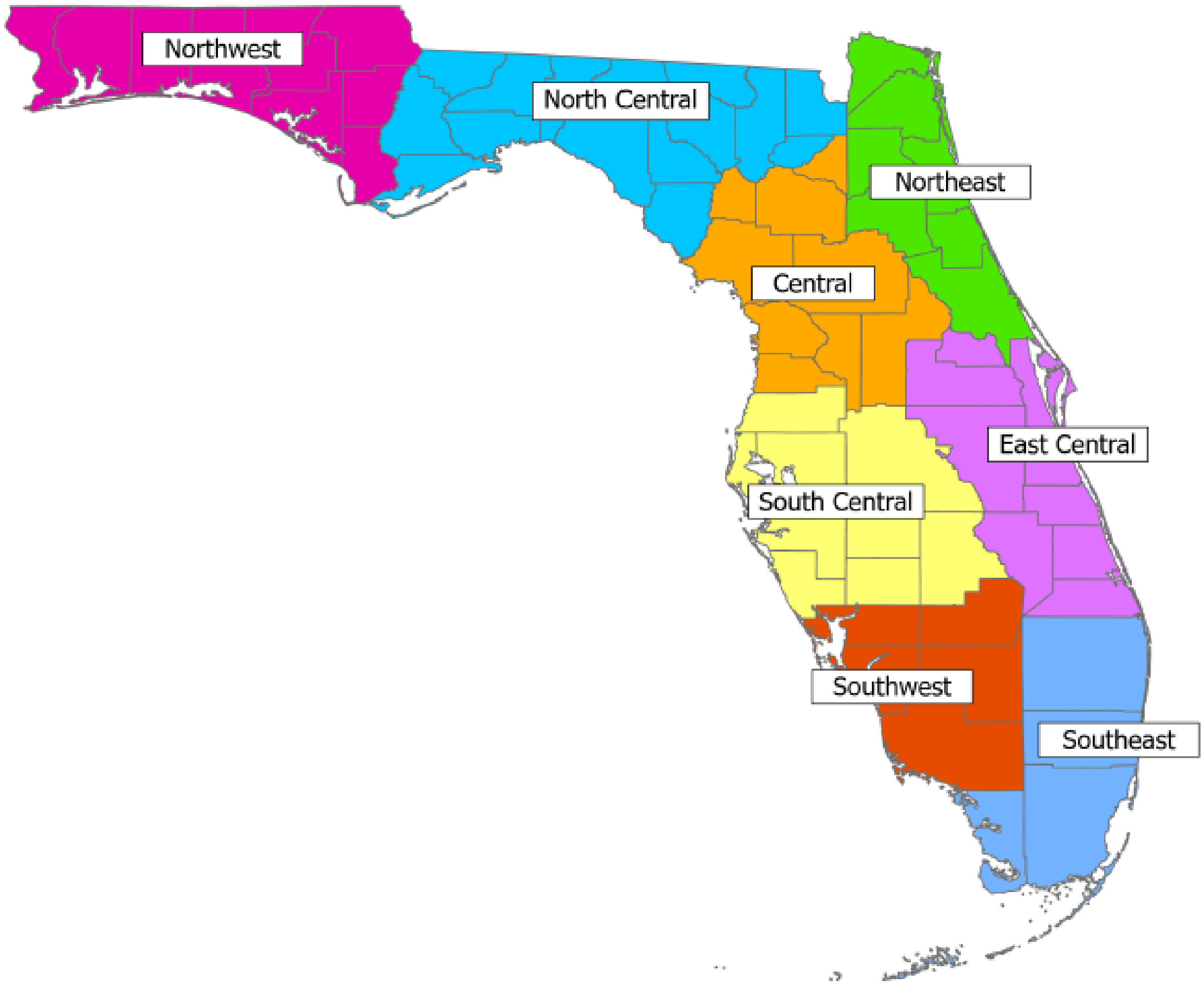
NREL, in conjunction with the California Air Resources Board (CARB), developed the EVI-Pro Lite tool to estimate how much EV infrastructure a city or state may need. The states of California and New York use this tool for their projections and planning. As has been mentioned, this tool has been developed and evaluated by other states and will provide a basis for more accurate comparisons.



Sample values used for illustration purposes only.

[3] https://afdc.energy.gov/evi-pro-lite

This infrastructure analysis will extend through 2030 and will be based on the geographic regional areas of the state used in the recent EV Survey that was distributed to registered EV users, enthusiast and other interested parties within the state.



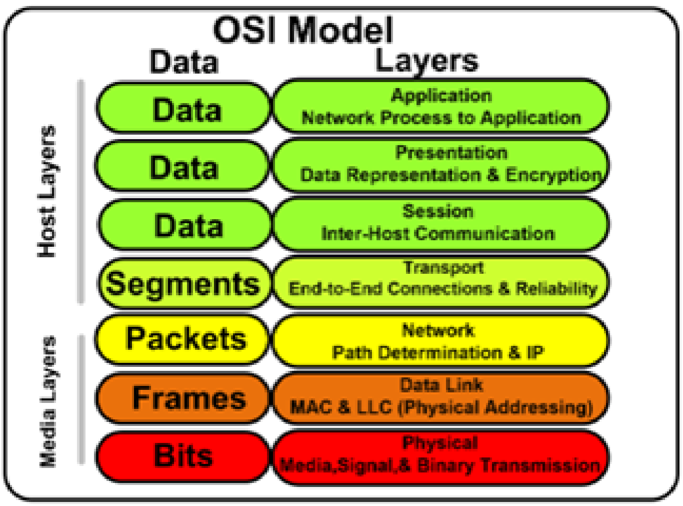
Roadmap EV Growth and Infrastructure Forecasts Methodology

Working directly with EIA, NREL and several others will allow us to develop forecasts that reflect Florida's specific needs. These forecasts will be based on the latest Florida specific data, and the growth rate projections used by several leading organizations for their individual forecasts. We will blend growth rates provided by these organizations to produce customized estimates of Florida's infrastructure needs. Please revisit the Battle Group graphic on page 12 in this report for an appreciation of the variability of several lead forecasts.

Estimates of location specific infrastructure needs for 2021, 2022 and 2023, will be provided in the final report near the end of this year; annual estimates for additional infrastructure needs and capital investment estimates for 2024-2030 will also be provided at that time.

Infrastructure Interoperability, Performance and Monitoring
Transportation is undergoing profound changes driven by new technologies in propulsion, fuels, engineering, planning, and many other segments. Near-term expectations for autonomous vehicles and connected infrastructure are revolutionizing transportation planning. There is promise in how these technologies will provided cleaner, more efficient transportation that can serve a disadvantaged and aging population, while expanding the capabilities of vehicles and infrastructure.

Interoperability
"Smart Technologies" have the ability to analyze data from devices in near real-time and make adjustments to the device or support infrastructure to improve efficiency and throughput. Data networks have thrived in an environment of standards that allow connections and hand-offs between devices, back-offices, and networks. An example of data network interoperability is the Open Systems Interconnection model (OSI), adopted as a standard by International Organization for Standards (ISO 7498) and the International Telecommunications Union (ITU-T X.200). OSI is based on a seven-layer Reference Model and a set of specific protocols.[4] The development and adoption of data network standards has allowed the ubiquitous availability of high-speed data and video, dramatic reductions in equipment cost, and the development of specialized applications and tools.



Work continues on the development of standards for EV charging, general recognized as the Open Charge Point Protocol (OCPP). OCPP is an application protocol enabling communications between EV charging stations and central management systems, it has not been widely adopted and is currently available as OCPP 2.0. The latest version has the following use cases.

[4] https://electricalacademia.com/computer/osi-model-layers-functions/

	Functional 'blocks'	# Use cases	Δ with 1.6
A	**Security**	**4**	**New**
B	Provisioning	12	Plus 5 use cases
C	Authorization	16	Plus 6 use cases
D	Local Authorization list management	2	-
E	**Transactions**	**15**	**Plus 2**
F	Remote control	6	Plus 1
G	Availability	4	Plus 1
H	Reservation	4	-
I	Tariff & Cost	6	New
J	Meter values	3	Plus 1
K	**Smart charging**	**20**	**Plus 10**
L	Firmware management	6	Plus 2
M	**15118 Certificate management**	**6**	**New**
N	**Diagnostics**	**8**	**Plus 7**
O	Display message	6	New
P	Data Transfer	2	-

The U.S. Department of Energy is involved in the development of standards and technologies for EV charging and EV to-Grid interface at its Argonne National Laboratory. Argonne provides research to support the EV industry and electric utilities. The goals of the EV-Smart Grid Interoperability Center are:[5]

- Enabling technology development to support EV-Grid integration,
- Enabling communication to manage vehicle charging loads,
- Reducing the cost of electric vehicle charging infrastructure,
- Enhancing the viability of fast/consumer-friendly charging, and
- Harmonization of global connectivity standards.

Adoption of standards could also provide more uniform reporting on network performance and utilization, allow faster restoration, and provide user information on availability. Many infrastructure providers have developed smartphone apps that provide availability information directly to their users; these apps could be a source of information on charging network performance and other metrics during the formal development of standards and metrics.

Network Monitoring and Performance

EV charging availability and reliability is becoming more important as the use, reliance and range of these vehicles increases. Conventionally fueled vehicles and the refueling network they rely on have had over a century to develop into robust and reliable systems. Standards have been developed, and requirements have been put in place to support the availability of liquid fuels. Additional requirements are also in place to require availability during emergencies.

[5] https://www.anl.gov/es/evsmart-grid-interoperability-center

The need for similar standards and requirements to support electric transportation are needed. EV charging infrastructure is growing rapidly, and both the users and owners of these systems would benefit from the establishment of performance standards and requirements. New infrastructure providers are introducing their systems and equipment in Florida, the current absence of standards and performance provides a very low bar for the deployment of this critical infrastructure.

The availability and reliability of EV charging is an important consideration, but so are the resources to support that availability. Consideration needs to be given to the support and field staff that provides network maintenance and restoration, as well as the inventory and availability of spare equipment. Emergency restoration plans also need to be periodically reviewed.

Finally, adequate network monitoring can document infrastructure utilization and provide a basis for forecasting infrastructure growth, the needed replacement of obsolete and defective equipment and the performance of software and network upgrades. More sophisticated monitoring in the future could provide additional enhancements for notifications of network elements degradation and predictive failures.

Infrastructure Signage and Information

Signage requirements for Florida's road system is a combination of FHWA requirements, Florida Department of Transportation (FDOT) requirements, and local jurisdictional requirements. Highway signage to support electric transportation is currently being reviewed by Clean Cities Coalitions, DOTs and the FHWA in the southeast region of the U.S. The goal of the discussions is to bring as much consistency to signage use in the Southeast as possible. FDOT also has an initiative to develop signage requirements for Florida.

Additional specific information on signage can be found on the USDOE's Alternative Fuel Data Center.

Training and Safety

There is an ongoing need for safety training of first and second responders in alternative fuel vehicles and their infrastructure. CFLCCC has facilitated this type of training for firefighters and tow operators, primarily on the topic of vehicles. Due to the dynamic growth of EVs and their charging infrastructure, training updates and resources must be readily available. Coordinating these efforts with established first responder training organizations like the National Fire Protection Association should be continued.

Recommended Guidance for EV Infrastructure Development

Based on information contained in this and previous interim reports as well as feedback from stakeholders, the following recommendations are offered for consideration.

Legislative funding to support the investigation and development these recommendations is critical to supporting the deployment of clean transportation and realizing the inherent benefits.

Action on these recommendations should be undertaken in conjunction with industry and stakeholder representation.

Planning

1. Information regarding EV sales in Florida is difficult to collect, analyze and report; it is recommended that the **Florida Department of Motor Vehicles** develop and publish quarterly standardized reporting for all classes of electric vehicles.
2. Permitting requirements for EV infrastructure installation is highly variable in Florida; it is recommended that the **Florida Building Commission** develop a standardized process for reviewing and permitting infrastructure installations.
3. Multi-family developments represent an untapped source for the expansion of EV use and infrastructure, they also present unique challenges to deployment; it is recommended that the **Florida Building Commission** develop guidance, policies and incentives to maximize this opportunity.
4. Florida municipalities, county governments and state agencies purchase products and services from vendors included on the State Contract and Agreements List; it is recommended that **Florida Department of Management Services** encourages vendors to provide more EVs options under the state term contract.
5. Florida Statutes require state agencies to select the vehicle with the greatest fuel efficiency within a given class; it is recommended that the **Florida Legislature** remove this outdated language and instead require agencies to perform an analysis on the total cost of ownership of a vehicle prior to its purchase.
6. Florida has critical gaps in charging infrastructure as it relates to emergency evacuation; it is recommended that the **State** purchase portable, solar powered EV chargers with battery storage as a means of addressing this immediate need.
7. EVs and the associated infrastructure offer substantial advantages in mitigating impacts from fossil fuels; it is recommended that the use of solar power and battery storage be investigated by **FDACS OOE** as a means of extending these benefits and reducing operating expense.

Financing and Incentives

1. Florida has allocated the maximum allowable funding under the Volkswagen Settlement for infrastructure installation, which will be used primarily for the installation of capital intensive DCFC; it is recommended that existing federal funding be reviewed by the **FDOT** to support EV infrastructure installation by local governments, underserved communities, and rural areas.
2. Workplace charging has been proven to increase EV adoption and expand its benefits; it is recommended that the **FDACS OOE** develop state incentives that can be made available to support workplace charging.
3. The Florida Legislature previously provided incentives that supported the deployment of alternative fuel vehicles that use natural gas; it is recommended that the **Florida Legislature** authorize similar incentives for the deployment of electric transportation and infrastructure with priority given to disadvantaged and rural communities.

Education

1. Lack of education is one of the biggest barriers to EV adoption; it is recommendation the **Florida Legislature** provide funding to the **FDACS OOE** to develop a statewide EV educational campaign that can rebranded locally.

Forecasting EV Adoption and Infrastructure Needs

1. The rate of EV adoption is key to determining the required infrastructure, the ability to do so has been difficult; it is recommended that that the **FDACS OOE**, the **FDOT** and the **Florida Public Service Commission (FPSC)** develop methodologies to track and forecast EV sales and infrastructure requirements.

Infrastructure Interoperability, Performance, and Monitoring

1. State standards for EV infrastructure interoperability, monitoring, availability, reliability and reporting have not been established; it is recommended that the **FDACS OOE**, the **FDOT,** and the **FPSC** develop these standards.
2. State standards for emergency response to restore EV infrastructure have not been established; it is recommended that the **FDACS OOE**, the **FDOT**, the **FPSC, and the Florida Department of Emergency Management** develop standards for restoration of this critical infrastructure, in conjunction with industry and stakeholder input. Standards should include provider staffing and spares inventory.

Appendix

Argonne Laboratory Florida EV Analysis

Summary Statistics for Light-Duty Plug-in Electric Vehicles In Florida, 2011 – 2019

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Energy Systems Division
Systems Assessment Group

August 6, 2020

ACKNOWLEDGMENTS

This activity was supported by the Vehicle Technologies Office, Office of Energy Efficiency and Renewable Energy, United States Department of Energy. Vehicle registration data was supplied by Doug Kettles of the Central Florida Clean Cities Coalition.

LIST OF ACRONYMS

DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	Environmental Protection Agency
eVMT	electric vehicle miles traveled
GWh	gigawatt-hour
ICE	internal combustion engine
kWh	kilowatt-hour
LDV	light-duty vehicle
mpg	miles per gallon
MPGe	miles per gallon gasoline equivalent
MY	model year
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
VMT	vehicle miles traveled

SUMMARY STATISTICS FOR LIGHT-DUTY PLUG-IN ELECTRIC VEHICLES IN FLORIDA, 2011 – 2019

ABSTRACT

This report examines properties of plug-in electric vehicles (PEVs) registered in the Florida from 2011 to 2019. Over 50,000 PEVs were registered in Florida in 2019, and these vehicles have driven over one billion miles on electricity in total. This has reduced gasoline consumption by over 50 million gallons and 280 thousand metric tons of carbon dioxide. In 2019, PEVs in Florida used 170 gigawatt-hours of electricity to drive 500 million miles.

1 INTRODUCTION

This analysis builds upon work published by Argonne National Laboratory in the report, "Assessment of Light-Duty Plug-In Electric Vehicles in the United States, 2010–2019" (Gohlke and Zhou, 2020), using annual vehicle registration numbers for the state of Florida supplied by the Central Florida Clean Cities Coalition. Aside from the difference in vehicle count, this analysis uses EPA electricity emissions data specific to Florida (EPA, 2020), rather than the United States grid average.

Table 1 summarizes the high-level impacts of these plug-in electric vehicles for active registrations, electric vehicle miles traveled (eVMT), gasoline displacement, electricity consumption, and reductions in carbon dioxide emissions in each year from 2011 to 2019 in the state of Florida. As the total number of on-road vehicles has grown, each of these quantities has grown since 2011. Through 2019, over 57 thousand PEVs have been registered in Florida and have driven 1.4 billion miles, displacing nearly 60 million gallons of gasoline and nearly 0.3 million metric tons of CO_2, and consuming over 500 gigawatt-hours of electricity.

TABLE 1 Annual Total Registrations of PEVs in Florida, and Total Annual eVMT, Gasoline Reduction, Electricity Consumption, and CO_2 Emissions Reduction by On-Road PEVs

Year	PEV registrations (thousands)	eVMT (million miles)	Gasoline reduction (million gallons)	Electricity consumption (gigawatt-hours)	CO_2 emissions reduction (thousand metric tons)
2011	1	3	0.1	1	0.6
2012	3	15	0.5	5	2
2013	6	40	1.6	15	7
2014	10	80	3.0	30	14
2015	13	110	4.2	40	20
2016	20	160	6.3	60	30
2017	25	220	9.0	80	45
2018	38	330	13.1	110	66
2019	57	520	19.8	170	101
Total	**57**	**1,480**	**57.7**	**510**	**286**

2 FLORIDA-LEVEL IMPACTS

This section presents metrics for PEVs, including vehicle sales, miles traveled, electricity consumed, gasoline displacement and carbon dioxide emissions.

2.1 PEV SALES

Nearly 60,000 PEVs are on the road in Florida. Approximately two-thirds of these are fully electric battery electric vehicles (BEVs), while the remainder are plug-in hybrid electric vehicles (PHEVs). The three most popular vehicles are the Tesla Model 3 (BEV), Tesla Model S (BEV), and the Chevrolet Volt (PHEV). The growth in PEV registrations is shown in Figure 1.

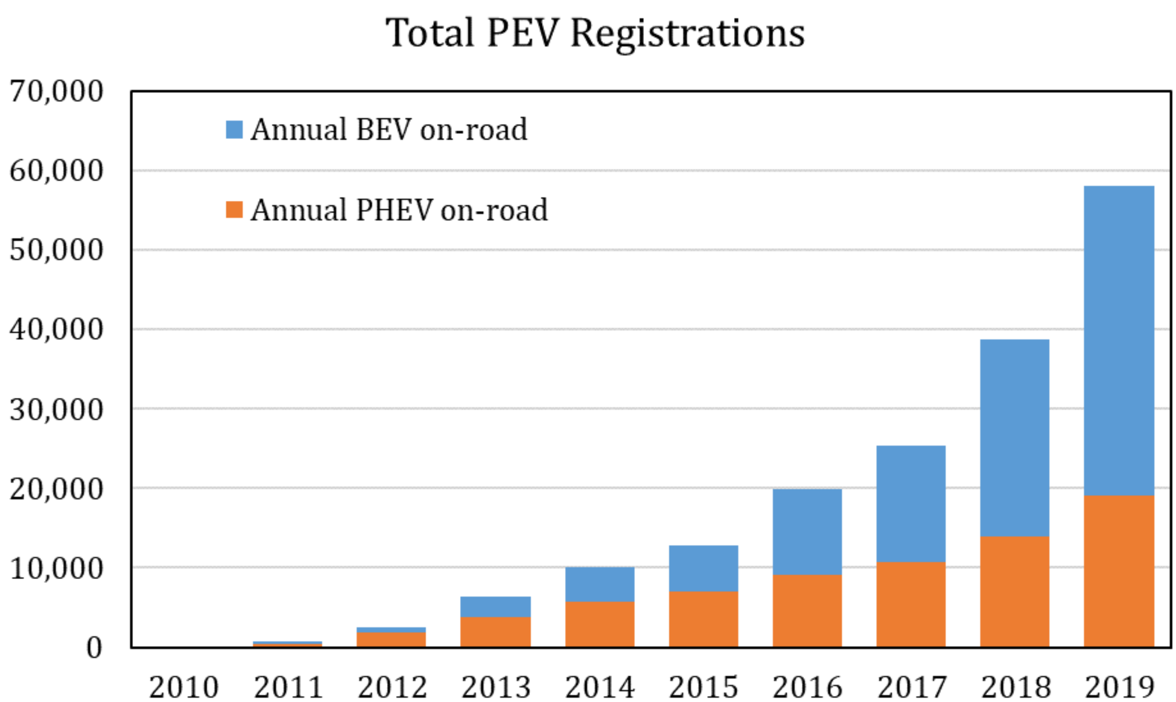

FIGURE 1 Annual total registrations of PEVs in Florida by year

2.2 ELECTRIC MILES TRAVELED

The total annual vehicle miles traveled (VMT) for each PEV depends on traveler behavior and the vehicle's all-electric range. Given the total registration number of PEVs as well as the all-electric range and the effective utility factor for each vehicle, the total mileage driven in all-electric mode across the entire light duty vehicle (LDV) fleet can be estimated. Figure 2 shows the total electric VMT (eVMT) by year in Florida, split by BEVs and PHEVs.

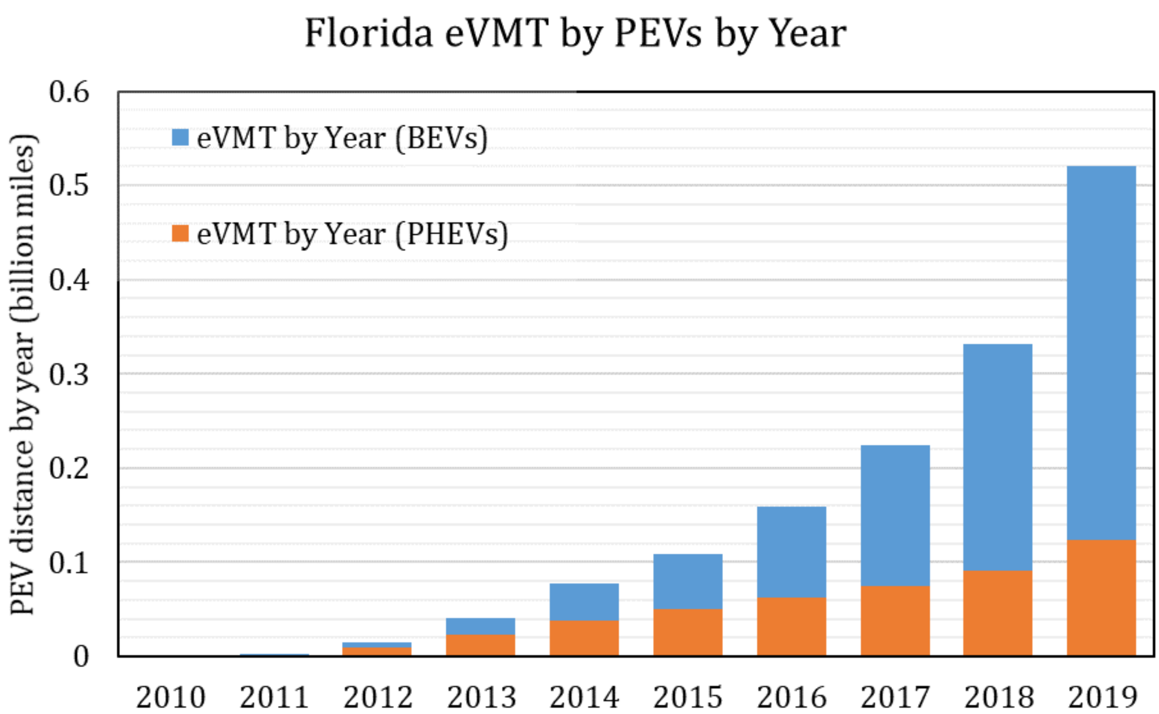

FIGURE 2 Electric vehicle miles traveled by LDVs by year

2.3 ELECTRICITY CONSUMPTION BY PEVs

Combining eVMT with knowledge of vehicle electricity efficiency allows us to determine the total electricity consumption by PEVs in Florida, shown in Figure 3. To find the total electricity consumption, the estimated eVMT in each month is multiplied by the electricity consumption per mile for each vehicle model. In 2019, the total electricity use for LDVs on the road was 170 gigawatt-hours. As a point of comparison, the entire state produced a total of 244,000 gigawatt-hours in 2018 (EIA, 2020).

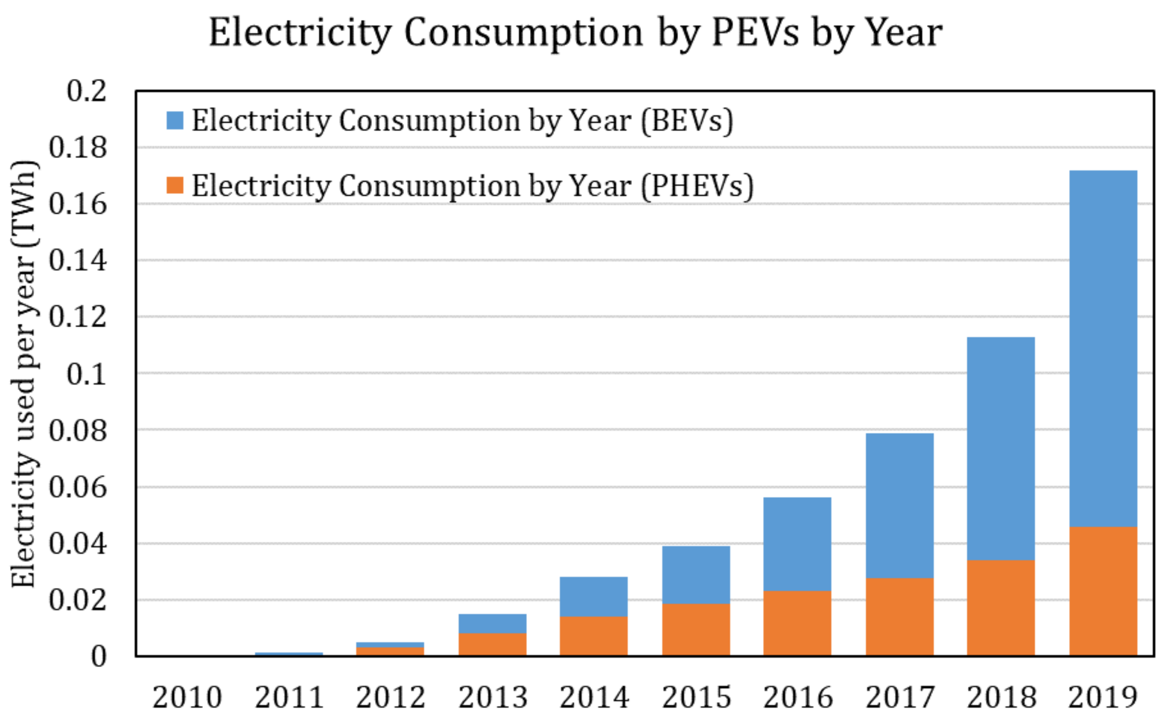

FIGURE 3 Electricity consumption by PEVs by year

2.4 GASOLINE CONSUMPTION REDUCTION

Use of electricity by PEVs displaces gasoline that would otherwise be used by an ICE vehicle.[1] To estimate this reduction in gasoline consumption, we need to make assumptions about how each mile would have otherwise been traveled, detailed in Gohlke & Zhou, 2020. For each PEV, we select a comparable ICE to calculate the gasoline consumption offset by using electricity. The total gasoline displacement by year is graphed in Figure 4. In 2019, nearly 20 million gallons of gasoline were offset by PEVs. Cumulatively, through 2019, PEVs have offset nearly 60 million gallons of gasoline in Florida.

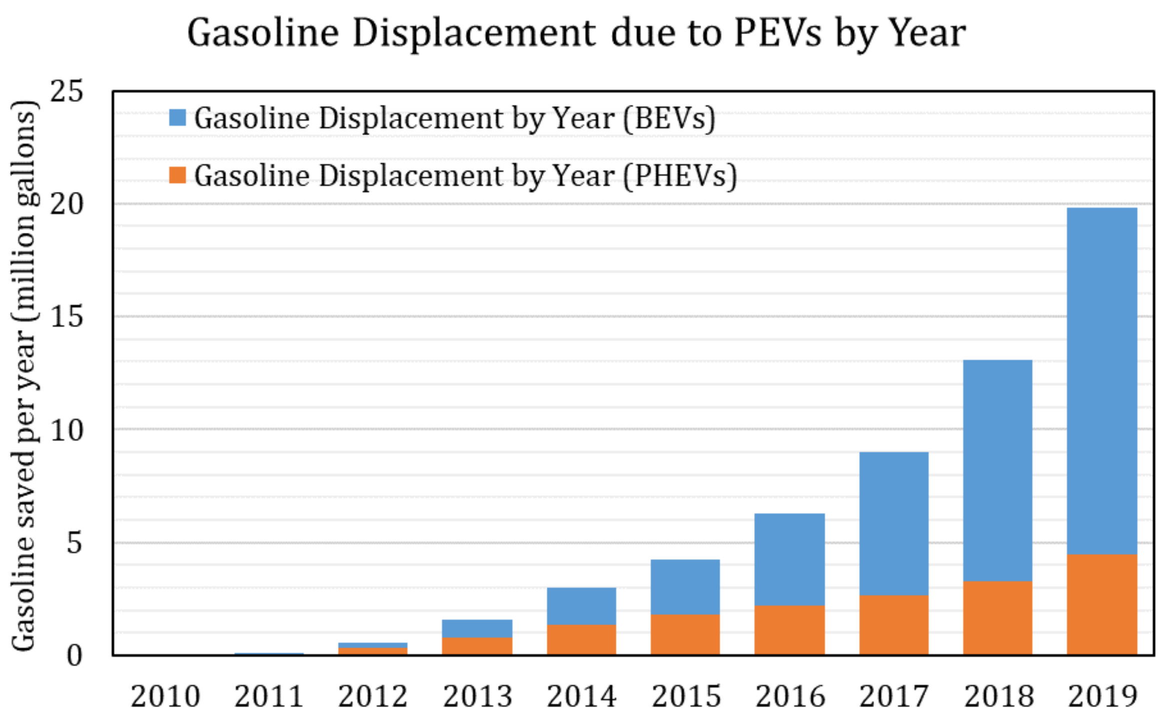

FIGURE 4 Gasoline displacement from ICE vehicles by LDV PEVs by year

1 This analysis only counts gasoline usage that is offset when the car is operating in electric mode. For PHEVs operating in charge-sustaining mode (i.e., using only gasoline), the hybrid engines are also generally more efficient than the average ICE vehicle, but this reduction in gasoline is not calculated here.

2.5 CARBON DIOXIDE EMISSIONS

Operation of PEVs reduces emissions as well. The EPA states that combustion of each gallon of gasoline emits 8,887 grams of CO_2 (EPA and DOT, 2010).[2] For an average gasoline vehicle in 2018, with an average fuel economy of 27.7 miles per gallon, this yields 321 grams of CO_2 per mile (Davis and Boundy, 2020). By contrast, electricity production in Florida emitted an average of 430 grams of CO_2 per kilowatt-hour in 2018 (EPA, 2020), down 23% from the 480 g CO_2 / kWh emitted in 2010. The emissions to drive an electric vehicle are found by multiplying the miles driven by the electricity consumption (in kWh per mile) by the emission rate. Across the LDV fleet, this averaged to 185 grams of CO_2 per mile, approximately one-half the carbon emissions of the average conventional ICE vehicle. Figure 5 shows how the total CO_2 emissions have been reduced by PEVs operating on electricity, with over 100 thousand metric tons being offset in 2019.

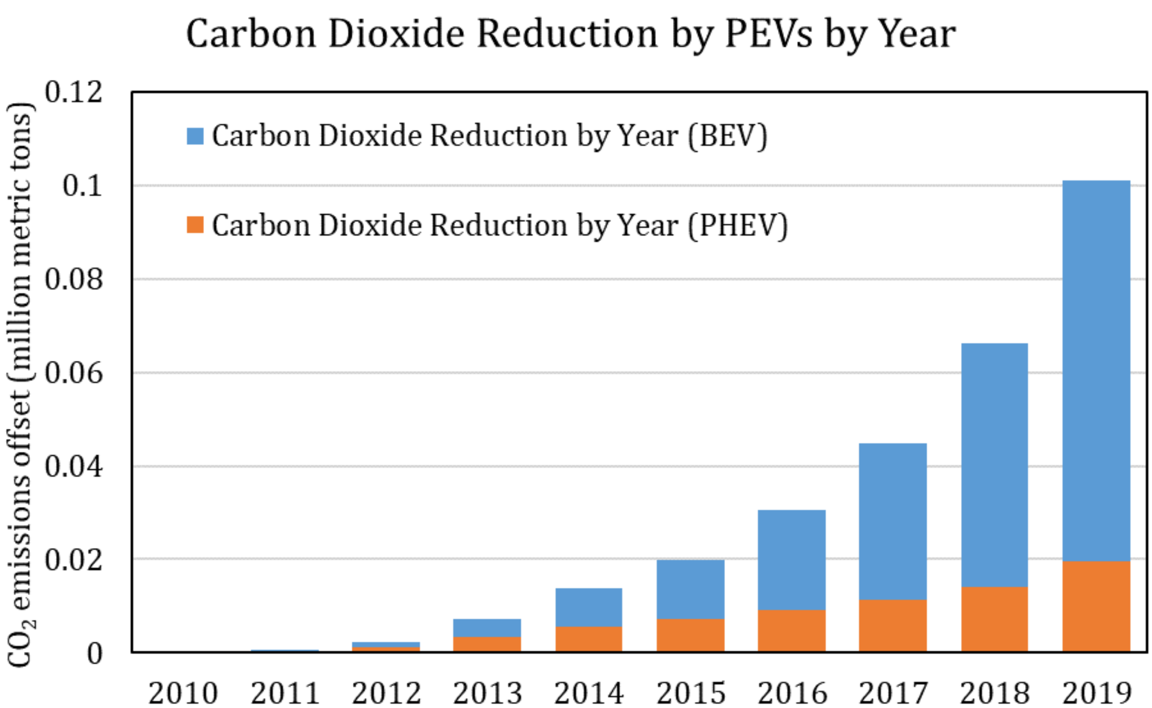

FIGURE 5 Carbon dioxide reduction from LDV PEVs by year

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[2] This calculation is for tailpipe emissions only; that is, it excludes upstream effects for refining and transportation of the fuel, as well as emissions from the production of the vehicles. For electric vehicles, the calculation is for the generation of the electricity for vehicle operation, again excluding vehicle manufacturing. The majority of emissions come from the operation, rather than the manufacturing, of both ICE vehicles and PEVs. A recent study found that tailpipe emissions from a midsize gasoline ICE vehicle were 68% of the total lifetime emissions, while electricity consumption for operation was responsible for 77% of the emissions from a midsize BEV (Elgowainy et al., 2016).

3 CONCLUSIONS

Since the latest generation of light-duty plug-in electric vehicles have been available in the United States, nearly 60,000 PEVs have been registered in Florida, driving nearly 1.5 billion miles on electricity. These 1.5 billion eVMT consumed more than 500 gigawatt-hours of electricity while reducing gasoline consumption statewide by nearly 60 million gallons. From 2011 to 2019, mileage driven by PEVs and electricity consumption has grown, which has offset gasoline consumption and CO_2 emissions from ICE vehicles. Further information about assumptions and calculation methodology can be found in a previous report (Gohlke and Zhou, 2020).

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Florida Electric Vehicle Owner Survey Analysis

Florida Electric Vehicle Roadmap

October 20, 2020

Electric Vehicle Owner Survey Analysis

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Introduction

This is a supplemental report for the FDACS OOE's *Florida Electric Vehicle Roadmap* project.

An online survey was conducted to solicit feedback from one of the largest stakeholder groups, the end-users. The survey's objective was to gain a better understanding of Florida's current charging infrastructure from those with first-hand experience. The survey served as a platform for Florida electric vehicle (EV) owners to communicate their specific needs and concerns. We believe this is the first survey of this nature to be conducted in Florida.

This supplemental report addresses the survey responses of Florida EV owners as well as outlines the methodology, results, and conclusions from the survey.

Methodology

The online survey consisted of sixteen multiple-choice questions and was open to the public from August 11, 2020 to August 25, 2020. Questions were focused on the user's environment, behavior, and opinions about Florida EV infrastructure. Several questions were rephrased and asked a second time to validate consistency. Not all participants answered every question.

There were 532 responses. In order to participate in the survey, qualifying respondents needed to meet two conditions: own a PHEV/BEV <u>and</u> live in Florida. The survey results are detailed below.

Survey Results

	Responses	Percentage
Q1. Do you live in Florida? (Qualifying question to continue survey)		
Q2. Do you own a Plug-In Hybrid or an All-Battery EV? (Qualifying question to continue survey)		
Q3. What regional area of Florida do you live?		
Southwest (Charlotte, Collier, Glades, Hendry, Lee)	46	9%
Southeast (Broward, Miami-Dade, Monroe, Palm Beach)	109	20%
West Central (Desoto, Hardee, Highlands, Hillsborough, Manatee, Pasco, Pinellas, Polk, Sarasota)	136	26%
Central (Alachua, Bradford, Citrus, Gilchrist, Hernando, Lake, Levy, Marion, Sumter)	41	8%
East Central (Brevard, Indian River, Martin, Okeechobee, Orange, Osceola, Seminole, St. Lucie)	117	22%
Northwest (Bay, Calhoun, Escambia, Gulf, Holmes, Jackson, Okaloosa, Walton, Washington)	8	2%
North Central (Baker, Columbia, Dixie, Franklin, Gadsden, Hamilton, Jefferson, Lafayette, Leon, Liberty, Madison, Suwannee, Taylor, Union, Wakulla)	40	8%
Northeast (Clay, Duval, Flagler, Nassau, Putnam, St. Johns, Volusia)	35	7%
Q4. What is your age range?	**Responses**	**Percentage**
18-29	13	2%
30-50	184	35%
50+	335	63%
Q5. How long have you owned your PHEV or EV?	**Responses**	**Percentage**
Less than 1 year	108	20%
1-3 years	239	45%
3-5 years	89	17%
5 or more years	96	18%
Q6. What is the mileage range of your EV on battery?	**Responses**	**Percentage**
20-40	71	13%
41-80	92	17%
81-125	54	10%
126+	313	59%
Q7. Do you feel Florida has adequate charging infrastructure?	**Responses**	**Percentage**
Yes	31	6%
No	453	86%
Don't know	43	8%
Q8. Do you live in a single-family residence or a multi-dwelling unit?	**Responses**	**Percentage**
Single-family residence	462	88%
Multi-dwelling unit	65	12%
Q9. Does your residence have EV charging installed?	**Responses**	**Percentage**
Yes	423	80%

No	103	20%
Q10. How often do you charge at your residence?	**Responses**	**Percentage**
Less than 24%	53	10%
25-49%	21	4%
50-74%	64	12%
75-100%	388	74%
Q11. What EV power charge level do you use most often?	**Responses**	**Percentage**
Home Level 1	140	27%
Home Level 2	281	54%
Public Level 2	53	10%
DCFC	50	10%
Q12. How would you rank the reliability (uptime) of public charging?	**Responses**	**Percentage**
Excellent	66	13%
Good	330	63%
Bad	126	24%
Q13. Where would you most like to see public charging?	**Responses**	**Percentage**
Government facilities	22	4%
Multi-dwelling units	36	7%
Work	51	10%
Shopping & Entertainment	192	37%
Public Highways	220	42%
Q14. How would you rank the availability of public charging?	**Responses**	**Percentage**
Excellent	10	2%
Good	174	33%
Bad	337	65%
Q15. EVs do not contribute gas taxes to maintain our roads, would you agree to an equitable EV fee if part of it was used to build EV infrastructure?	**Responses**	**Percentage**
Yes	252	47%
No	115	22%
No Response	165	31%
Q16. What do you believe is the biggest barrier for purchasing an EV?	**Responses**	**Percentage**
Vehicle cost	95	18%
Driving range	103	20%
Lack of information	158	30%
Lack of public charging	163	31%

Comparative Analysis

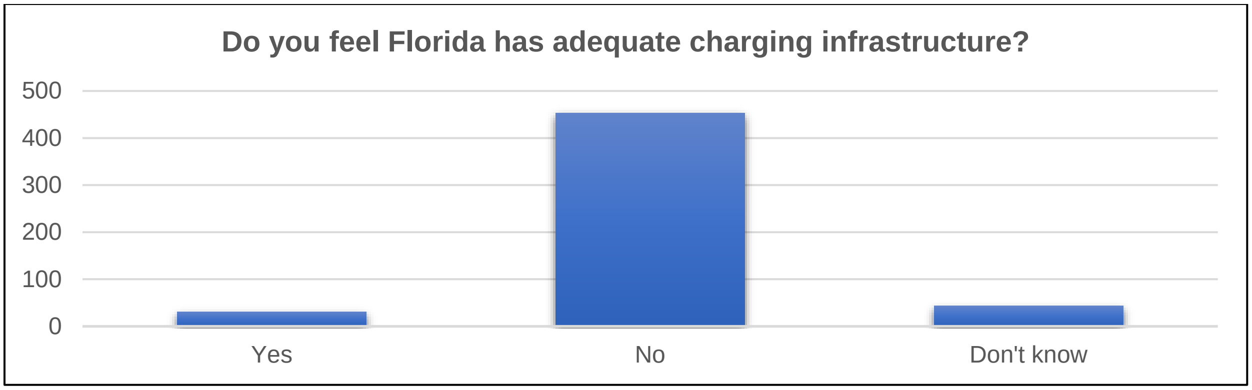
The survey response data was comparatively analyzed to gain a better understanding of the relationships between responses to different questions. For example, how does vehicle range impact the respondent's feelings towards public charging infrastructure, how does type of residence relate to charging behavior, etc.

Comparing inter-related questions helped identify several patterns. Key takeaways from the analysis are highlighted below. The following points are derived from the direct survey results and have not been tested for statistical significance.

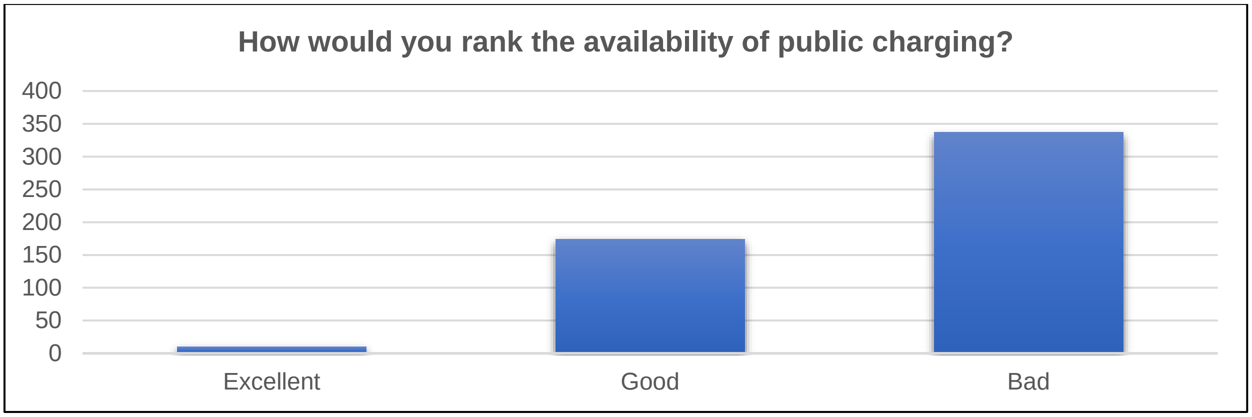
Key Takeaways

1. **Most end-users feel Florida's charging infrastructure is inadequate and the availability needs to be improved.**

- 86% of respondents answered that they do not feel Florida has adequate charging infrastructure (Q7).

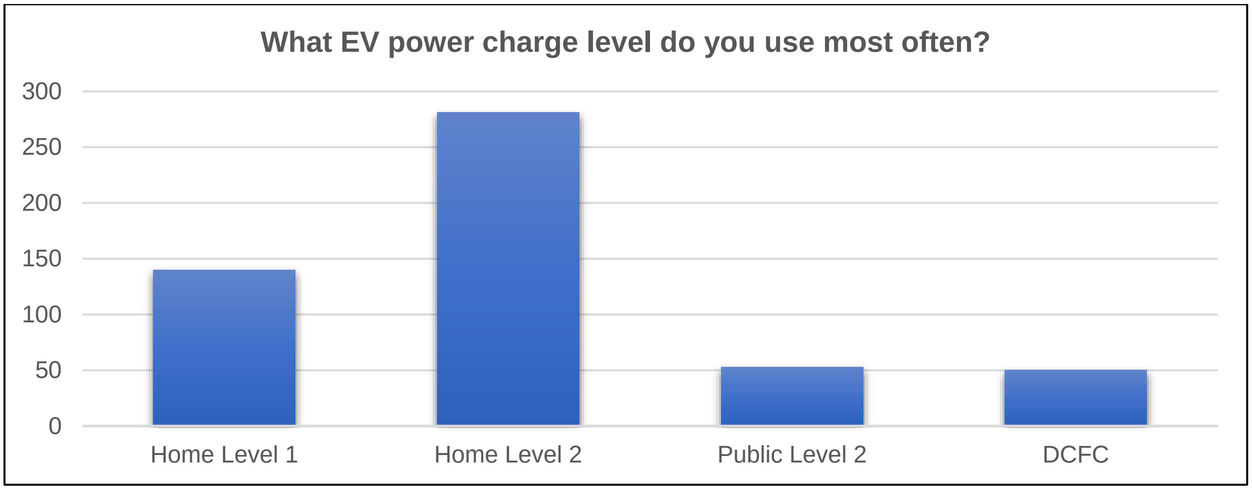


- 65% of respondents ranked the availability of public charging as "Bad" (Q14).

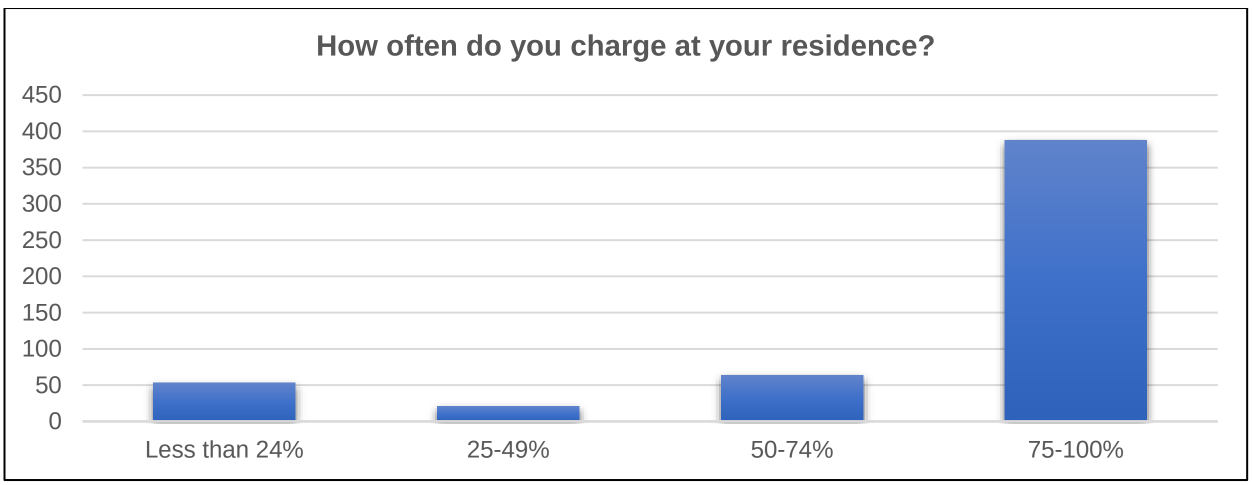


2. Overall, EV drivers complete most of their charging at home.

- 54% of respondents reported they use Home Level 2 charging most often (Q11).
- 27% of respondents reported they use Home Level 1 charging most often (Q11).

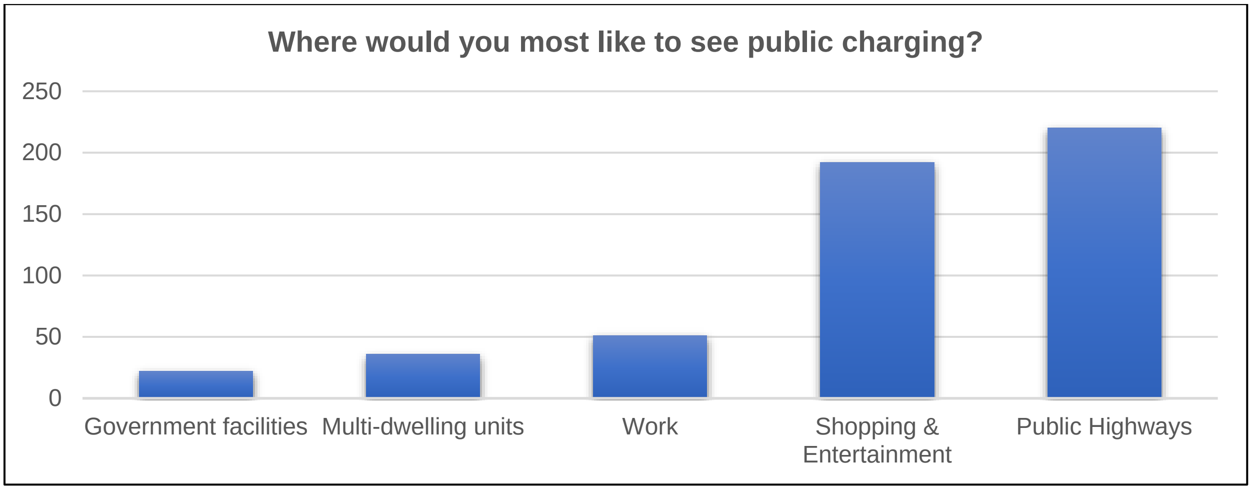


- 74% of respondents reported that they complete 75-100% of charging at their residence (Q10).



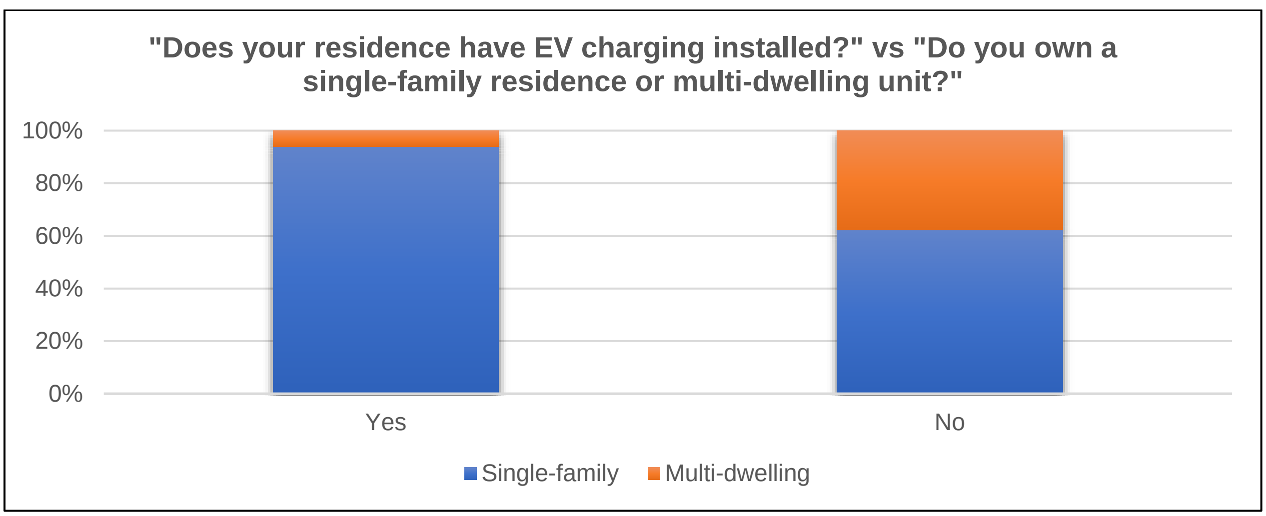
3. Most respondents would like to see more public infrastructure along public highways or at shopping/entertainment locations.

- 42% of respondents said they would most like to see public infrastructure along public highways (Q13).
- 37% of respondents said they would most like to see public infrastructure at shopping/entertainment centers (Q13).

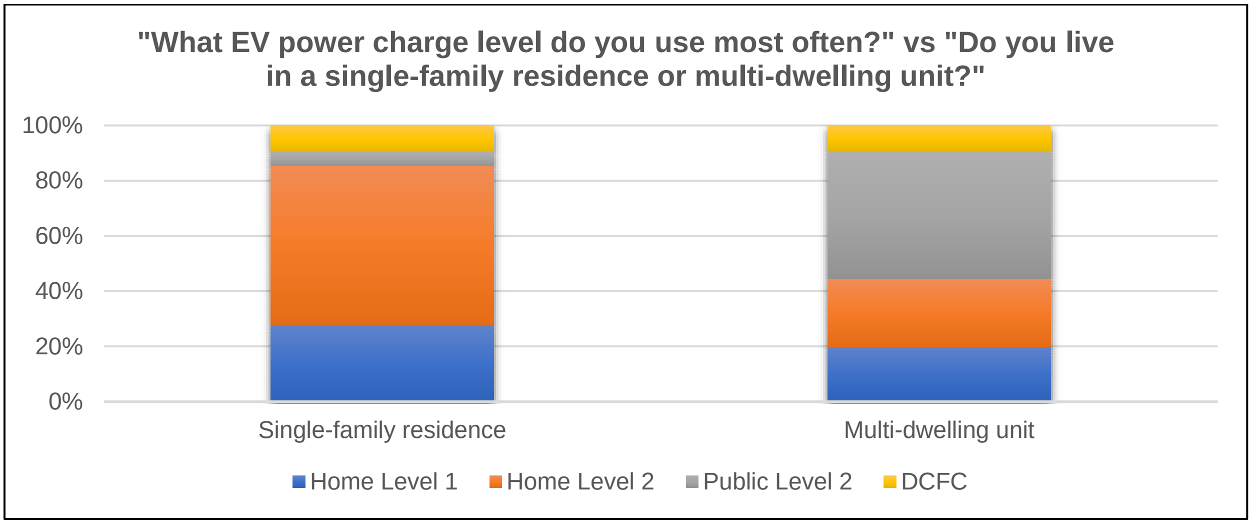


4. Charging behavior is much different for those living in a single-family residence than those living in multi-dwelling units.

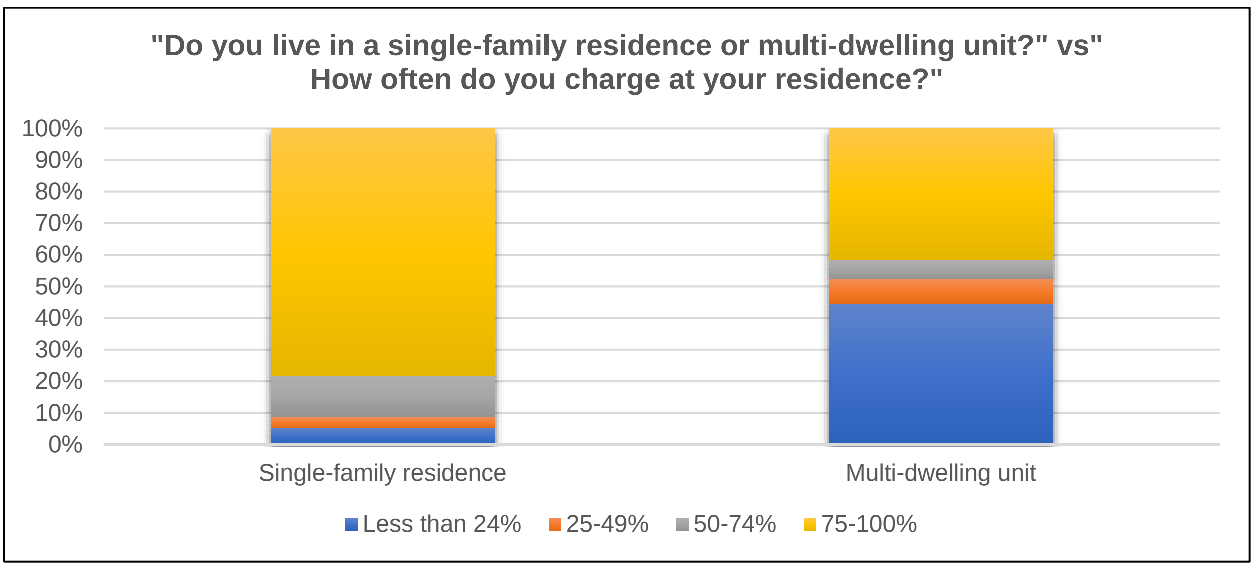
- 40% of those who live in multi-dwelling units have EV charging installed (Q9, Q8).
- 86% of those who live in a single-family residence have EV charging installed (Q9, Q8).



- 45% of respondents living in multi-dwelling units said they use a Home Level 1 or Home Level 2 charger most often (Q11, Q8).
- 80% of those living in single-family residence said they use Home Level 1 or 2 charging most often (Q11, Q8).

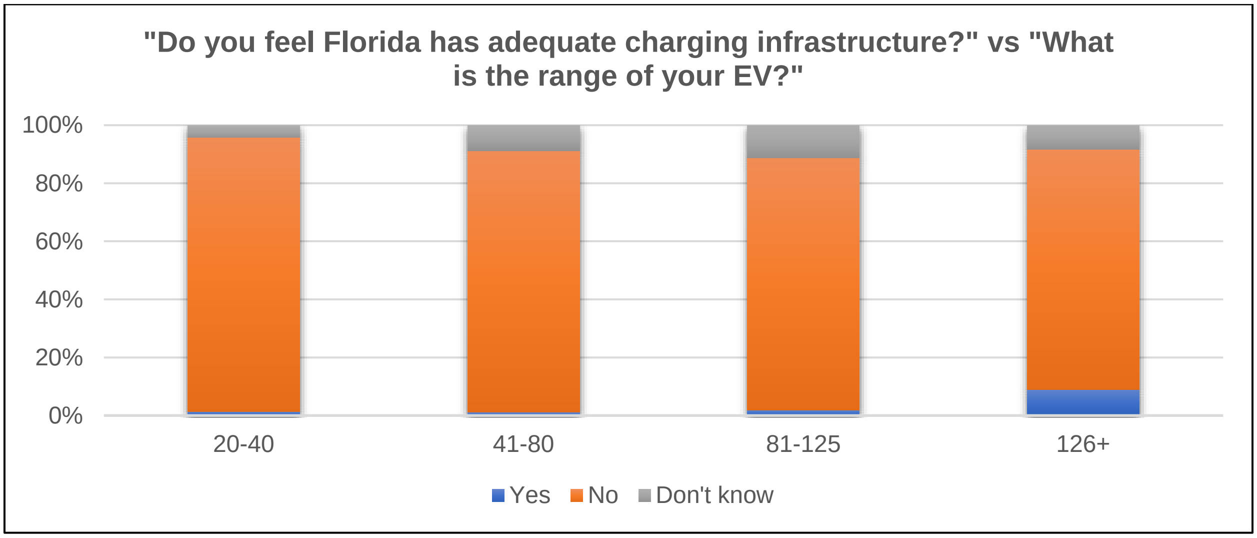


- 45% of respondents living in multi-dwelling units said they complete 24% (or less) of total charging at their residence (Q10, Q8).
- 5% of respondents living in a single-family residence said they complete 24% (or less) of total charging at home (Q10, Q8).

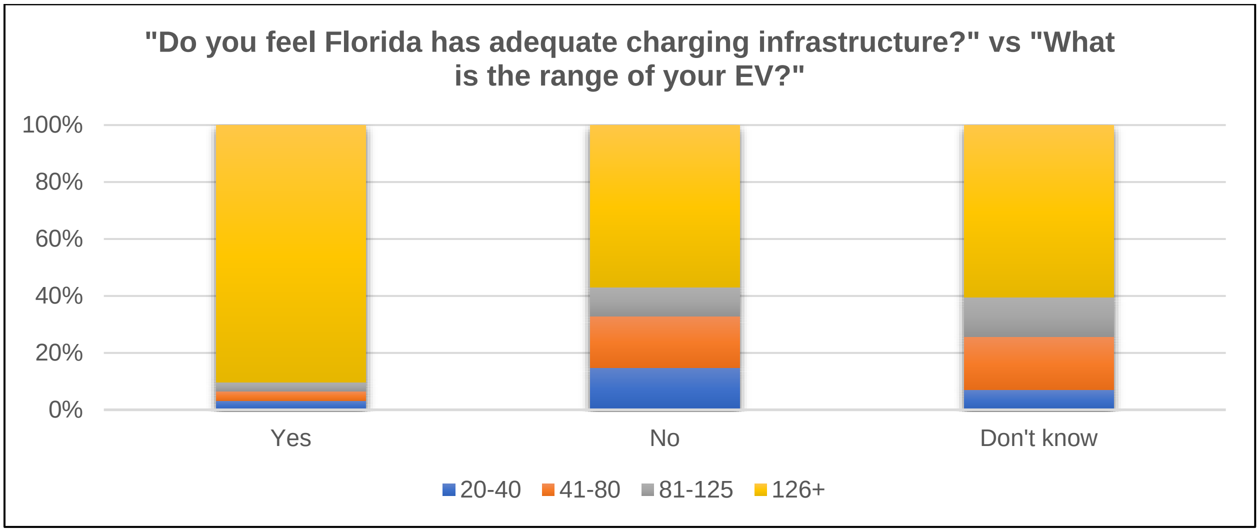


5. **<u>Owners of higher-range electric vehicles seem to have a more positive outlook on Florida's charging infrastructure.</u>**

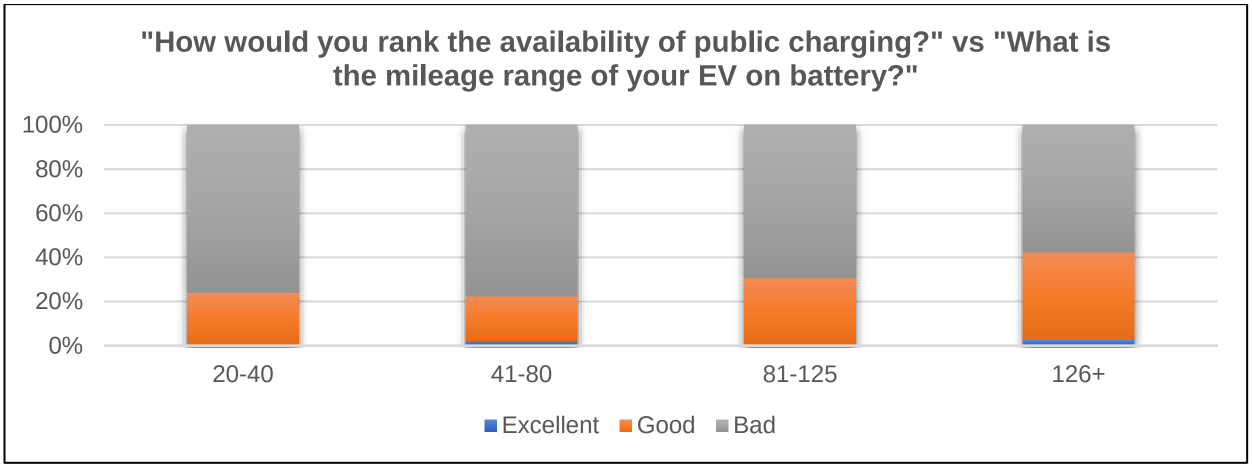
- 1% of those with 20-40 mile range said Florida has adequate charging infrastructure, while 94% said it does not (Q7, Q6).
- 1% of those with 41-80 mile range said Florida has adequate charging infrastructure, while 90% said it does not (Q7, Q6).
- 2% of those with 81-125 mile range said Florida has adequate charging infrastructure, while 87% said it does not (Q7, Q6).
- 9% of those with 126+ mile range said Florida has adequate charging infrastructure, while 83% said it does not (Q7, Q6).



- Of the 6% of respondents that answered "Yes" to "Do you feel Florida has adequate charging infrastructure?", 90% of them have vehicles with a range of 126+ (Q7, Q6).



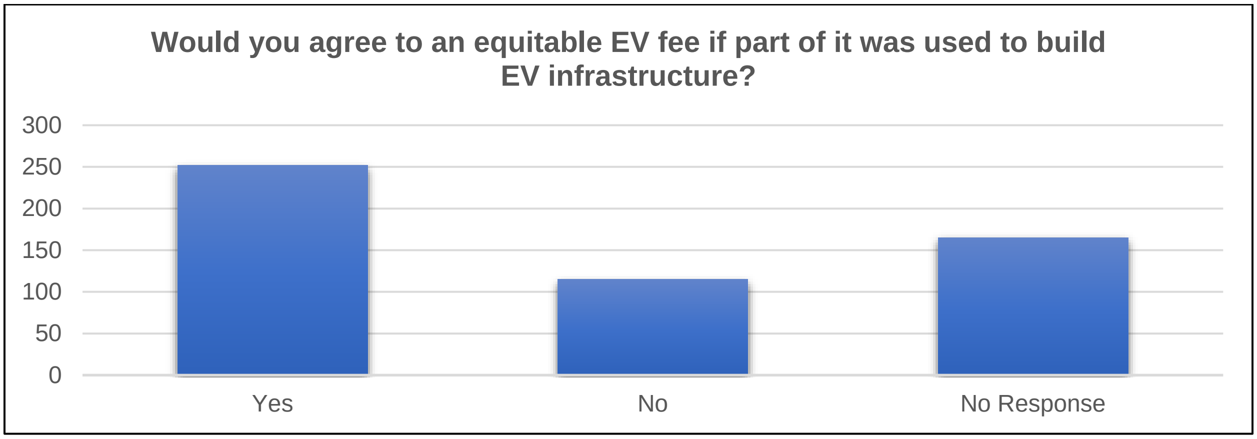
- 76% of those with 20-40 mile range ranked the availability of public charging infrastructure as “Bad” and 24% ranked it as “Good” (Q14, Q6).
- 78% of those with 41-80 mile range ranked the availability of public charging infrastructure as “Bad” and 20% ranked it as “Good” (Q14, Q6).
- 69% of those with 81-125 mile range ranked the availability of public charging infrastructure as “Bad” and 31% ranked it as “Good” (Q14, Q6).
- 58% of those with 126+ mile range ranked the availability of public charging infrastructure as “Bad” and 40% ranked it “Good” (Q14, Q6).



Other Insights

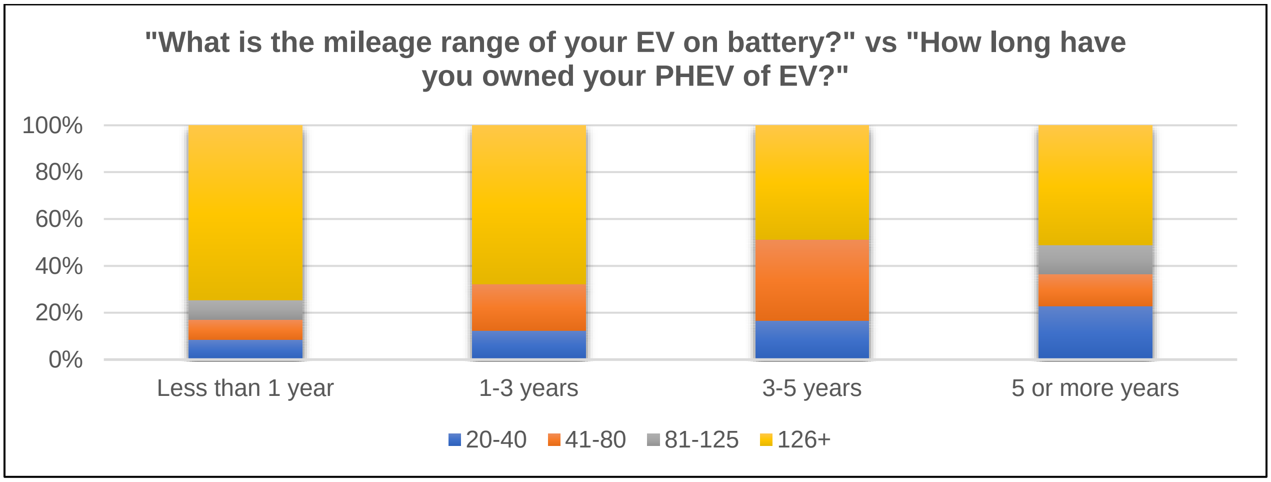
1. **<u>Most respondents would agree to an equitable EV fee if part of it was used to build EV infrastructure.</u>**

    - 47% of respondents said they would agree to an EV fee (Q15).
    - 22% of respondents said they would not agree to an EV fee (Q15).
    - 31% of respondents did not respond to this question, which was a much lower response rate than the other questions (Q15).



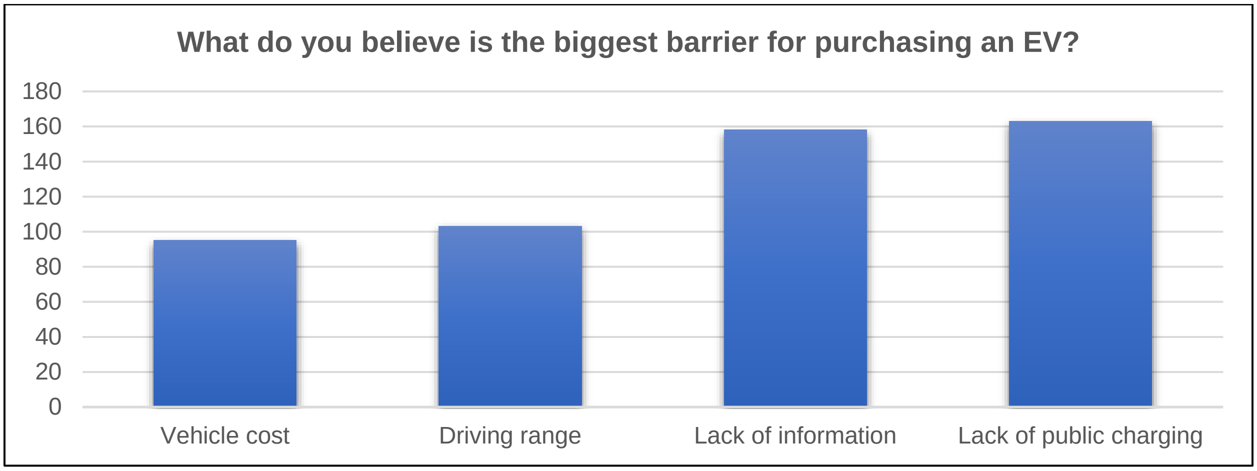
2. **<u>There is an upward trend between vehicle range and time of ownership.</u>**

    - 51% of vehicles owned “5 or more years” had a range of 126+ (Q5, Q6).
    - 49% of vehicles owned “3-5 years” had a range of 126+ (Q5, Q6).
    - 68% of vehicles owned “1-3 years” had a range of 126+ (Q5, Q6).
    - 75% of vehicles owned “less than 1 year” had a range of 126+ (Q5, Q6).



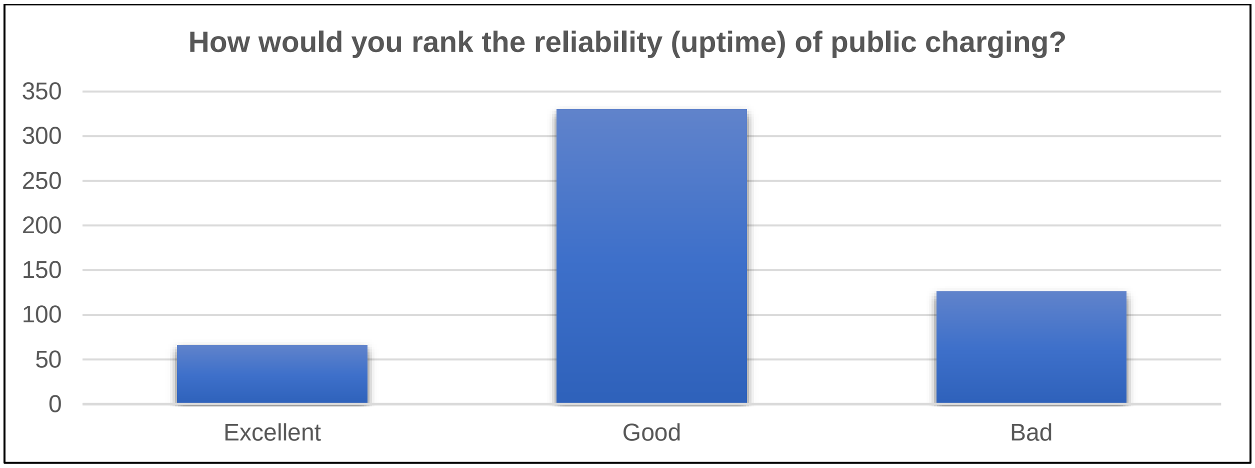
3. **<u>There are several significant barriers for purchasing an EV, but lack of information and lack of public charging are most notable.</u>**

- 31% of respondents believe “Lack of public charging” is the biggest barrier (Q16).
- 30% of respondents believe “Lack of information” is the biggest barrier (Q16).
- 20% of respondents believe “Driving range” is the biggest barrier (Q16).
- 18% of respondents believe “Vehicle cost” is the biggest barrier (Q16).



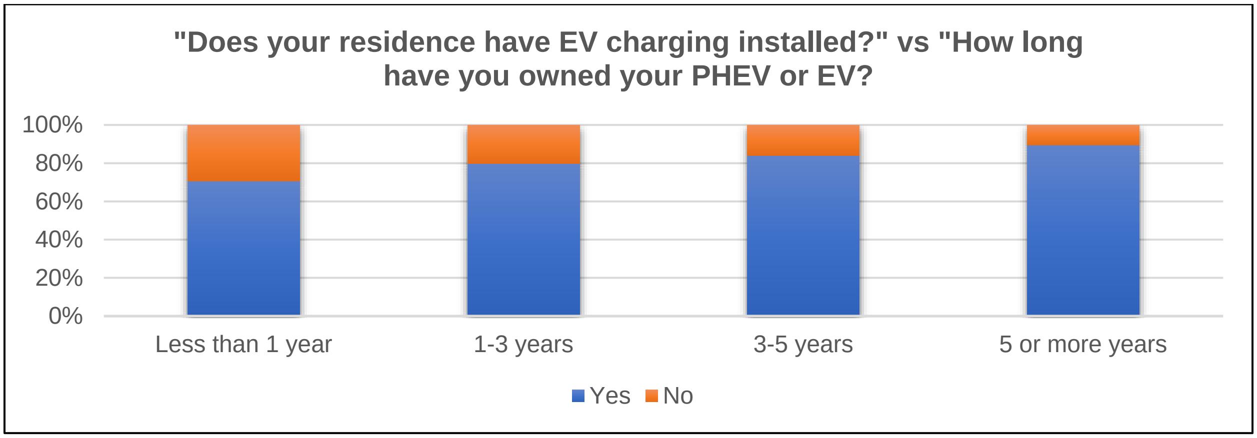
4. **<u>Most respondents feel the reliability/uptime of public charging is good but could be better.</u>**

- 13% of respondents ranked the reliability of public charging “Excellent” (Q12).
- 63% of respondents ranked the reliability of public charging “Good” (Q12).
- 24% of respondents ranked the reliability of public charging “Bad” (Q12).



5. **<u>Users who have owned EVs for longer are more likely to have EV charging installed at their residence and complete more charging at home.</u>**

- 71% of those who have owned their EV for a year (or less) have EV charging installed at their residence (Q9, Q5).
- 80% of those who have owned their EV for 1-3 years have EV charging installed at their residence (Q9, Q5).
- 84% of those who have owned their EV for 3-5 years have EV charging installed at their residence (Q9, Q5).
- 89% of those who have owned their EV for five years (or more) have EV charging installed at their residence (Q9, Q5).



- 66% of those who have owned their EV for 1 year (or less) complete 75-100% of charging at their residence (Q10, Q5).
- 73% of those who have owned their EV for 1-3 years complete 75-100% of charging at their residence (Q10, Q5).
- 75% of those who have owned their EV for 3-5 years complete 75-100% of charging at their residence (Q10, Q5).
- 83% of those who have owned their EV for five years (or more) complete 75-100% of charging at their residence (Q10, Q5).