Electric Vehicle Charging Station Study

Thomas Jefferson Region

ABSTRACT

This study identifies means to improving supports for the use of electric vehicles for area residents in the Thomas Jefferson Planning District Commission region—increasing transportation options, reducing fossil fuel emissions, and improving transportation infrastructure.

Thomas Jefferson Planning District Commission

Summer 2021

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Introduction

Local governments will be the first to respond to community needs precipitated by the effects of climate change and are uniquely posed to take a leadership role in charting a resilient future while reducing the impacts of climate change. In alignment with Virginia's goal to reduce greenhouse gas emissions by 30% in 2030 and reach net zero by 2050, the City of Charlottesville, Albemarle County, and University of Virginia have set emission reduction goals as well. Electric vehicle (EV) use is part of these plans to reduce emissions and mitigate climate change in the Charlottesville Albemarle area. While electric vehicles include hybrid electric vehicles, plug-in hybrid electric vehicles and battery electric vehicles, this study will focus on battery electric vehicles because they are the most reliant on charging infrastructure.

The objective of this study is to help the Thomas Jefferson Planning District Commission (TJPDC) region increase transportation options, reduce fossil fuel emissions, and improve transportation infrastructure by identifying means to improving supports for the use of electric vehicles for area residents. This report provides a background for the local and global need to reduce greenhouse gases, confirms how the use of electric vehicles is one step towards this goal, and reports the number of electric vehicles and charging infrastructure in the TJPDC region. The final sections explore factors that affect EV adoption and use, and shares examples other communities use to support the growth of EV use.

Background

As the effects of climate change continue to tax the global community and TJPDC area with more frequent extreme weather events and diminished public health, national and local governments are looking for ways to mitigate climate change by reducing greenhouse gas emissions. Transportation is one of the largest contributors to emissions in our region and supporting alternatives to traditional gas fueled vehicles is identified as a strategy to reduce contributions to greenhouse gases.

Rising temperatures are identified as a measure of the severity of climate change and have been well documented by the United States government and scientists globally for over 70 years. The Intergovernmental Panel on Climate Change (IPCC) links rising global temperatures to greenhouse gasses produced by human activities and predicts significant long-term effects including rising temperatures, increased drought, and more extreme weather events. (NASA, 2020) July 2020 was the hottest recorded in the Northern Hemisphere since records began in 1951. In fact, the last six July's have been the hottest recorded global temperatures on record. (US Department of Commerce, 2020) The City of Charlottesville, Albemarle County, and the University of Virginia have all proactively taken steps to support initiatives to reduce greenhouse gas emissions, including supporting the use of EVs.

Benefits of EVs

The Commonwealth of Virginia responded to the threat of global warming by committing to reducing statewide greenhouse gas (GHG) emissions by 30% by 2030 and to reach net zero by 2050. (Alena Yarmosky, 2020) The City of Charlottesville, Albemarle County, and the University of Virginia set similar goals to reduce carbon emissions in our region. While climate change is a global issue, local governments will be responding to the effects, such as more frequent and greater weather events, greater temperature extremes, and public health risks associated with a changing climate. (Centers for Disease Control and Prevention, 2019)

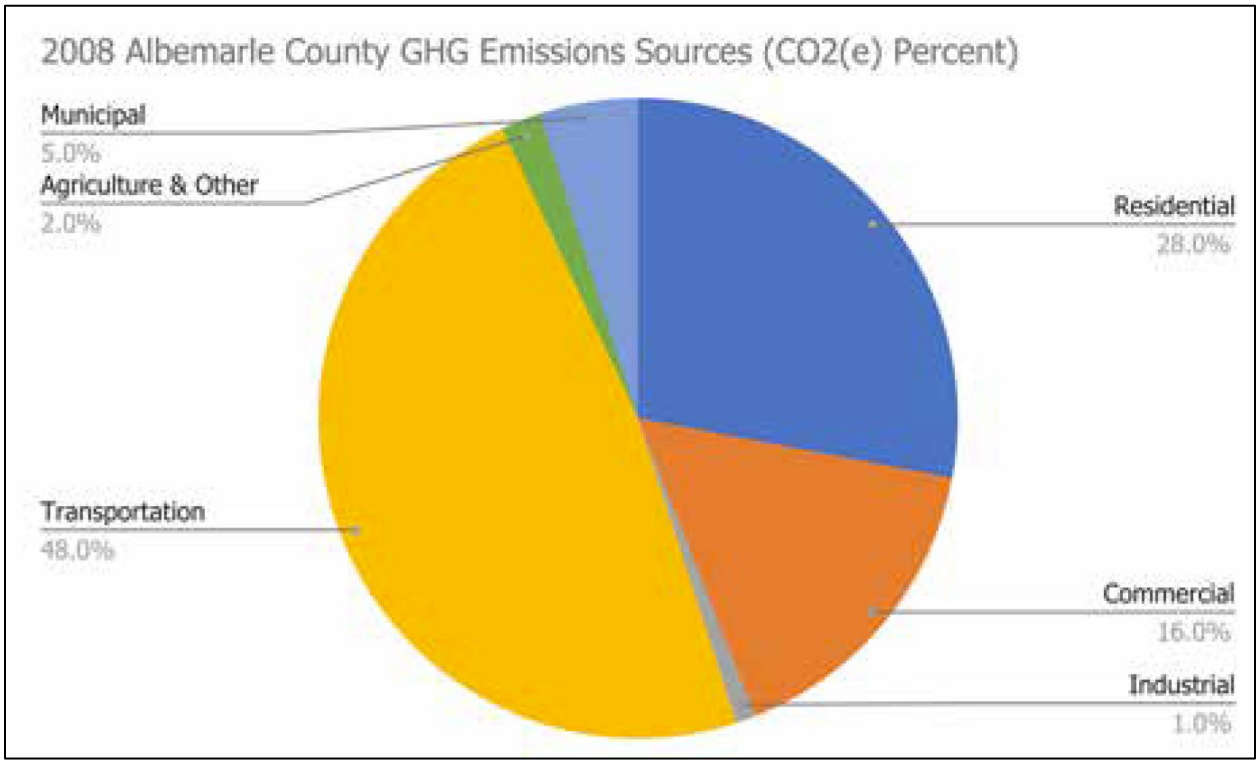
The Charlottesville area has been active in reducing their reliance on fossil fuels and emission reduction for several years. The Charlottesville City Council unanimously endorsed the US Mayors Climate Protection Agreement in 2006. Albemarle County's Board of Supervisors unanimously approved a Cool County Resolution in 2007 and in that same year, the University of Virginia solidified their commitment to reduce greenhouse gas emissions. (The LCAPP Steering Committee, 2011)

In 2009 the City of Charlottesville and Albemarle County assembled a committee of local representatives, including the University of Virginia to coordinate the community's response to climate change. They produced a report, titled Local Climate Action Planning Process (LCAPP), outlining a five-part framework to aid discussion and understanding of the region's energy use and help organize approaches and strategies to reach net zero by 2050. One of the recommendations in the Framework is to support the use of EVs by developing municipal and private sector guidelines for electric EV charging stations, parking, and incentives. (The LCAPP Steering Committee, 2011)

Albemarle County's 2008 inventory of greenhouse gas emissions[1], found that county's emissions were over 1.6 million tons carbon dioxide equivalent. When broken down by emission source, transportation accounted for almost half (48%) of the emissions of greenhouse gasses in the county. The City of Charlottesville's percentage of emissions for transportation was slightly less, but still accounted for the greatest emission source. (The LCAPP Steering Committee, 2011) Figure 1, copied from Albemarle County's Climate Action Plan Phase One illustrates the other emission sources in the county, including residential as the second highest source at 28%. (Albemarle County, Winter 2020)

[1] The measurements used included the total amount of all GHGs (expressed as an equivalent amount of CO2) generated to produce the energy needs of the community – whether the energy use is derived from fossil fuel combustion directly (such as by driving a gas vehicle) or indirectly (such as by using electricity generated by a natural gas-fired power plant) –minus the amount of GHGs sequestered within the community due to new practices that draw down carbon out of the atmosphere, like planting new trees (afforestation) and regenerative agriculture.

Figure 1: GHG Emissions Sources in Albemarle County



Source: Albemarle County Climate Action Plan Phase One

The City of Charlottesville has taken steps to reduce greenhouse gas emissions. The City Council Vision 2025: A Green City and Comprehensive Plans include actions to mitigate climate change on a local level. The City conducted greenhouse gas inventories in 2000, 2013, 2016, and 2018 finding that in 2016 greenhouse gas emissions were reduced by 23% since their baseline inventory in 2000. (City of Charlottesville, 2019)

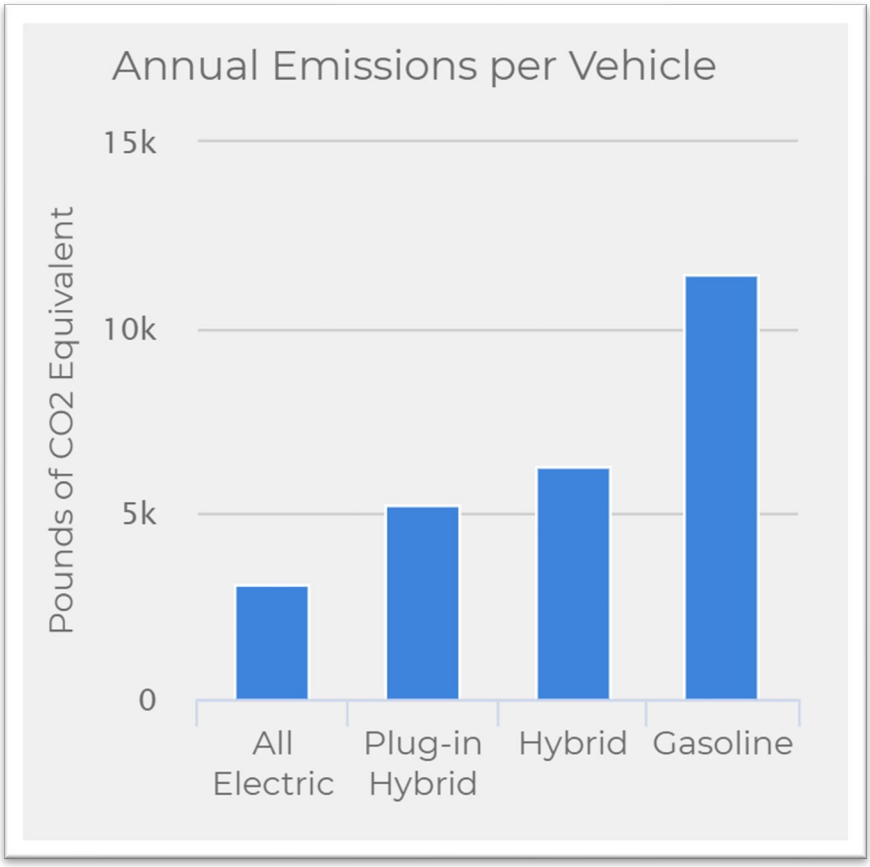
The US Department of Energy estimates that EV's in Virginia produce almost 70% less CO2 emission than traditional gas-powered vehicles. In Virginia, EV's generate approximately three thousand pounds of CO2 equivalent emissions per year per vehicle compared to gasoline powered vehicles which produce approximately eleven thousand pounds of CO2 equivalent annual emissions per vehicle. This amount was calculated using the "Well-to-wheel"[2] method for calculating emissions for vehicle miles traveled. This includes the emissions generated by producing the electricity used to charge EVs, assuming they are not being charged using renewable resources like solar and wind. (Energy, Emissions from Hybrid and Plug-In Electric

[2] "Well-to-wheel emissions include all emissions related to fuel production, processing, distribution, and use. In the case of gasoline, emissions are produced while extracting petroleum from the earth, refining it, distributing the fuel to stations, and burning it in vehicles. In the case of electricity, most electric power plants produce emissions, and there are additional emissions associated with the extraction, processing, and distribution of the primary energy sources they use for electricity production." (Energy, Emissions from Hybrid and Plug-In Electric Vehicles, 2020)

Vehicles, 2020)

Figure 2 illustrates estimated emissions based on fuel types used, including EV's, Plug-in Hybrid, Hybrid, and Gasoline vehicles based on average electricity sources in Virginia. As you can see, in Figure 2, EV's produce significantly less emissions than traditional gas-powered vehicles.

Figure 2: Comparison of Vehicle Emissions



Source: (Energy, Emissions from Hybrid and Plug-In Electric Vehicles, 2020)

Number of EVs in TJPDC

In 2020, there were 509 electric vehicles registered in the TJPDC region. According to projections, this number will continue to increase as the availability of EVs increase and purchase prices decrease. In addition, as the older EVs age there will be more used EVs available on the market, helping the purchase price decrease over the years.

Table 1 uses information gathered by Virginia Clean Cities from annual vehicles registration

data from the Virginia Department of Motor Vehicles to demonstrate the number of EVs registered in the TJPDC area over the past 12 years.

Table 1: Number of Electric Vehicles Registered in TJPDC Area

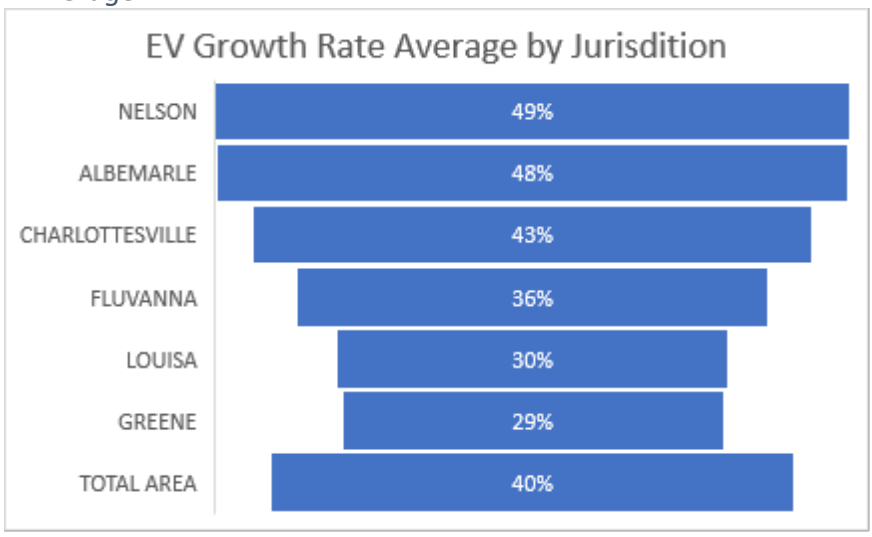
Jurisdiction	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ALBEMARLE	5	9	10	10	15	26	42	48	85	101	183	298
CHARLOTTESVILLE	3	4	8	8	10	12	17	18	28	49	84	119
GREENE	2	2	2	2	-	-	-	2	5	7	8	8
NELSON	-	1	1	1	1	1	1	2	5	6	15	25
FLUVANNA	2	4	5	3	3	3	5	3	5	6	14	23
LOUISA	3	4	6	7	4	5	6	6	9	15	21	36
Total	15	24	32	31	36	47	71	77	132	184	325	509

Source: Virginia Annual Vehicle Registration Data provided by Virginia DMV to Virginia DEQ each year

As seen in Table 1, the number of EVs in the TJPDC area has grown over the past twelve years. Based on the number of vehicles registered, EV registrations in the TJPDC area have grown between 30% and 49%. Figure 3 shows that while Albemarle County and the City of Charlottesville have the highest number of EVs, 298 and 119 respectively, Nelson County's EV registrations are growing at a faster rate. Virginia Clean Cities calculates the average growth for the state during 2008 to 2019 to be similar to TJPDC's EV growth, 39%.

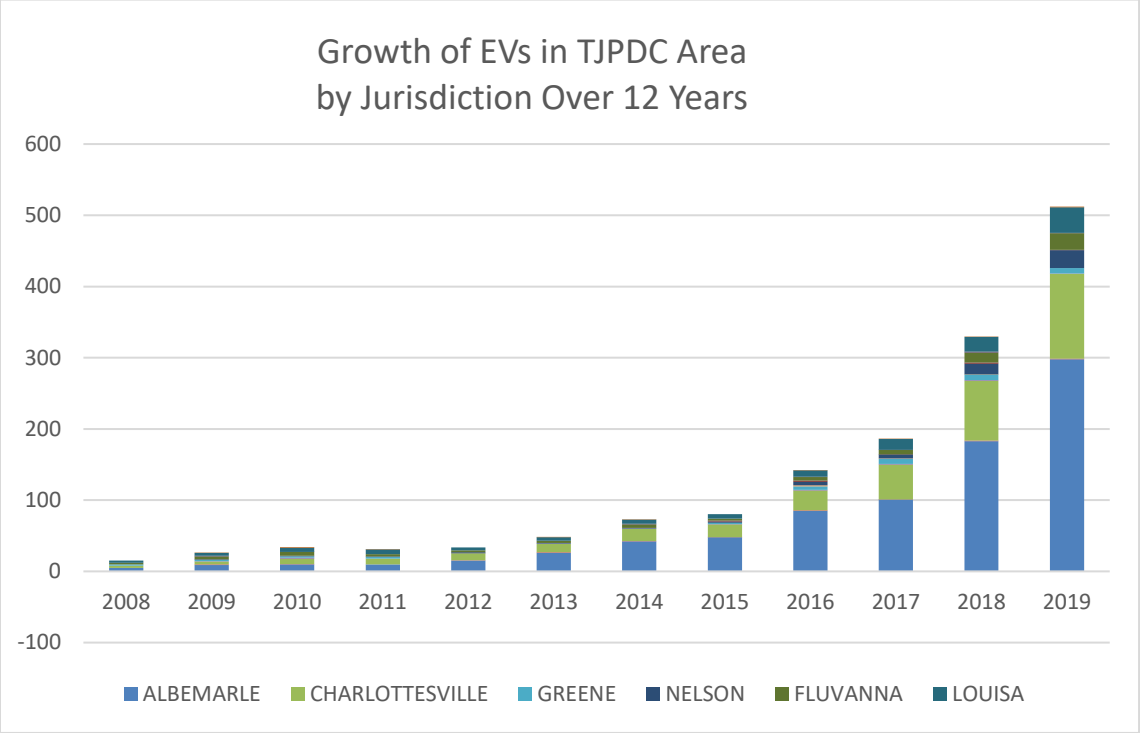
Figure 4 illustrates the EV registration growth over a period of 12 years, from 2008 to 2019, in the TJPDC region. Each bar on the *Growth of EVs in TJPDC Area by Jurisdiction Over 12 Years* chart is segmented to show the number of EV registrations for each jurisdiction by color.

Figure 3: Growth Rate by Jurisdiction, Weighted 12 Year Average



Source: Virginia Annual Vehicle Registration Data provided by Virginia DMV to Virginia DEQ each year

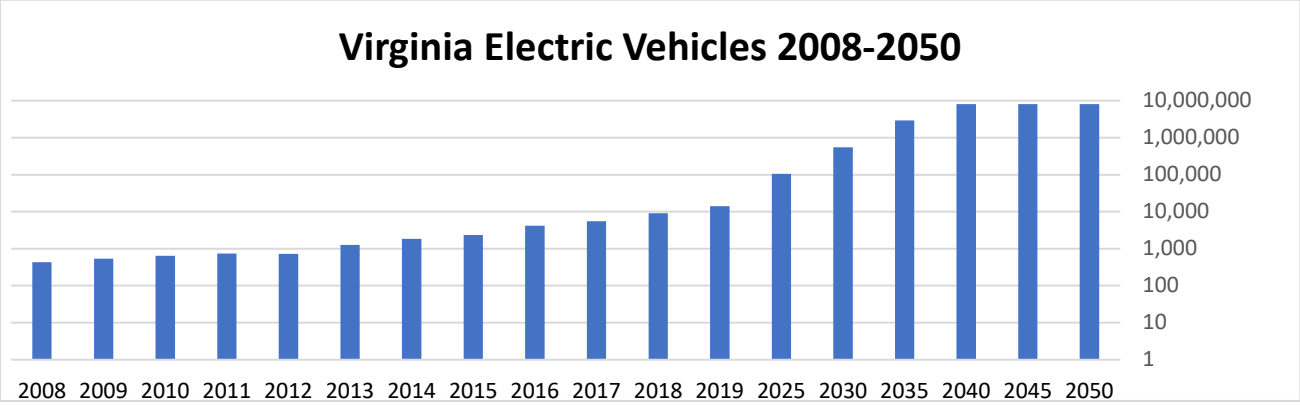
Figure 4: Historical EV Growth in TJPDC



Source: Virginia Annual Vehicle Registration Data provided by Virginia DMV to Virginia DEQ each year

Virginia Clean Cities used Annual Vehicle Registration Data from the Virginia DMV to project EV ownership growth over the next fifty years, estimating that by 2050, there will be eight million EVs in the commonwealth. Figure 5 illustrates the projected growth rate of EVs in Virginia.

Figure 3: Projected EV Population in Virginia



Source: Virginia Clean Cities

If current trends hold, there will be tens of thousands more electric vehicles on Virginia's

roadways in the coming decades.

Infrastructure Supporting EVs in TJPDC Region

In their Climate Action Plan, Albemarle County recognizes that climate change has the potential to impact the county, its residents, and especially its agriculturally based businesses. Thus, threatening the local economy and rural character. Increasing public EV charging infrastructure is one of the strategies outlined in the county's plan to mitigate climate change. Two steps identified to increase EV charging station locations are through local ordinances and policies encouraging new developments to include EV charging stations and explore partnerships and funding strategies to support EVs. (Albemarle County, Winter 2020)

As Charlottesville set goals to reduce greenhouse gas emissions by 45% by 2030 and to reach net zero by 2050, the city is also drafting its climate action plan. (Woods, 2020) The city reports that residents and visitors are requesting more public charging stations. The city is working to support EV use to provide more transportation options, lower transportation costs, reduce noise and air pollution, and greenhouse gas emissions for their residents. Access to public charging stations in the city is especially important for people who live in apartments, condominiums and rental properties and cannot install a charging station at their homes. Public charging stations also support the businesses on the Downtown Mall through the installation of EV chargers near the mall for customers to dine and shop while their EVs are charging. (City of Charlottesville, 2020)

EV Charging Locations in the TJPDC Region

As of June 2021, there were 35 public charging locations in the TJPDC area. Each charging location typically has more than one charging device. Most charging locations are in the City of Charlottesville (21) and eleven are in Albemarle County. Greene County has no public charging locations, Nelson, Louisa, and Fluvanna each have one. Table 2 illustrates the number of public charging locations in the TJPDC region by locality.

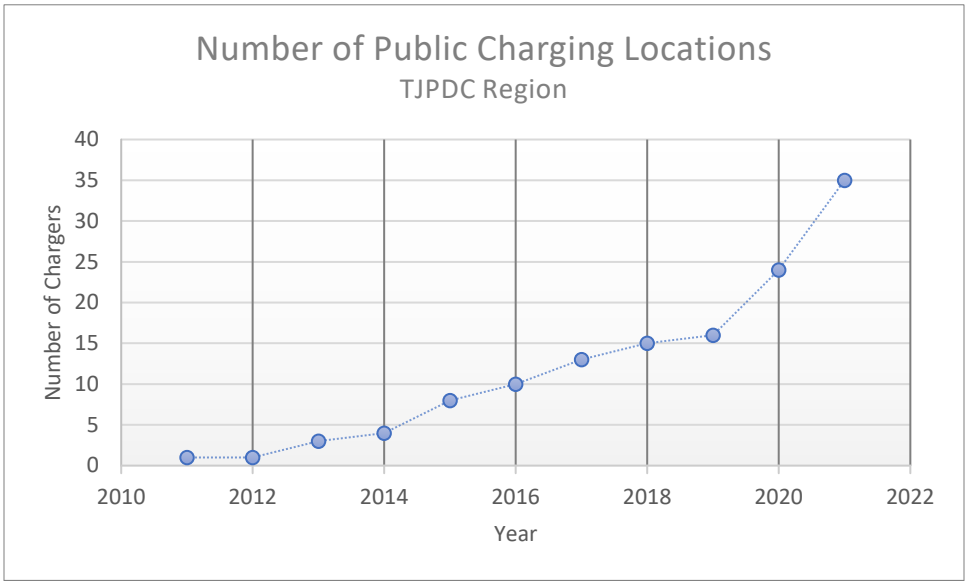
Table 2: Number of EV Charging Locations in TJPDC

Jurisdiction	# Locations	Jurisdiction	# Locations
ALBEMARLE	11	NELSON	1
CHARLOTTESVILLE	21	FLUVANNA	1
GREENE	0	LOUISA	1

Source: www.vacleanxcities.org, Station Locator

As seen in Figure 4, the number of public charging locations in the TJPDC region more than doubled from 2019 to 2021. Four new charging locations were added to Albemarle County in 2020 and 2021. Charlottesville saw an addition of 14 new locations during the same time-period. Eight of the additional station locations added to Charlottesville were in Albemarle County's parking lots.

Figure 4: Number of Charging Locations



Source: www.vacleanxcities.org, Station Locator

The City of Charlottesville supports EV drivers in the region through several initiatives, including the development and support of a publicly accessible EV charging network and educational events. The City maintains several web pages with information and resources to support EV users. In 2020, the City installed two DC Fast Chargers (City of Charlottesville, 2021) in their Water Street Parking Garage and has offered EV Charger Mini Grants since 2013. (City of Charlottesville, 2021) The EV Charger Mini Grant program helps private property owners install public EV charging stations. In 2019 they hosted an educational *Charlottesville Electrify Your Ride* event for EV owners and enthusiasts. (Charlottesville, 2020)

Types of EV Charging Stations

EV charging stations or electric vehicle supply equipment (EVSE) come in three major categories and can be tailored to different types of vehicles based on the vehicle model. The categories are based on the maximum amount of power the charger provides to the vehicle.

- Level 1: Does not require installation of additional charging equipment, it uses the typical 120 V AC plug and is used frequently by residents to charge their personal vehicles. Level 1 chargers deliver 2 to 5 miles of range per hour.
- Level 2: Requires the installation of additional charging equipment, it uses 240 V (residential) or 208 V (for commercial). Level 2 chargers deliver 10 to 20 miles of range per hour. These types of chargers are used in residential, public stations, and workplaces.
- DC Fast Charge: Requires instillation using specialized high-powered equipment, using

480 V AC to provide 60 to 80 miles of range in 20 minutes of charging. These stations are used mostly in public areas along heavy traffic corridors. (US Department of Energy, Energy Efficiency & Renewable Energy, 2020)

In addition to supporting residents who live in apartments and other housing types that do not support the installment of EV chargers, public chargers are needed to extend the range of the vehicles away from driver's homes—and to support lower range EVs such as plug-in hybrids that have an average range of 50 miles. In 2019, Clean Cities Virginia estimated that there are enough charging stations for ½ of 1% of EV trips in Virginia; if EV technology is going to effectively support the goal mitigating global carbon pollution, the number of EVs on the road needs to increase.

Table 3 and Figure 5 show the locations of public charging stations in the TJPDC region. Most of the public charging stations are in garages, primarily at hotels, the University, and Municipal parking. Level 1 and 2 chargers are accessible to all EVs in the US. There are adaptors to help facilitate the use of different types of chargers. Tesla's superchargers are mostly restricted to Tesla vehicles, however there are plans to open the Tesla charging infrastructure to other types of vehicles using an adaptor.

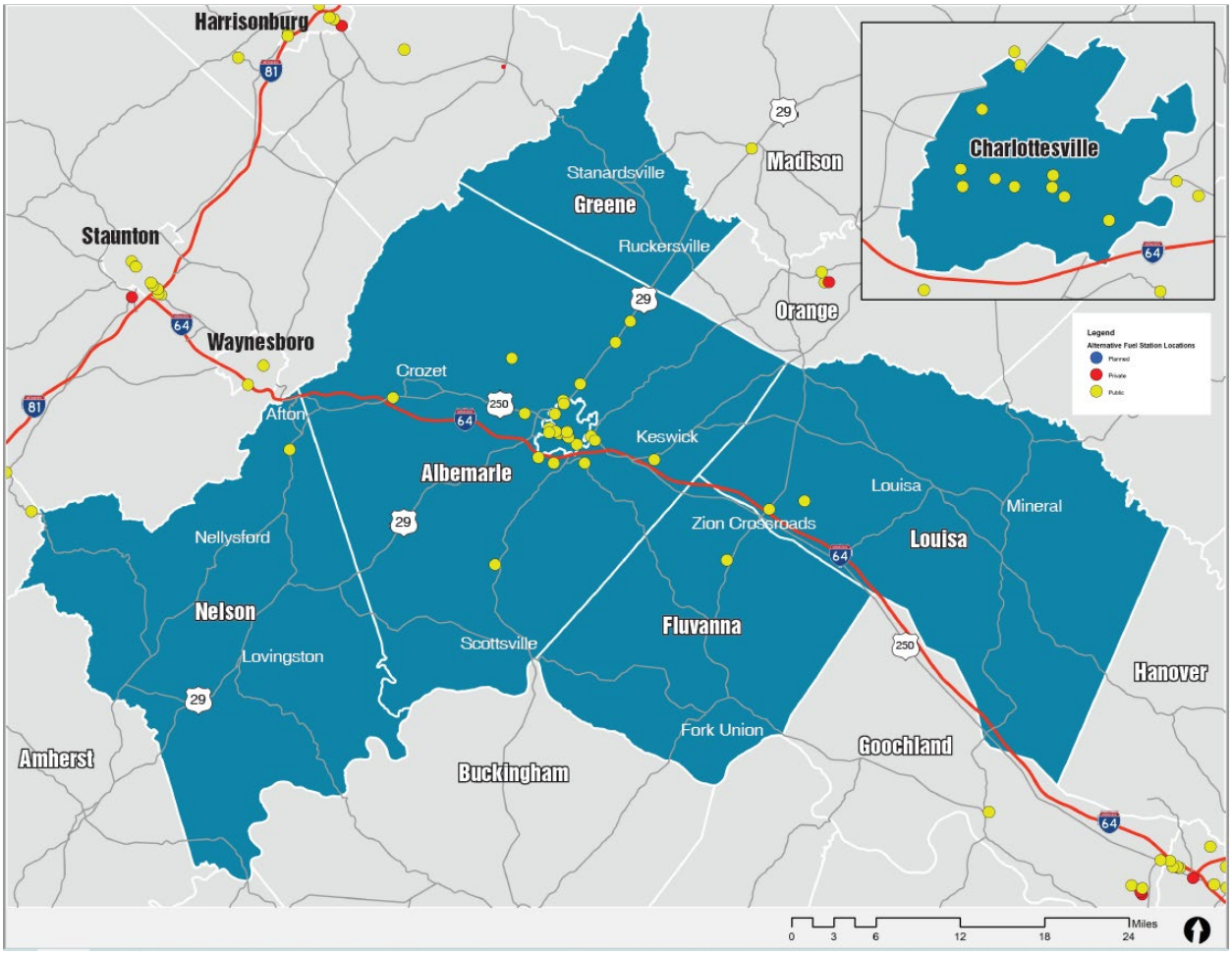
Table 3: Location of EV Charging Stations in TJPDC

Station Name	Street Address	Location	Charging Level	EV Connector Types
Colonial Nissan	200 Myers Dr	Albemarle	2 & 3	CHADEMO J1772
The Shops at Stonefield - Tesla Supercharger	2100 Hydraulic Road	Albemarle	3	TESLA
Hyatt Place Charlottesville - Tesla Destination	2100 Bond St	Albemarle	2	J1772 TESLA
Foxfield Inn, a Select Registry Property - Tesla Destination	2280 Garth Rd	Albemarle	2	J1772 TESLA
Wawa - Tesla Supercharger	3267 Profit Rd	Albemarle	3	TESLA
Seraphic Group Inc. - Tesla Destination	4351 Seminole Trl	Albemarle	2	TESLA
Rivanna Ridge Shopping Center	1900 Abbey Rd	Albemarle	2	J1772
BMW of Charlottesville	1295 Richmond Rd	Albemarle	2	J1772
Sheetz 491 - Zion Crossroads, VA	135 Market Street	Albemarle	2 & 3	CHADEMO J1772COMBO
Pro Re Nata Brewery - Tesla Destination	6135 Rockfish Gap Turnpike	Albemarle	2	J1772 TESLA
Keswick Hall & Golf Club - Tesla Destination	701 Club Dr	Albemarle	2	J1772 TESLA
Southside Shopping Center	32 Mill Creek Dr	Charlottesville	2 & 3	CHADEMO J1772COMBO
Martin Horn	210 Carlton Rd	Charlottesville	2	J1772

Omni - Charlottesville	212 Ridge McIntire Rd	Charlottesville	2	J1772
ALBEMARLE FAST MIDDLE 2	401 McIntire Rd	Charlottesville	2 & 3	CHADEMO J1772COMBO
ALBEMARLE FAST MIDDLE 3	401 McIntire Rd	Charlottesville	2 & 3	CHADEMO J1772COMBO
ALBEMARLE FAST MIDDLE 1	401 McIntire Rd	Charlottesville	2 & 3	CHADEMO J1772COMBO
ALBEMARLE MIDDLE LOT 3	401 McIntire Rd	Charlottesville	2	J1772
ALBEMARLE MIDDLE LOT 1	401 McIntire Rd	Charlottesville	2	J1772
ALBEMARLE MIDDLE LOT 2	401 McIntire Rd	Charlottesville	2	J1772
ALBEMARLE EXERCISE BUILDI	401 McIntire Rd	Charlottesville	2	J1772
ALBEMARLE DSS	1600 5th Street Extension	Charlottesville	2	J1772
Monticello	931 Thomas Jefferson Parkway	Charlottesville	2	J1772
Thatch Winery - Tesla Destination	1650 Harris Creek Rd	Charlottesville	2	TESLA
University of Virginia - Central Grounds Garage	400 Emmet St S	Charlottesville	2	J1772
Graduate Charlottesville - Tesla Destination	1309 W Main St	Charlottesville	2	J1772 TESLA
Boar's Head Inn - Tesla Destination	200 Ednam Dr	Charlottesville	2	J1772 TESLA
The Flats at West Village - Tesla Destination	852 W Main Street	Charlottesville	2	J1772 TESLA
Oakhurst Inn - Tesla Destination	100 Oakhurst Cir	Charlottesville	2	TESLA
Water Street Garage	200 E Water St	Charlottesville	2 & 3	CHADEMO J1772COMBO
Barracks Road Shopping Center	1117 Emmet St N	Charlottesville	2 & 3	CHADEMO J1772COMBO
TRAINING CENTER VMDAEC	1293 Salem Church Rd	Fluvanna	2	J1772
Prospect Hill Plantation Inn - Tesla Destination	2887 Poindexter Rd	Louisa	2	J1772 TESLA
Afton Mountain Bed & Breakfast - Tesla Destination	10273 Rockfish Valley Hwy	Nelson	2	TESLA

Source: www.plugshare.com

Figure 5: Charging stations in Charlottesville



Source: TJPDC

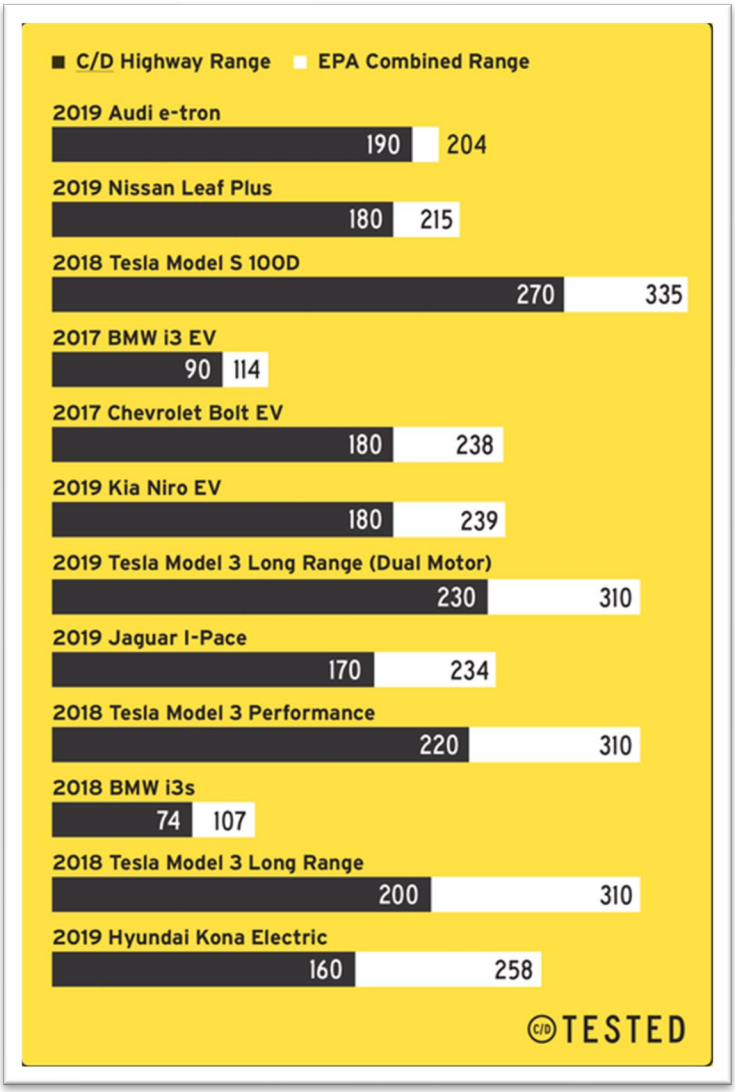
EV Range

Most EVs have to fill-up/re-charge twice as frequently as gas-powered vehicles. In their May 22, 2020 article, *EV Range: Everything You Need to Know*, Car and Driver Magazine estimated that EVs are limited to driving nearly half the distance of a gas-powered vehicle. This makes the location and availability of charging stations a major factor in EV usage. The Environmental Protection Agency (EPA) rates vehicles in multiple variants based on the speed the car is driven. Because of EV's regenerative power from decelerating, gas mileage improves in stop and go driving conditions and at lower speeds. The EPA's combined range[3] for EVs varies between 110 miles and 373 miles.

Car and Driver tested EVs at a steady 75 mph to estimate the lowest mileage range. The ranges resulting in this test fell short of both the EPA's highway and combined range estimates. Figure 7, copied from Car and Driver's website shows the Car and Driver (C/D) and the EPA ranges for top EVs in the United States. (Vanderwerp, 2020)

As shown in Figure 6, Based on Car and Driver's conservative estimates, electric vehicles can require charging as soon as 74 miles. Tesla models have significantly more range with the 2018 Tesla Model S 100D lasting 270 miles. The EPA's combined estimates for the Tesla 2018 Model S 100D were up to 335 miles before needing a charge. This is longer than most trips in the TJPDC area.

Figure 6: Estimate Driving Miles Range from Car and Driver



Source: Car and Driver (Vanderwerp, 2020)

[3] The EPA's range is used as the advertised figure for electric vehicles that are sold in the US. The 310-mile range is an estimate of the number of miles the vehicle should be able to travel in combined city and highway driving from a full charge.

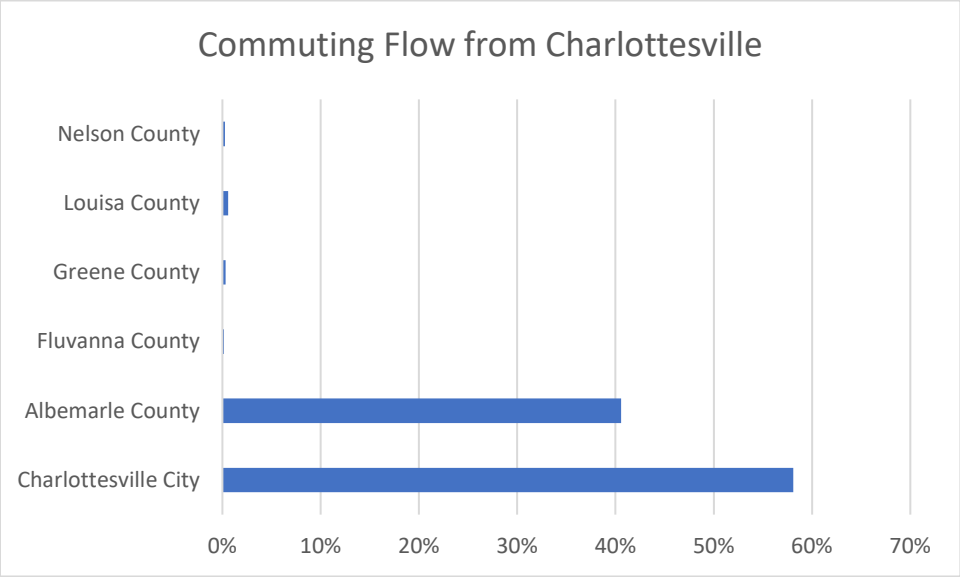
Commuting and Trip Patterns in TJPDC Region

The US Census collects locations of employers and where workers live. The data shows that most of the commuting trips in the TJPDC region are 25 miles or less and that most commuting trips in TJPDC take place within Albemarle County. Major employment areas include the following locations.

- The University of Virginia
- Charlottesville Downtown area
- Pantops area—US 250
- Fontaine Research Park
- University Research Park—Northfork
- Rt. 29 Corridor—US 250 to the Airport
  (Thomas Jeffesrson Planning District Commission, 2016)

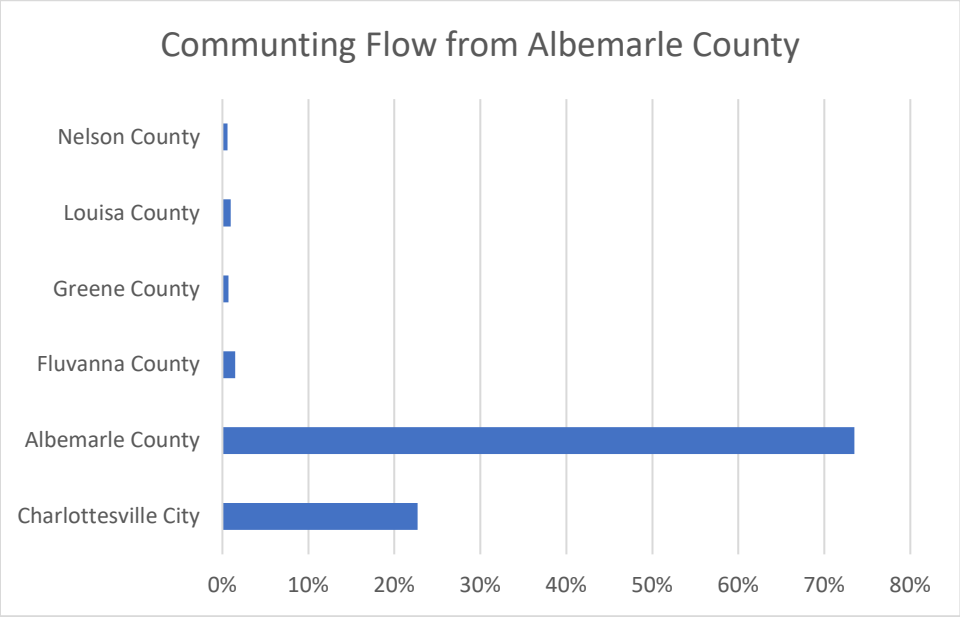
Most trips for work by residents of the TJPDC area are within the county or to other close locations within the region. As seen in Figures 7 through 12, more than fifty percent of commute trips in the TJPDC region are within a jurisdiction, except for Fluvanna and Greene counties who had more trips going to Albemarle County. Sixty percent of Greene county's residents travel to Albemarle County for employment destinations. Thirty-eight percent of Fluvanna's residents travel to Albemarle County for employment and another twenty-eight percent travel to Charlottesville. (US Census, 2020) Most commutes in the TJPDC region are short enough to not need a public charging station during the trip, especially if employers have charging stations at their facilities. These numbers will have changed during and after COVID as more people are working remotely and population and employment circumstances have changed.

Figure 7



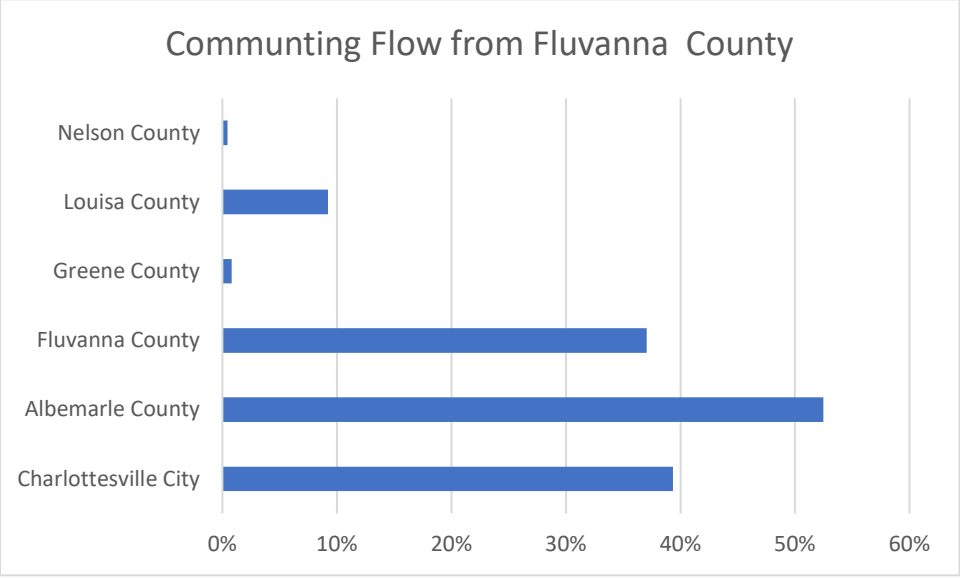
Source: US Census, 2011-2015, 4 Year ACS Commuting Flows

Figure 8



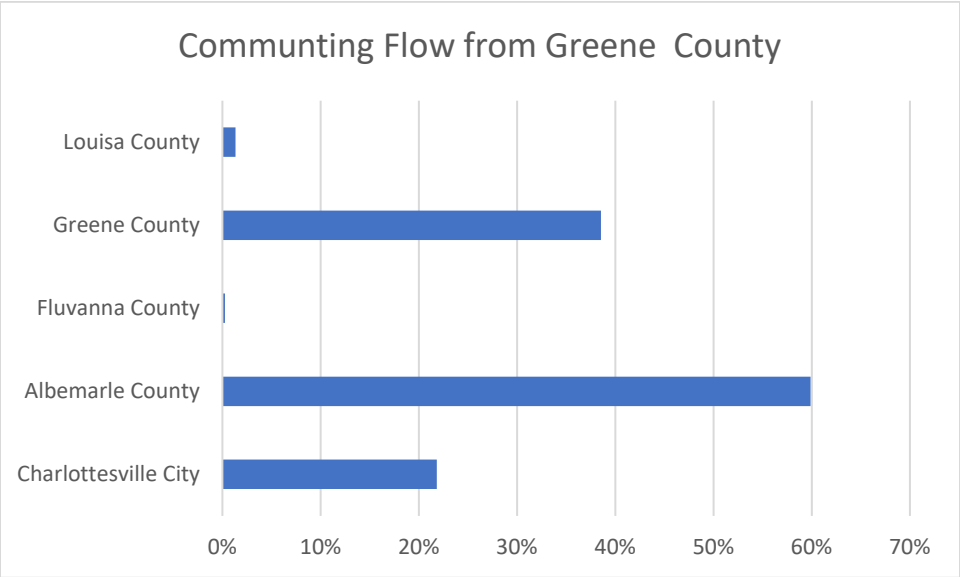
Source: US Census, 2011-2015, 4 Year ACS Commuting Flows

Figure 9



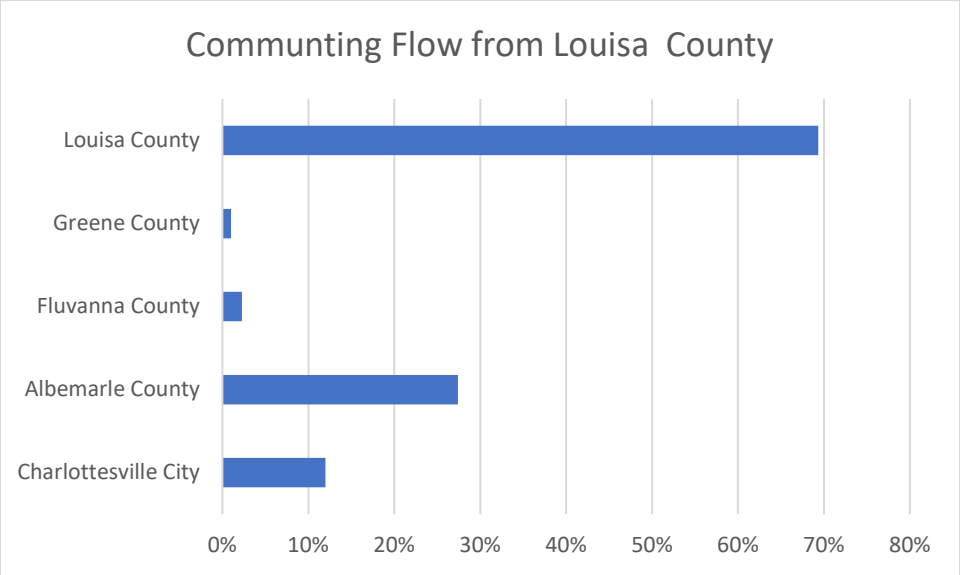
Source: US Census, 2011-2015, 4 Year ACS Commuting Flows

Figure 10



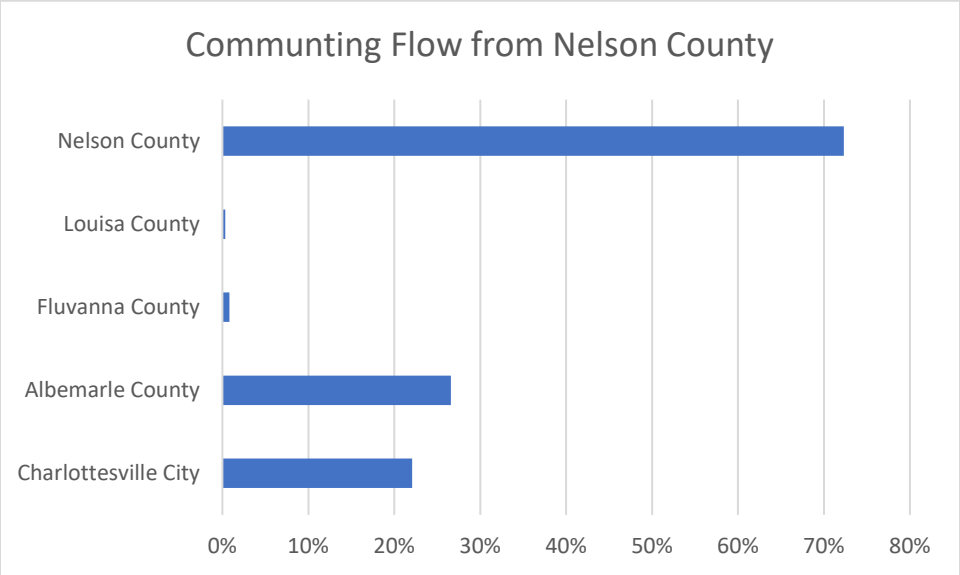
Source: US Census, 2011-2015, 4 Year ACS Commuting Flows

Figure 11



Source: US Census, 2011-2015, 4 Year ACS Commuting Flows

Figure 12



Source: US Census, 2011-2015, 4 Year ACS Commuting Flows

Factors that Affect EV Adoption

As with national markets, the challenges to EV adoption in the TJPDC area are mostly financial. However, there are also design considerations that local governments can implement to encourage the use of EVs. Some factors that negatively affect EV growth in the TJPDC area include the cost of purchasing vehicles, higher licensing fees, and lack of charging infrastructure.

Many electric vehicle models are more expensive than their gas-powered counterparts if they are bought new. Because it is a newer technology, the cost of purchasing EVs is higher than gas-powered vehicles and there are less used EVs available for sale. It is difficult to connect the future savings to a consumer when there are cheaper cars with more places to buy fuel, but this gap is shortening. Chen and Paleti's report, *Would You Consider a "Green" Vehicle? Anticipating Electric Vehicles, Adoption Patterns and Emissions Impacts in Virginia*, (2018) expects that federal and state financial incentives are critical factors to support EV adoption by helping to offset higher purchase prices. (Chen & Paleti, 2018) A September 2020 article in the New York Times, *The Age of Electric Cars Is Dawning Ahead of Schedule*, reports that with lower battery costs, EV purchase prices are dropping at a higher rate than expected. (Ewing, 2020) (Hanley, 2020)

In addition to the higher purchase cost, often the future benefits of an EV are not well known by consumers. There are many upsides including cheaper fuel and less maintenance. ChargEVC, a not-for-profit trade and research organization, estimates that the average driver could save almost $800 per year in fuel costs by switching to an EV. In addition to lower fuel costs, EVs

have one third of the moving parts compared to gasoline vehicles which translates to less maintenance related costs. (ChargeEvC, 2020)

In Virginia, the licensing fee for an electric vehicle is increasing from $64 to $88 a year compared to $40 for gas fueled cars. According to the Virginia Department of Motor Vehicles, effective July 1, 2022, fuel-efficient[4] and electric vehicles will be charged a Highway User Fee of $88 a year to offset the reduced gas tax revenue from the use of these vehicles. Starting in the spring of 2021, the Highway Use Fee will be tied to the fuel tax rate and the average number of miles traveled by a passenger vehicle in Virginia. (Virginia Department of Motor Vehicles, 2020) This added cost could be a discouraging aspect of investing in an electric vehicle.

Charging infrastructure is a key factor when considering the purchase of an EV. Depending on the part of the state, there could be many charging stations that allow for a quick vehicle charge or charging stations could be farther apart requiring a special trip to charge a vehicle. The EPA reports that 80% of privately owned EV charging is completed at home. Only 40% of households in the US have electricity located within 20 feet of the parking area. (US Department of Energy, Energy Efficiency & Renewable Energy, 2020) The majority of those households with electricity located within 20 feet of their parking spaces are higher income households. Lower income households will have more difficulty adopting EVs due to the additional barriers associated with multi-unit housing.

According to the 2015-2019 American Community Survey 5-Year Estimates, 34% of the TJPDC housing units are not single-family detached homes. Meaning that occupants may not have the option of installing a charging station in the garage or near their house. Occupants also may not own a parking space to install a charger in. This number of attached units in the TJPDC region, 38,331, includes 1-unit attached (townhome), 2-units up to 20 or more units and the 32 boats, RVs, and vans counted as housing units in Albemarle. Figure 13 breaks down the number of attached units versus the

THE U.S. EPA REPORTS THAT 80% OF PRIVATELY OWNED EV CHARGING IS COMPLETED AT HOME.

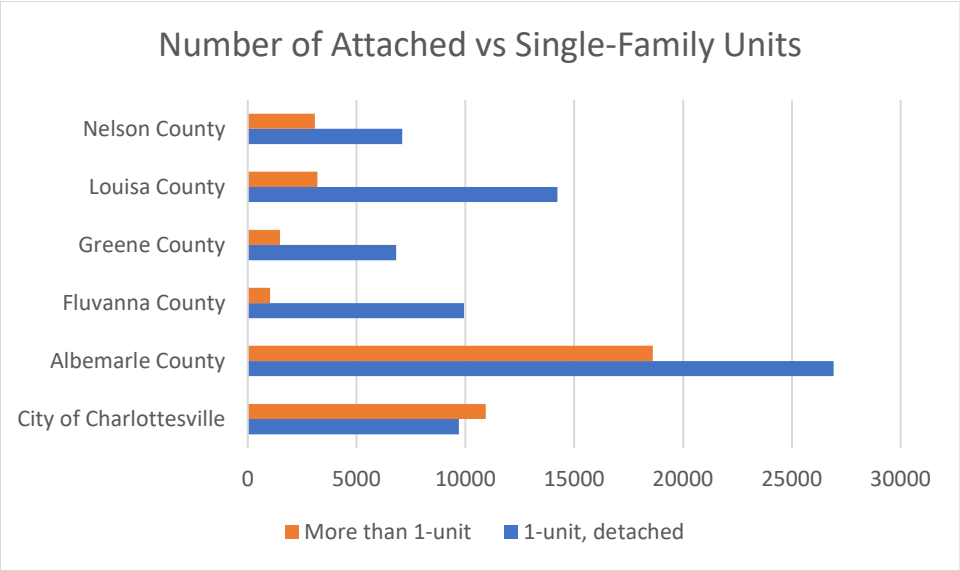
THERE ARE AN ESTIMATED 40K HOUSING UNITS IN THE TJPDC REGION WITH POTENTIAL BARRIERS TO CHARGING EVS AT HOME.

Sources: U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2020 and *U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates*

[4] Fuel efficient vehicles are defined as having a combined miles-per-gallon rating of 25 or greater, electric vehicles, or alternative fuel vehicles that run on something other than gasoline or diesel.

number of detached units. While all but the City of Charlottesville have more detached or single-family units, there are still almost forty thousand households in the region with barriers to charging an electric vehicle at home.

Figure 13: Estimated Number of Housing Units that are Suitable to Installing an EV Charger



Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates

People who live in apartments, condominiums, and townhouses, as well as those in communities with homeowners' associations may have barriers to charging EVs at home. Commutes and most trips in the PDC region are relatively short and less than the range of most EVs, making home charging the most likely practice, especially in rural areas. Table 4 breaks down the housing unit types by each jurisdiction.

Table 4: Number and type of Housing Units by Jurisdiction

Number and Type of Housing Units by Jurisdiction			
Geographic Area	**% More than 1-Unit**	**More than 1-unit**	**1-unit Detached Single-Family**
City of Charlottesville	53%	10,938	9,704
Albemarle County	41%	18,606	26,914
Fluvanna County	9%	1,018	9,930
Greene County	18%	1,481	6,810
Louisa County	18%	3,203	14,235
Nelson County	30%	3,085	7,090
Total TJPDC Region	34%	38,331	74,683

Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates

Recommendations

Based on the research conducted and other initiatives that are already underway in the region, these are the opportunities that stakeholders could consider to support the adoption of electric vehicles throughout the region. Stakeholders like local governments, developers, educational institutions like the University of Virginia (UVA), employers, utility companies, Virginia Department of Transportation (VDOT), transit providers, non-profits, and the TJPDC and MPO can all work together to reduce greenhouse gas emissions through initiatives supporting the adoption of electric vehicles. These opportunities include areas like—infrastructure, funding, policy, and information gathering and sharing.

Infrastructure

Opportunity	Stakeholders
Identify convenient and highly visible public locations that could support EV charging infrastructure such as shopping centers, parking decks, stadiums, etc.	Local Governments Developers UVA
Collaborate with utility companies to provide EV charging infrastructure near utility pole sites that can be accessed via street parking to provide access to those in high-density housing without access to building-based charging infrastructure.	Local Governments Utility Companies VDOT
Assess opportunities to collaborate with transit providers as they consider opportunities to expand EV fleets.	Local Governments VDOT Jaunt CAT UTS
Collaborate with VDOT to consider incorporation of EV charging station infrastructure at new or existing Park and Ride lots.	Local Governments VDOT MPO/PDC
Include installation of EV charging infrastructure at major employment centers throughout the region.	Developers
Include EV charging infrastructure in new housing developments, especially multi-family developments.	Local Governments Developers Affordable Housing Agencies

Funding

Opportunity	Stakeholders
Pursue public/private partnerships and/or state and federal grants to support an increase in the availability of EV charging infrastructure.	Local Governments
Pursue Department of Rail and Public Transit's MERIT grants for electric public transit vehicles in coordination with VA Department of Environmental Quality's Environmental Mitigation Trust.	Jaunt CAT UTS
Offer subsidies and grants to owners of multi-family residential	Local Governments

developments to support the installation of EV charging infrastructure.	UVA
Offer subsidies and grants to employers to support the installation of EV charging infrastructure.	Local Governments UVA

Policy

Opportunity	Stakeholders
Develop local ordinances and policies that encourage or require new developments to provide EV charging stations, as appropriate.	Local Governments
Assess a reduction of the personal property tax rate for EVs.	Local Governments
Assess opportunities to develop utility demand response programs to facilitate electric vehicle charging.	Utility Companies Local Governments Community Climate Collaborative MPO/PDC
Consider incentive programs to encourage owners of existing commercial/residential developments and employment centers to install EV infrastructure.	Local Governments
Support state and federal legislation encouraging the adoption of EVs like tax breaks and other incentives.	Local Governments Community Climate Collaborative

Information Gathering/Sharing

Opportunity	Stakeholders
Develop an inventory of existing multi-family housing developments that do not have access to building-based electrical infrastructure.	Local Governments MPO/PDC Affordable Housing Agencies
Develop a comprehensive database of resources to include information on financial incentives and technical guidance for stakeholders interested in adopting/supporting EV use.	Local Governments Community Climate Collaborative UVA MPO/PDC
Collaborate with local stakeholders on unified marketing and programming to support greater EV adoption throughout the region.	Local Governments Community Climate Collaborative UVA MPO/PDC

Guidance

Many communities are leading the way in the adoption of EVs and reducing greenhouse gases, California's EV charging network is four years ahead of Virginia's (Chen & Paleti, 2018) and many European countries are investing in infrastructure to support public charging stations for residents of dense neighborhoods with limited off-street parking. Some examples of how communities are implementing recommendations like the ones above are provided in this section.

For example, through London's Go Ultra Low Cities funding program, neighborhoods are installing EV charger ports on streetlight posts in front of public parking spaces. As of the fall of 2020, the Boroughs of Kensington and Chelsea have 43 Source London[5] charging ports and 225 lamp column chargers operated by Ubitricity. (The Royal Borough of Kensington and Chelsea, 2020) The March 24, 2020 CleanTechnica article, *Siemens Brings Street Light EV Charging To London Neighborhood,* reported that the City of Westminster has over 300 public EV charging stations and plans to reach a thousand stations in the 2021. (Hanley, 2020)

Some of the information identified through this research can assist the TJPDC region to encourage the adoption of EVs are listed below.

- Sample guidelines for EV Charging Stations, siting, and design
- Sample local ordinances and policies to encourage new developments to include EV charging stations (Zoning, Parking, and signage, building codes and permitting)
- Strategies to support the addition of charging stations for residents who live in multi dwelling units
- Available financial incentives and strategies
- Power grid and electric utility policies and planning
- Analysis of need for non-residential/employer charging stations and locations for the public
- Examples of successful strategies implemented by other agencies/governments

The next section offers examples of guidelines and ordinances localities in the United States have used to support building additional EV charging stations and EV use.

Sample Guidelines for EV Charging Stations

The Charlottesville *Local Climate Action Planning Process Report* recommends supporting the use of EVs by developing municipal and private sector guidelines for EV charging stations, parking, and incentives. The US Department of Energy, *A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects* provides examples of guidelines and considerations localities enacted to encourage the use of EVs in their community. (Frades, 2014) Some of the topics to consider in developing guidelines are shared in this section. The

[5] Source London is a membership-based charging network of on-street parking EV charging stations that are powered by 100% renewable energy. In 2020 they had over 1,000 7kW and 22kW charging stations in London. They plan to double that amount by the end of 2020. (Bolloré Group, 2020)

section after this one, *Sample Local Ordinances*, provides considerations and examples of ordinances to support EVs in the development process.

Fairfax County, Virginia has an easy-to-use webpage explaining their permitting process for charging stations. They require plans for commercial and multi-family installations. Single-family units only submit electrical permits. The website has information about the requirements specific for EV charger installations and defines the types of electric vehicles and the types of chargers. (Fairfax County, 2020) Localities in the TJPDC region can consider the following design characteristics to add to their building codes:

- Structure and characteristics of the charging station itself
- Location and characteristics of parking spaces
- Uniform signage, including wayfinding signs
- ADA standards

Public charging stations will also have additional considerations like:

- Parking restrictions;
- Terms of use—hours of operation, cost to charge, cost to park, time limits; and
- Enforcement.

Providing clear guidelines for charging stations will help people install, find, and use the stations. Developers will have clear designs on what they are expected to plan for and produce. EV drivers will know what to look for and how to use the stations if they are all uniform, they will be easily recognizable, and all have similar operating procedures. This also signifies the localities' support for electric vehicles and supporting infrastructure.

The type of structure the EV charger is mounted on should be considered so that it is accessible to all kinds of users and does not interfere with local pedestrian and vehicle movement. For example, the height the charger is mounted can help avoid damage to vehicles and the charger as the result of collisions.

Specifying EV Charger parking space configurations can also include directions on whether builders should locate chargers in perpendicular, parallel, or angled parking spaces. Parking spaces should be designed to accommodate the added space needed to mount EV charges. Some localities choose to locate EV stations in less desirable locations to discourage non-charging vehicles from using them while other localities use the location of EV charging spaces as an incentive for using EVs. For example, St. Louis Park, MN specifies the following in their ordinances.

"The EVCS[6]s shall be located in desirable and convenient parking locations that will serve as an incentive for the use of electric vehicles." (Cooke & Ross, 2019)

[6] EVCS - Electric Vehicle Charging Station

Clear uniform signs on roadways and at parking facilities are recommended to help drivers find charging locations and understand the use requirements. For example, are EVs allowed to park in charging locations while not charging? Some public EV parking limits the amount of time vehicles can use the space. Who should an EV driver contact for assistance if the station is out-of-order? What are the costs and terms to use the charger?

Municipalities will also want to consider enforcement for parking in public EV charging spaces. If EV chargers are in prime parking spots, it is essential to ensure that EV drivers can use the spaces and that non-EVs are not blocking the spaces. This can include clear consistent rules with consequences posted in visible locations throughout the region.

By providing minimum standards or required designs for charging stations, localities can facilitate a smooth permitting process while planning for future technologies and trends. When developing these standards, consider the electrical supply equipment standards and parking space requirements.

Sample Local Ordinances

Albemarle County's *Climate Action Plan* suggests using local ordinances and policies to encourage new developments to include EV charging stations and explore partnerships and funding strategies to support EVs. In their 2019 report, *Summary of Best Practices in Electric Vehicle Ordinances,* the Great Plains Institute provides examples of zoning ordinance language and associated tools as a guide for cities on developing EV-ready zoning standards.

Including mention of where EV charging stations are allowed in ordinances helps streamline installation, eliminates confusion, and affirms the localities support for EV infrastructure. For example, Iowa Clean Cities Coalition recommends defining what types of EV charging installments are allowable by land use. For example, level 1 and 2 EV charging stations are allowed in all zones and level 3 stations are restricted to specific zoning districts or require a special use permit. (Ross, 2019)

Retrofitting parking structures can be much more expensive than outfitting garages during the initial construction phase. **Minimum requirements** and **make-ready standards** can be used to ensure that new buildings, especially multifamily residential developments are designed with future EV charging needs in mind. Localities often recommend or require that a proportion of parking spaces contain EV charging stations or be EV ready. For example, Howard County, MD has the following minimum requirement.

"For new occupancies subject to this section: at least 1 parking space for each 25 residential units shall feature energized outlets." (Cooke & Ross, 2019)

Some localities base their proportion requirements on land use, requiring more EV spaces in multifamily developments and lodging and less in retail, eating and drinking establishments.

Localities can also allow flexibility to exchange EV charging stations for meeting existing minimum parking requirements. For example, Middletown, CT provisions state:

"Requests for reduction of general parking spaces in exchange for additional EV parking: For any development that exceeds the minimum number of EVCs as required … The reduction of parking cannot be greater than 10% of the total amount of parking for the proposed development." (Cooke & Ross, 2019)

Make-ready standards or requirements for new construction can facilitate the installment of EV charging stations as the need arises. For example, St. Louis Park, MN requires all new, expanded, and reconstructed parking areas for multifamily residential uses to provide the electrical capacity necessary to accommodate the future hardwire installation of Level 2 EV charging stations for a minimum of 10% of required parking spaces. (Ross, 2019)

The Great Plains Institute provides the following recommendation for make-ready standards for multifamily parking spaces in a structure to ensure that electrical conduit (trunk line) and subpanels are preinstalled throughout the parking garage to allow Level-2 Charging Equipment to be connected in the future.

"Require that all parking spaces in a parking structure be made "EV-Capable" i.e. conduit be installed throughout the structure and subpanels sized to accommodate 60A or 40A breakers for each." (Cooke & Ross, 2019)

Conclusion

Statewide and nationally, EVs are recognized as an integral part of climate change mitigation strategies. As the City of Charlottesville, the University of Virginia, and Albemarle County Continue to develop strategies to mitigate climate change and reduce emissions, EVs will be part of the plans.

While financial incentives, like tax breaks, for purchasing EVs have been found to be an effective incentive for the adoption of EV technology, there are political barriers to tax incentives for EVs in Virginia. Localities can take actions in other ways, by laying out clear pathways for the installation and use of charging stations by using ordinances and incentives to encourage new developments to plan for and install charging infrastructure. Charlottesville's EV Charger Mini-Grant program helps increase charging options near commercial and retail activities and their website offers useful information and links about EVs, regulations and charging stations for potential hosts and EV users.

There are 10 public EV charging stations in the City of Charlottesville and 7 in Albemarle, with more coming. These stations are in public parking garages and retail/commercial parking lots. Most EV charging is completed at home and places of employment where vehicles will be parked for numerous hours. Increasing charging options for people who live in apartments and/or don't have designated parking with infrastructure to support installing an EV charger

will reduce a common barrier to EV purchase and use. Secondly, places of employment providing EV charging options for employees will also help support EV use. Localities in the TJPDC area can address this barrier with, guidelines, ordinances, and incentives to support the installation of EV charging infrastructure for multifamily housing and employment centers.

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