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Landscape Survey of Electric Vehicle Infrastructure with Recommendations for the Town of Manlius, NY

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Maxwell School of Citizenship and Public Affairs

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Project Introduction

Pressure to reduce sources of carbon emissions continues to grow as evidence of its impact shows accelerated climate change. "Climate scientists have reached a strong consensus that in the absence of measures to reduce GHG (greenhouse gas) emissions significantly, the changes in climate will be substantial, with long-lasting effects on many of Earth's physical and biological systems," according to the Hamilton Project and the Stanford Institute for Economic Policy Research (2019). Rapid solutions are needed to reverse this trend. A recent Syracuse.com article pointed out a 2.4% increase in area temperatures since 1970, likely resulting from the combination of tree loss and climate change, (Coin, G., 2020). Efforts to plant trees are one approach to mitigate rising temperature. Another approach is to reduce the amount of carbon-based fuel used in the transportation sector, by encouraging greater adoption of alternatively fueled vehicles into the transportation fleet. The transportation sector contributes 30% - 40% of overall emissions making it a significant factor (EPA, 2018).

The electric vehicle (EV) with a low carbon footprint is a reasonable alternative to the carbon-based gas-powered vehicle. While EV's have become more readily available and priced more affordably in the last several years, infrastructure to support their usage is scattered. Infrastructure for EV's would include an organized network of charging stations creating multiple options for charging. Focused efforts to support EV adoption through education and expansion of infrastructure will contribute to a reduction of greenhouse gases and may also contribute to a reduction in area temperatures.

An evaluation of the current status of EV infrastructure within The Town of Manlius, offers an opportunity to provide a landscape assessment of the town and surrounding area.

Within this landscape, I will identify charging station infrastructure currently in place and then identify what will be needed to meet demand in the next 5 years. Using an online survey, I will assess resident readiness for EV adoption. Finally, I will provide a roadmap that the town (and surrounding areas) could follow to better prepare for greater EV adoption. In addition to town officials and residents, other parties have a vested interest in climate mitigation. They include elected officials, local businesses, non-profit organizations, the New York State Department of Environmental Conservation and the U.S. Department of Transportation. I would like to identify additional potential partners since these alliances may bring about more comprehensive results.

Introduction to EV's

It's important to first identify the differences between electric and gas-powered vehicles and their impacts. Electric vehicles (EVs) have a battery rather than a gasoline tank, and an electric motor instead of an internal combustion engine. According to the Environmental Protection Agency (EPA), they utilize energy more efficiently and do not produce tailpipe emissions. When energy is generated from renewable sources, emissions are lower when driving EVs than those for gasoline cars. Coal-generated electricity is an exception. The EPA offers a calculator that provides total grams of emissions per mile based upon local energy sources. I used the EPA calculator to generate data for my area of residence. My electric vehicle generates 40 grams per mile using the energy sources utilized in my area. Other areas of the country average 140 grams per mile for EV driving since they utilize less clean sources of energy than the Town of Manlius (and NYS in general). A typical gas car in our area will generate ten times the emissions as an EV- approximately 410 grams per mile. The substantial reduction in

emissions per mile supports the use of EV adoption. To reduce emissions even further, I could utilize solar (or wind) power to generate electricity at my home to power our EV.

To illustrate key differences between gas-powered vehicles and battery-powered vehicles two figures are provided. Figure 1 (Transportation and Climate Initiative, 2012) shows power flows for each type of vehicle. The gas-powered cars are described in the visual as internal combustion engines (or ICE). Plug-in hybrids with parallel power flows are shown as well as plug-in hybrids using an electric series power flow. Finally, the battery-powered flow is shown.

Figure 1. Comparison of Power Flows for Different Vehicle Types

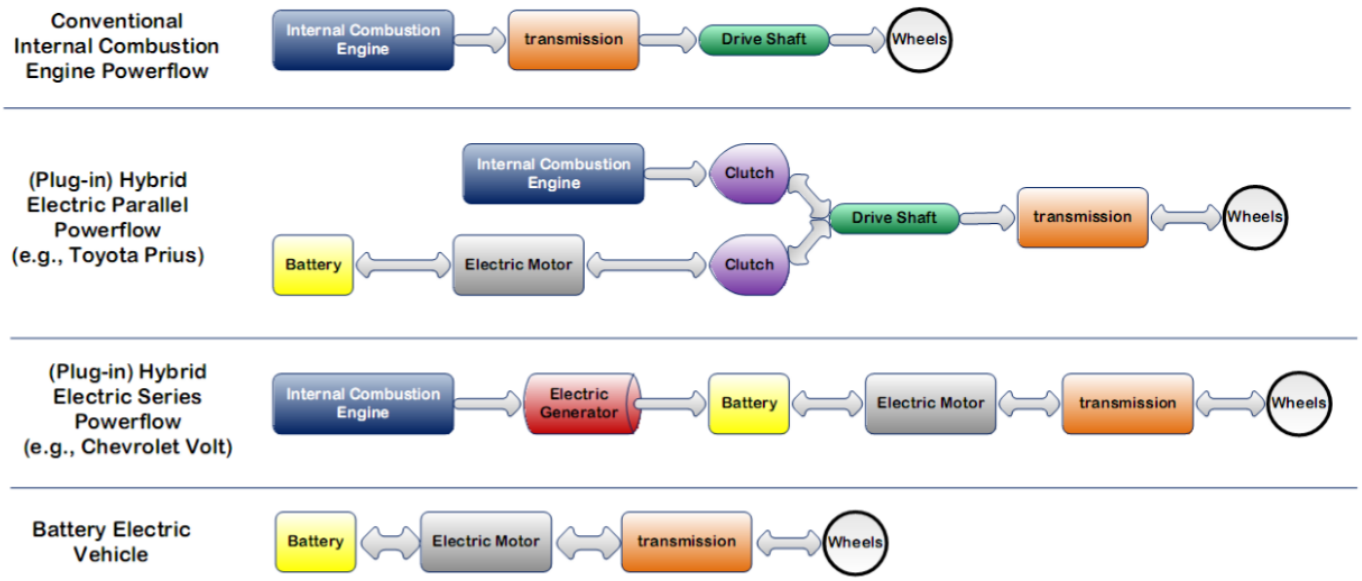


Figure 1. Power Flow Comparison for Gas-powered, Plug-In Hybrid and Plug-In Electric Transportation and Climate Initiative, 2012

In Figure 2, I've explored the distinctions between plug-in hybrids further in response to a question raised by the Town of Manlius Supervisor. In the case of the extended range electric vehicle, an electric motor turns the wheels. With a blended plug-in hybrid both the gas-powered engine and the electric motor propel the vehicle. In both cases fuel economy is influenced by driving style and conditions. Features of each are listed in Figure 2.

Figure 2. Comparison of Plug-in Hybrids

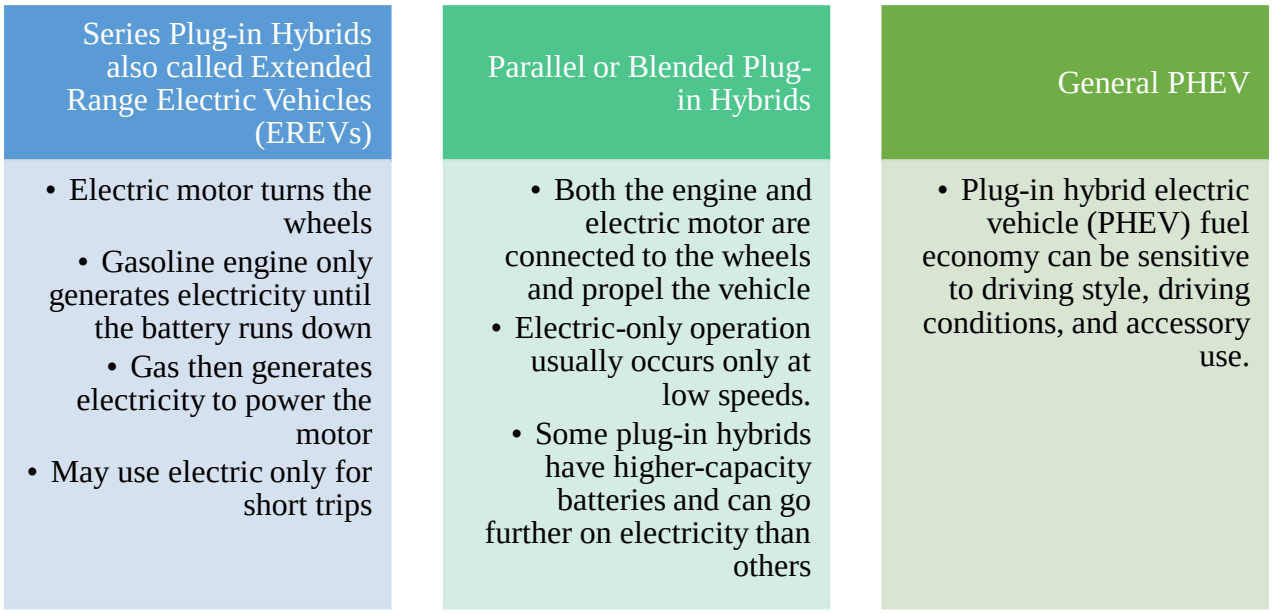


Figure 2. Plug-in Hybrid Comparison

Since EV's require electric power sources, I've provided an overview of the three primary types of electric vehicle supply equipment (EVSE) or charging stations in Figure 3. Residential stations are typically wall mounted. Commercial stations are generally free standing and are an important component of EV infrastructure. Charging stations are commonly

classified into levels 1, 2, and 3. AC chargers provide alternating current at two different levels (1 and 2). DC chargers provide direct current (level 3) and, "are different in appearance and plug type." They are, "mostly to be found on the major intercity routes," (Gaton, 2020).

Public charging station demand is influenced by factors that include battery capacity of the type of EV's driven, driving habits, and the number of miles typically traveled daily and weekly. According to Gaton, (2020), "AC charging at home or locally is the norm when it comes to charging, and real-world usage data shows it is used for over 90% of EV charging." The majority of EV users are currently charging at home utilizing level 1 or level 2 chargers. This may in part be due to charging station availability in public locations which I'll explore further in the study.

Table 1. Electric Vehicle Charging Infrastructure Terminology and Specifications in the United States

Charging Level	Typical Power	EV Charge per Hour	Miles available from one hour of charge	Setting
Level 1	120 V AC	1.2–1.4 kW AC	3–4 miles	Primarily at home and some workplaces
Level 2	208 V– 240 V AC	3.3–6.6 kW AC	10–20 miles	Hardwired public charging station or installed home unit
Level 3	DC fast 400 V– 1,000 V DC	50 kW or more 20- 30 minutes 80-100% battery capacity	Up to 10 miles of range per minute of charging 150 – 1,000 miles	Public charging – typically on highways

Table 1. EV Charging Infrastructure Terminology, Nicholas, Hall and Lutsey, (2019)

Pricing methodologies are not yet consistent for EV charging. According to Drive Clean, "Many people charge their electric car at public charging stations. They can be free, pay-as-you-go or subscription-based, with prices set by networks or property owners. Some automakers, such as Hyundai, Nissan and Tesla may provide complimentary public charging at certain chargers. The industry is moving toward a fee structure based on kWh used, rather than by the time it takes to charge the car." Some municipalities have opted to provide free EV charging to encourage shopping at local businesses. Some workplaces provide free charging as a "perk" for their employees. It's important to also note that Tesla utilizes its own charging network for Tesla electric-powered vehicles. There are some instances of compatibility, however, generally other EVs cannot use the Tesla charging network.

Project Objectives

The purpose of this research is to consider how to encourage and prepare for an EV transportation future in the Town of Manlius and surrounding areas. I will start by making a case for EV's benefits including its important role in climate mitigation. I'll also address concerns raised about EVs. Next, I will look at current ownership, an EV landscape survey and conduct a community assessment of resident's perspectives. I'll consider research reflecting purchasing trends and infrastructure projections. Finally, I'll identify funding opportunities and recommendations for the town to encourage and prepare for growth in demand.

Key Research Questions

- How many EV's are currently owned by residents in the Town of Manlius?

- Community Assessment – What are Manlius Residents' Perspectives on EV's?
    - How familiar are residents with electric vehicles?
    - What concerns, if any, do residents have about EV adoption?
    - What concerns, if any, do EV owners have?
- What incentives are in place to encourage consumer adoption?
- What are the costs and benefits of battery-powered electric vehicles to individuals and the community?
- What are the anticipated demands for EV infrastructure?
- What is the current landscape of EV infrastructure within the Town of Manlius and surrounding area?
- Is funding currently available for municipalities?
- What activities can the town undertake to promote and prepare for the growth of EV ownership?

Key Challenges that the Project will Address

Comprehensive plans to provide charging station infrastructure and support adoption of EV's in our region have not been updated since the CNY Regional Energy Board Plan in 2016. Recommendations in this county-wide plan have not yet been fully acted upon. This creates lost opportunity to reduce carbon emissions impacting health, wellbeing, and our area's natural resources. This study will look at actions which may be taken in the Town of Manlius.

Many new EV models are becoming available peaking interest in EVs sleek new designs. Developments in battery technology are enabling EVs to travel longer distances. These developments are also leading to lowered costs of batteries, which is subsequently reflected in EV prices. Based on these factors, an increase in the number of electric vehicles is likely which then contributes to higher demand for charging stations. EV infrastructure will need to be in place to meet growing needs.

According to information from the U.S. Department of Energy, a variety of charging sources should be available to meet varied travel needs and support adoption. Level 1 provides the slowest charge by plugging in to a standard household outlet. This is typically done overnight. Level 2 charging is faster than level 1, but still requires extended time. Level 2 chargers can be installed at home, in public or at workplaces. Their use has been compared to providing power to a refrigerator or dishwasher. Level 3 is a rapid charge of direct current important for quick charging especially when traveling across distances. Highway rest stops are ideal locations for rapid charging stations. Research has shown that the availability of public chargers impacts how well the public adopts the use of electric vehicles since charging stations help to mitigate, “range anxiety,” the fear of running out of available battery power.

A complete charging ecosystem or infrastructure would include public access stations, workplace options, and whenever possible, charging at home. This array of stations is not currently in place to meet the needs of existing and future EV owners. Lack of infrastructure leaves some hesitant to make an EV purchase. A full complement is needed to allay fears, encourage adoption and provide a needed service to EV owners. While infrastructure costs are high; potential resources to support development of EV infrastructure do exist. Many are not aware of resources available. This study serves to identify those potential resources.

New York State is one of the states that has adopted the Zero Emissions Vehicle (ZEV) Mandate led by California. This mandate requires a percentage of plug-in vehicles sold in the state. In addition, The Climate Leadership and Community Protection Act was approved by the NYS Assembly, NYS Senate and signed into law by the Governor in 2019. It requires that the Department of Environmental Conservation (DEC) establish, "Statewide greenhouse gas emissions limits by regulation, to reduce emissions 85 percent of 1990 levels by 2050," (NYS Climate Action Council). Comprehensive plans and funding are needed to meet these targets at a statewide level. Local communities have options to educate and inform the public about the need for climate protection and the benefits of EVs.

An additional concern that has been raised relates to accessibility and car dealer support. Some critics have said that, "Car dealerships also remain reluctant to display and sell electric models, which often require less maintenance and are less profitable for their service departments. Surveys have found that salespeople are often unprepared to pitch the cars," (Plumer, 2017).

Looking more closely at a local level, the topic of sustainability is now being discussed by the Town Board. Implementation of a Sustainability Committee with sub-committees is a recent addition. Prior to this, Town of Manlius residents have not had a forum to engage in dialogue, ask questions, and express concerns or interest in EV adoption. Through this study, I wish to enhance the opportunity for dialogue and education. This will be done in collaboration with the town in order to support their efforts to best meet the needs of town residents.

Project Methods

Research Data Acquisition

This EV landscape research was conducted from February through May 2020. Informational data came in the form of conversations with local energy experts, government officials, Town Board members, and the Town Clerk. I participated in a facility tour of the Syracuse University Center of Excellence for Environmental and Energy Systems and Syracuse University's Energy Systems and Sustainability Management department to explore charging systems and future University plans. I met with the Director for the Autonomous Systems Policy Institute (ASPI) to consider how autonomous vehicles might factor into charging station demand. I also conducted an extensive search of information from state and federal agencies, other municipalities, academic research, periodicals, energy-related publications and electric vehicle industry research.

A presentation was delivered to the Town of Manlius Board on February 26, 2020 to introduce the research project and briefly share initial findings. The presentation included a descriptive definition of EV's, a charging station overview, the benefits of EV's and a summary of research questions. I provided data on the growth of EV ownership within the town by zip code over a five-year period. I described the funding sources utilized when making a family EV purchase. I also described the survey purpose and shared sample questions. The board supported collaboration on the project to strengthen its sustainability and comprehensive planning efforts. It approved inclusion of the, "Town of Manlius EV Survey" on the Town of Manlius website. In addition, it would support other means to share the survey link for which I am grateful.

The EV Survey was developed in conjunction with Professor Saba Siddiki and with support from Chris Carrick from the CNY Regional Energy Center. Both are experts on electric vehicle efficiency and infrastructure. The survey, delivered using the Survey Monkey online platform, collected data from residents living in the Town of Manlius only. Non-residents were screened out during initial questions. Links to the survey are available on the Town of Manlius website, Town of Manlius Facebook page, text blasts, through neighborhood Facebook groups and town residents sharing the survey link. Additional efforts to communicate the survey link were made in conjunction with Earth Day's 50th Anniversary on Wednesday, April 22, 2020. 187 responses were received in total.

The following actions were completed as part of this research using the data sets noted:

- Scope of EV ownership in the Town of Manlius using New York State vehicle registration data made available through the CNY Energy Challenge – a program of the CNY Regional Planning and Development Board
- Quantity, pricing, reliability, and locations of existing infrastructure within the Town of Manlius, Town of Dewitt and on the New York State Thruway using data available from the Alternative Fuels Data Center, ChargePoint, GoElectric, EVGo, PlugShare and NYS Thruway station locators.
- Incentives for municipalities were identified through the U.S. Department of Transportation, New York State Department of Environmental Conservation, and other private foundation websites.

- Federal (IRS Plug-in Electric Vehicle Credit) and New York State (NYSERDA Drive Clean Rebate) Incentives for potential EV owners were identified via state and federal websites.
- A summary listing of currently available EV's with specifications, pricing and availability was provided through the EV Car Explorer available from Drive Change Drive Electric

Research Project Findings

Research Question - ***How many EV's are currently owned by residents in the Town of Manlius?***

Current EV Ownership in the Town of Manlius

In order to estimate the scope of EV ownership in the Town of Manlius, I utilized EV Ownership Data by zip code provided by the CNY Regional Energy Challenge. This data is generated directly from the Department of Motor Vehicle Registration database and was updated in March of 2020. While the zip codes do not align perfectly with the town boundary, most of the data derived reflects Town of Manlius resident data. All the data reflects plug-in electric vehicles. PHEV reflects plug-in hybrid electric vehicles. EREV stands for extended-range electric vehicles distinguishing between the two types of plug-in hybrids. Total numbers are for plug-in hybrid vehicles are combined in the column (PHEV/EREV). EV simply stands for

electric vehicle, also known as a BEV or battery electric vehicle. There are 218 plug-in electric vehicles registered to owners in the zip codes noted within the Town of Manlius.

Table. 2 EV Ownership by Zip Code in Town of Manlius

Location	Zip Code	PHEV/EREV	EV	EV Total
Fayetteville	13066	41	43	84
Manlius	13104	59	41	100
E. Syracuse	13057	26	11	34
Kirkville	13082	6	1	7
Minoa	13116	3	0	3
Total for Zip Codes		123	95	**218**

Table 2. Electric Vehicle Ownership in the Town of Manlius as of March 2020

Research Question: What is the current landscape of EV infrastructure within the Town of Manlius and its resident's commuting area?

Current Landscape

To identify quantity, pricing, reliability, and locations of existing infrastructure I conducted a web search of potential sources. Several websites provide on-the-spot access to EV charging station information. In addition, some have downloadable Apps available that can be

used for traveling. I reviewed: ChargePoint, EVGo, GoElectric, New York State Energy Research and Development Authority (NYSERDA), the New York State Thruway Authority and the Alternative Fuels Data Center in order to gather detailed information and cross-reference each location. Most provided instructions to locate the station, pricing information, working condition and comments from users. Several of these sites also provide an indicator as to whether the station is currently in use or available for charging. This helps to support in-route decision-making.

Charging stations that are accessible and available within the Town of Manlius are extremely limited. I have also included the Town of Dewitt (Table 4) and the Village of Cazenovia (Table 5) due to their proximity to the Town of Manlius. You'll note that while there are five charging stations shown in Table 3 within the Town of Manlius, not all are available for public use, operating efficiently, or priced reasonably.

Table 3. – Existing Charging Stations within the Town of Manlius

Location	Location Detail	Charger Description	Price	Hours of Availability	Comments
215 Brooklea Dr.	Village Lot on Brooklea Dr.	Level 2 1 station, 2 ports	Free	Always Open	Unit is powered off/unavailable (10 user comments)
Towne Center - Fayetteville	599 Towne Dr. Units located on Burdick side of lot	Level 2 3 single port stations	.49 cents/KWH	Always Open	Priced higher than gas equivalent.
Green Lakes State Park	7900 Green Lakes Road & 8265 Green Lakes Park Terrace Fayetteville	Level 1, 2 ports at each location	$8 parking, Free Charging	Unknown	May be seasonal

Location	Location Detail	Charger Description	Price	Hours of Availability	Comments
Romano Ford	5431 Burdick St. Fayetteville	Level 2 stations outside service area	Free	Not readily available	Units not powered. Gas cars parked blocking chargers frequently noted.
Mercedes-Benz of Syracuse	5433 N. Burdick St.	Dealership with single non-network unit powered and unlocked.	unknown	unknown	No comments regarding usage.

Table 3. Electric vehicle charging infrastructure in the Town of Manlius

Table 4. – Existing Charging Stations within the Town of Dewitt

Location	Location Detail	Charger Description	Price	Hours of Availability	Comments
Dewitt Town Hall	5400 Butternut Dr. Dewitt	Level 2 2 stations, 2 ports	.35 cents/KWH plus charging fee	Always Open	n/a
Covanta Energy/National Grid	5801 Rock Cut Road Jamesville	Level 2 1 station, 2 ports	Free	Undetermined	Comments about lack of clarity as to whether public vs. private.
Saab Sensis	85 Collamer Crossings East Syracuse, NY 13057	Level 2, 10 stations	EV Connect	Always Open	n/a
Chili's Restaurant	3691 Erie Boulevard, Dewitt	Level 2, 1 station, 2 plugs	Free	Always Open	Many favorable comments and thank yous.

Table 4. Electric vehicle charging infrastructure in the Town of Dewitt

Table 5. – Existing Charging Stations within Cazenovia

Location	Location Detail	Charger Description	Price	Hours of Availability	Comments
Lakeland Park	11 Forman Street	2 outlets	Free	Dawn to Dusk Daily	Non-networked
Empire Farm Brewery	33 Rippleton Road	3 outlets	Free	Always open	Non-networked Frequently blocked.

Table 5. Electric vehicle charging infrastructure in the Village and area of Cazenovia

Research Questions: *Community Assessment – What are Manlius Residents' Perspectives on EV's? How familiar are residents with electric vehicles? What concerns, if any, do residents have about EV adoption? What concerns, if any, do EV owners have?*

Community Assessment Survey Data

A survey was administered using the online Survey Monkey Tool to gather data from town residents. A complete set of questions can be found in the Appendix of this document. Residents were required to answer the question, "Do you live within the Town of Manlius?" If they answered, "no" they would be redirected out of the survey in order to capture data specific to town residents only. Next, they were asked to provide their zip codes providing additional information about the residence of respondents. The subsequent question, "Do you own an

electric-powered vehicle (EV)?" led them to two different paths based upon a "yes" or "no" response.

EV owners received specific questions which applied to ownership experience and any concerns they might have. Non-EV owners answered questions to assess their familiarity with EV's, provide statistical information about EV's and to gauge potential interest in learning more or considering an EV lease or purchase. All respondents were asked for their work zip codes (as applicable) and provided with an opportunity to receive sustainability information or participate in sustainability efforts with the town.

Using the resident survey developed and delivered via the Survey Monkey online platform, I gathered data from 187 respondents. Of the 187 responses, 25 were current EV owners representing 11% of the 218 EV owners in the town. Non EV owners represented .5% of an estimated 32,000 residents.

Of the non-EV owners, 37% said they were "somewhat" familiar with EV's. 31% said they were, "not so familiar." Figure 3 on the following page illustrates responses for non-EV owners familiarity with EVs. A combined 68% had limited familiarity with EVs.

Figure 3. Survey Question and Responses for Non-EV owners - Familiarity

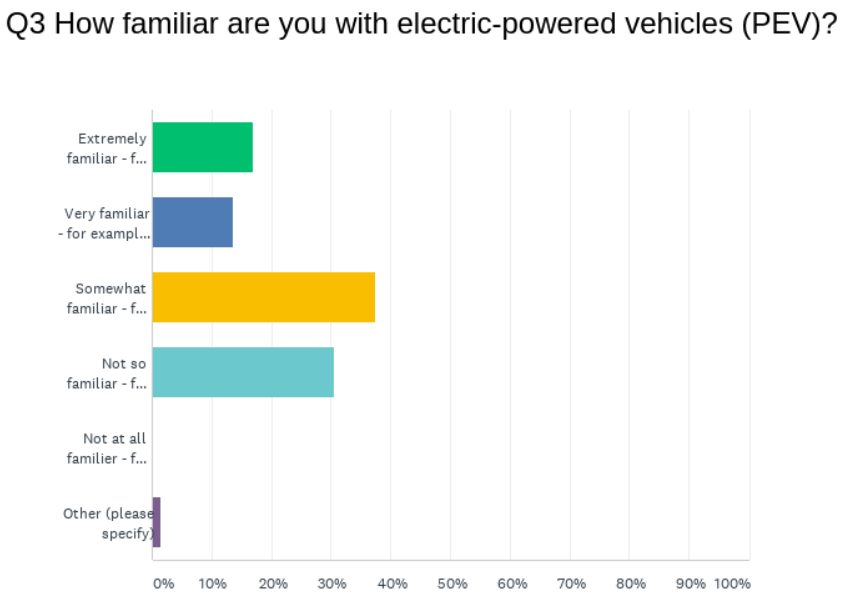


Figure 3. Familiarity of non-EV owners with electric-powered vehicles

Many non-EV owners may not be aware that (as a national average), the fuel for a gas-powered car is more than double the cost as that of an EV. The next survey question included research data from the University of Michigan Sustainable Worldwide Transportation Program (2018 study). The data was incorporated to provide contextual information specific to non-EV owners. "A gas-powered car costs 2.3 times as much as a battery-powered care per mile. How interested are you in learning more about electric-powered vehicles?" (Berman, 2018). Responses are illustrated in Figure 4.

Figure 4. Survey Question and Responses for Non-EV owners - Interest

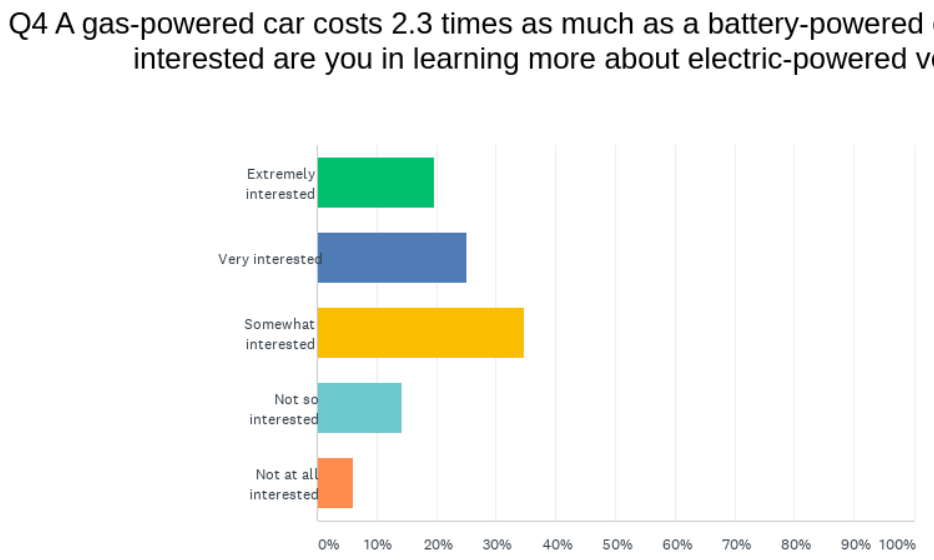


Figure 4. Interest of non-EV owners in electric-powered vehicles

20% of the respondents responded, “extremely interested.” 25% of the respondents were, “very interested.” This combination of responses (45%) at the two highest interest levels indicates that there is an opportunity to provide educational information about EV cost savings and other benefits explored further in this study.

In the subsequent question non-EV owners were provided with the following information. “The required fuel economy that gasoline vehicles would need to exceed for driving them to be less expensive than driving an electric car is 57.6 mpg in the United States,” (Berman, 2018). The objective was to make non-EV owners aware that despite higher up-front costs, battery-powered vehicles are less expensive per mile, and over the lifetime of the vehicle. It’s helpful to also note, as automobile commercials often state, “actual mileage may vary,” based

upon specific car models, gas prices at the time, driving habits and conditions. EV ownership inclusive of these variations still offers significant savings. 11% of the respondents said they were, "extremely likely" to consider leasing or purchasing and EV. 14% said they were, "very likely" to consider leasing or purchasing an EV. 45% said they were, "somewhat likely." Responses are illustrated in Figure 5 below.

Figure 5. Survey Question and Responses for Non-EV owners – Likelihood of Lease or Purchase of an EV

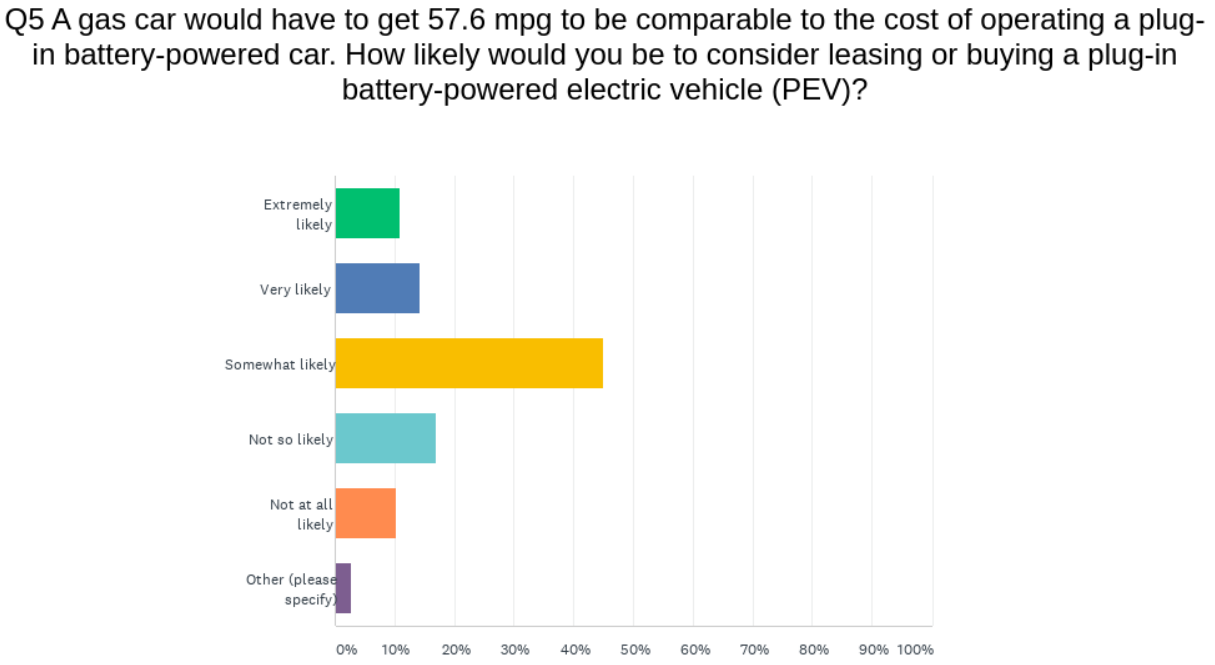


Figure 5. Likelihood of non-EV owners leasing or purchasing electric-powered vehicles

Non EV owners were asked, "Which options would encourage you to lease or purchase a battery-powered vehicle? (Please choose up to three options that are appealing to you.)" The top four selections that non-EV owners found to be most encouraging are:

- A subsidy to pay for a charger for my home (57% chose this)

- Tax deductions when I file my taxes (57% also chose this)
- Charging stations easily accessible from the highway and the main roads (53% chose this)
- Rebates – cash back when I buy my car (53% also chose this)

The highest responses relate to reducing the up-front costs of an EV. Not far behind, non-EV owners were concerned about the accessibility of charging stations as one of their top concerns. Federal tax credits for EV purchases and a $1,000 tax credits available for EVSE (charging equipment) available to consumers can be found in Table 6.

The next set of questions refers to EV owners. 25 EV owners responded to the survey. They were asked "Would you recommend an EV to a friend?" A rating of 1 star indicates that they are less likely to recommend an EV. A 5-star rating stars means that they are most likely to recommend an EV to a friend. The EV owners rated 4.9 out of 5 stars indicating that they are highly likely to recommend EVs to a friend.

In the subsequent question EV owners were asked, "What (if any) concerns do you have about owning an EV?" Their responses demonstrated the existence of "range anxiety," the EV equivalent of running out of gas. Town of Manlius survey respondents who owned EVs expressed views that were consistent with multiple studies.

EV owners ranked their top 3 concerns as follows:

- Number of available charging stations (65% chose this)
- Location of charging stations (52% chose this)
- Range of electric vehicles (48% chose this)

"Consumer surveys cite a very high percentage level of charging infrastructure as one of their key concerns," (Pew, 2019). Town of Manlius respondents reinforced this sentiment by identifying the number and location of charging stations as primary concerns. The following specific comments were also noted. One respondent identified a, "lack of DC fast chargers" as a concern. Another respondent said, "Public charging should cost less than gasoline equivalent."

"There is very good data that shows that [electric] vehicle adoption is slowed by a shortage of charging infrastructure," Stanberry, (2019) said. This is supported by 53% of non-EV owners selecting a concern for, "Charging stations easily accessible from the highway and the main roads." This theme will be explored further in the study.

Finally, all respondents were asked to enter their work zip codes (if applicable). Survey data with workplace zip code locations was limited. Some respondents indicated that they did not work outside the home. Others skipped this question. The predominant zip codes provided, however, include: 13066, 13057, 13104, 13202, 13210, and 13244. The first three are within the Town of Manlius. The second two are in Syracuse. Greater research is needed to definitively identify charging station location needs at the workplace to best meet resident needs.

Research Question: ***What incentives are in place to encourage consumer adoption?***

Consumer Incentives

New York State has implemented policy to support and encourage EV adoption as part of its climate mitigation efforts. The Drive Clean Rebate for Plug-In Electric Vehicles is a New York State program and part of Governor Andrew Cuomo's Climate Initiative. It is designed to

reduce overall vehicle emissions particularly in urban centers of the state. Consumers may choose from over 40 EV models and receive a $2,000 credit at the time of lease or purchase.

Table 6. – Incentives for Consumers to Purchase Plug-In Vehicles

Source	Type	General Information	Amount Available
New York State	Drive Clean Point-of-Sale Rebate	For Plug-In Hybrid and Plug-In EV	$2,000
IRS Federal Tax Credit	Plug in Electric Drive Vehicle Credit	For plug-in electric vehicles with at least 4KwH recharged from an external source. Phased out when manufacturer sells 200,000 qualified vehicles.	$2,500 up to $7,500 depending upon the battery capacity
Federal Alternative Fuel Tax Credit	Infrastructure	"Fueling" equipment for alternative fuels including electric.	$1,000 for consumers

Table 6. Consumer Incentives

Research Question: ***What is the case for EV's supporting climate change mitigation efforts?***

The Case for EV's

A typical gas-powered vehicle emits about 4.6 metric tons of carbon dioxide per year according to the EPA. This calculation is based on fuel economy of about 22.0 miles per gallon and 11,500 miles driven per year. Every gallon of gasoline burned creates about 8,887 grams of CO_2. It emits Methane (CH_4) and nitrous oxide (N_2O) from the tailpipe and hydrofluorocarbon from leaking air conditioners. Methane and nitrous oxide have higher global warming potential (GWP) than CO2 (EPA). These greenhouse gas emissions contribute to the concerns raised by scientists across the globe.

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. It produces ongoing reports with climate change rates, socio-economic impacts, risks and global recommendations to mitigate climate change. Full reports can be found on their website https://www.ipcc.ch/. This source serves as a resource for further reading, information and data.

According to the New York State Department of Environmental Conservation (NYSDEC), warming trends continue in New York State. These observations include rising temperatures, rising water levels along the coast of New York State, increased winter precipitation, reduced summer precipitation, a rising number of extreme precipitation events, earlier bee migration and bird migration shifting northward. A visual summary of indicators is provided in Figure 6. According to the DEC, "undesirable climate change impacts frequently outweigh the possible benefits. Impacts are projected for public health, natural resources, agriculture, transportation, tourism, water supply and quality, public infrastructure, energy, and many other sectors," (2020). Small changes that have been occurring over time as a result of greenhouse gases have a negative cumulative impact on our well-being. A visual look at indicators of a warming world is shown on the following page in figure 6.

Figure 6. Indicators of a Warming World Physical Observations of Rising Temperatures

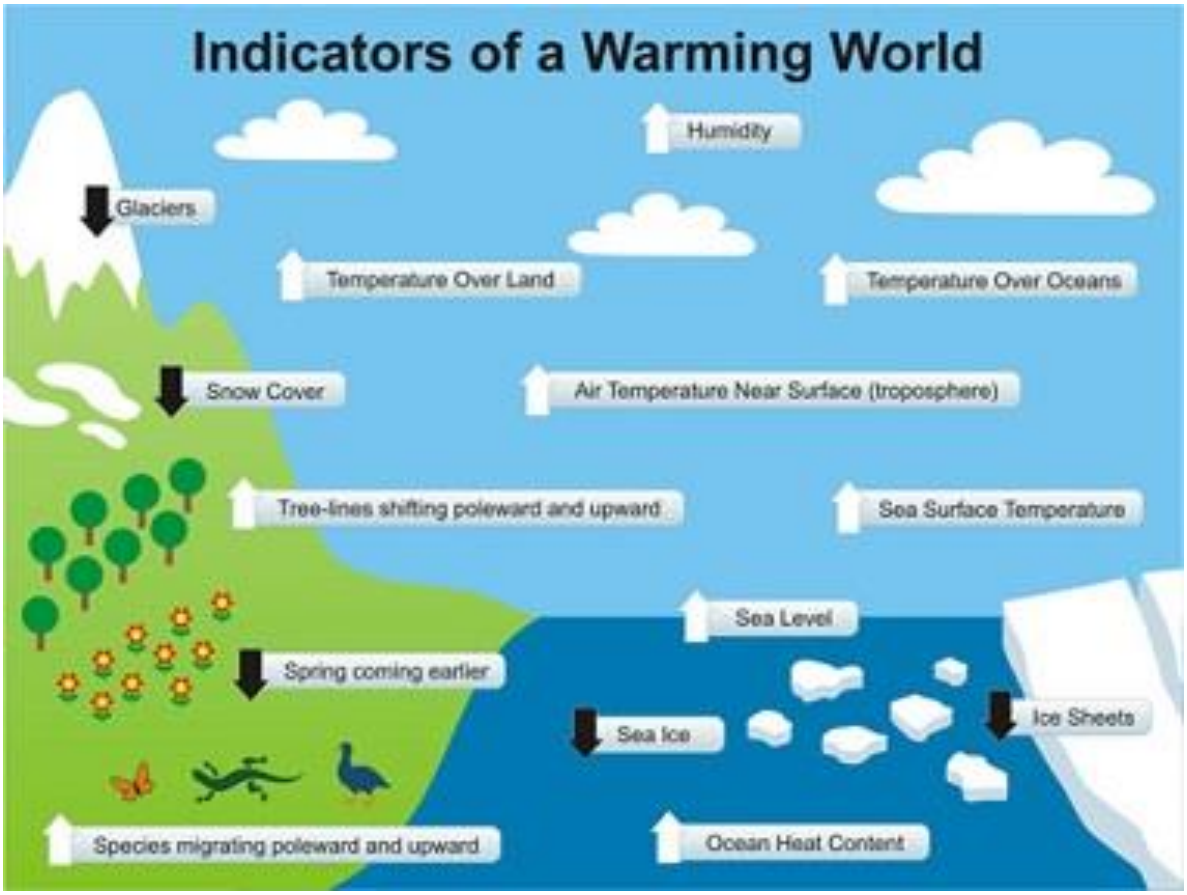


Figure 6. Warming World Indicators Courtesy of Skeptical Science and the NYSDEC

The DEC and other organizations researching these patterns stress that we do have the ability to reduce greenhouse gas emissions through a combination of renewable energy and clean energy programs. The Transportation Climate Initiative (TCI) is a collaboration of twelve states in the Northeast and Mid-Atlantic region, including Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Delaware and Virginia. Together the states of the TCI region represent a population of 72 million people with a GDP larger than any country other than the United States and China, (Gatti, 2019).

The following quote captures the Transportation Climate Initiative's Memorandum of Understanding highlighting the significant contribution of transportation emissions.

> "The transportation sector is currently responsible for more than 40 percent of climate-changing greenhouse gas emissions in the region, and soot and smog from cars and trucks are major contributors to lung disease and other health problems region-wide, particularly in low income communities. Preliminary modeling estimates that by 2032, the proposed program could yield monetized annual public health benefits of as much as $10 billion, including over 1,000 fewer premature deaths, and over 1,300 fewer asthma symptoms annually region-wide, among other safety and health benefits. "
>
> *Transportation Climate Initiative Memorandum of Understanding. 2012*

TCI states are collaborating to address the largest source of pollution in most of the TCI states - transportation. According to more recent data (TCI), transportation is responsible for 44% of global warming emissions in the region. "Our cars are trucks are also a leading source of particulate matter pollution that causes thousands of asthma attacks and preventable deaths each year," (Gatti, 2019). Unchecked, our public health, natural resources, agriculture, tourism, water supply and quality, and public infrastructure will continue to be impacted by transportation emissions.

Significant opportunity exists to mitigate climate change by reducing transportation emissions with a transition away from carbon-based fuel sources. "If national governments want to hit the aggressive emissions reductions targets they have set, a stronger policy push will be needed to accelerate adoption," (Bloomberg NEF, 2019). Policy efforts are needed at every level - nationally, regionally, state-wide and locally.

Each level of government has an opportunity to have an impact. At the town and village levels, engaging the public with information and learning forums can contribute to knowledge and action that can bring about lasting change. According to UCS (2017), efforts can be made at the local level to streamline the permitting process for home charging installation. Working with utilities on electric rate pricing and clean energy also serves to support a climate receptive to change. Other efforts include improving and supporting the process to install charging units at workplaces and apartment settings, providing information and serving as a resource.

Research Question - What are the costs and benefits of battery-powered electric vehicles to individuals and the community?

Costs and Benefits of EVs

EVs run on electricity only. They significantly reduce emissions. They are propelled by one or more electric motors powered by rechargeable battery packs. EVs have several advantages over gas-powered vehicles according to FuelEconomy.Gov. They are:

- **Energy efficient**
- **Environmentally friendly**
- **High Performing – they drive quietly, ride smoothly and have greater acceleration**
- **Less energy dependent on fuel imports**

According to FuelEconomy.Gov, battery-powered electric vehicles, (BEV's or EVs), "convert over 77% of the electrical energy from the grid to power at the wheels. Conventional

gasoline vehicles only convert about 12%–30% of the energy stored in gasoline to power at the wheels." This difference in energy utilization is significant. In addition, EVs use regenerative braking to recapture and reuse kinetic energy that is normally lost when braking. They do not use electricity when idling. This combination of efficiencies allows electric vehicles (EVs) to save money and reduce energy waste.

Compared to gasoline-powered cars, EVs cost fifty to seventy percent less to operate per mile (Energy Challenge CNY). They require less maintenance thereby reducing operational costs. The U.S. Department of Energy website: https://www.fueleconomy.gov provides side-by-side comparisons of specific models of gas to electric vehicles. A summary of the costs and benefits of EVs can be found in Table 7.

For many individuals, the high up-front cost of EVs is a significant concern. While rebates and tax credits can alleviate that burden for some, individuals in the lowest socio-economic groups will still not find EV's affordable at current pricing. We continue to see advancements in battery technology contributing to reduced costs. Up-front costs are expected to reach parity with gas-powered vehicles within this decade. Additional savings can be found by timing electric car charging to maximize off-peak rates.

The spread in popularity of EVs also has the potential to impact gas stations as the dependence on gas decreases. While some oil industry experts point to low EV adoption rates, adoption is expected to increase as the price of EV cars continues to drop. Creativity in re-deploying gas stations for EV fleets and other purposes should be considered as this transition occurs.

Table 7. Electric Vehicles Benefits and Costs for Owners and Society

	Benefits	Costs/Issues
Internal (User Impacts)	Reduced cost per mile compared to gas-powered cars. Reduced cost over the life of the vehicle. Greater convenience – less maintenance trips.	Higher up-front costs at the present time
External Impacts (Impact on Others)	Reduced energy consumption and pollution/ No driving emissions. Reduced noise pollution/quieter. Increased safety – multiple braking options. Clean energy capacity is increasing.	Social equity concerns. Lack of availability to lower income individuals. Increased infrastructure costs. Potential impacts on area gas stations.

Table 7. Electric Vehicle Ownership Benefits and Costs

According to reports from the U.S. Energy Administration (2020), demand for natural gas will increase then level off by 2050. Demand for coal will continue to decrease. Slow growth in domestic consumptions of crude oil and petroleum will lead to more exports of the supply. Demand for renewable energy will continue to grow. The main sources of renewables are wind and solar contributing to growing industries. The dynamics of these continued shifts are worth exploring in additional research outside the scope of this study.

Vehicle Life Cycles

All vehicles have three distinct life stages regardless of how they are powered. They are manufacturing, operation, and end-of life. Both electric and gas-powered cars produce carbon dioxide during all three stages. Emissions vary for electric and gas-powered vehicles at each stage. I'll describe the differences below.

Electric vehicles produce more emissions during manufacturing due to the energy needed to make the battery. "Electric-vehicle batteries are larger than those used in gas-powered cars… While vehicles that run on gas tend to use lead-acid batteries, electric vehicles use lithium-ion batteries, like those found in cellphones and laptops. Lithium-ion batteries require a lot of energy to produce. So, too, does the extraction and refinement of metals like lithium, nickel, and cobalt," (Nealer, R., Reichmuch, D., Anair D., 2015). An additional concern relates to labor from mining minerals according to Broom, (2019). Efforts are being made to use recycled cobalt and limit sources from North America only, (UCS, 2019).

"Studies have shown that in the US, Europe, and in China, producing an electric vehicle creates more greenhouse-gas emissions than producing an equivalent gas-powered vehicle," (Mastouk, 2019). This research has been cited as a reason to abandon EV production and maintain the status quo. This has been perpetuated particularly by the oil and gas industry. This, however, misses a critical feature. Despite producing more emissions during the production stage, electric vehicles still pollute far less than gas-powered cars over the course of their lifespan.

While current EV battery production contributes to greater emissions, "the extra emissions associated with electric vehicle production are rapidly negated by reduced emissions from driving," (Nearer, R., Reichmuch, D., Anair D., 2015). Once in operation, battery-powered vehicles far out-perform gas-powered vehicles. They are vastly more efficient and emit less carbon. EVs realize significant emissions savings when driven compared to gas-powered vehicles more than making up for production emissions.

Another important factor to look at is the source of electricity providing power for EV charging. While EVs emit no tailpipe pollutants, power plants producing the electricity may contribute to emissions. While this is true, it is still the case that "driving the average EV is responsible for fewer global warming emissions than the average new gasoline car everywhere in the US. In some parts of the country, driving the average new gasoline car will produce 4 to 7 times the emissions of the average EV," Reichmuth (2020).

On a national scale, "driving the average EV produces global warming pollution equal to a gasoline vehicle that gets 88 miles per gallon (mpg) fuel economy. That's significantly better than the most efficient gasoline car (58 mpg) and far cleaner than the average new gasoline car (31 mpg) or truck (21 mpg) sold in the US," (Reichmuth, 2020).

Our region is cited specifically as an example in Reichmuth's 2020 study. He says, "the average EV driven in Upstate New York has emissions equal to a (hypothetical) 231 mpg gasoline car," (2020). This is attributed to electricity generated from clean energy sources such as nuclear, hydro, solar, and wind-powered plants that do not contribute to greenhouse gases (FuelEconomy.gov). Clean energy in our region allows us to realize even greater savings on emissions when switching to EV transportation.

Popp points out that, the "falling costs of wind and solar energy improved the competitiveness of these sources of electricity, leading to a rising share of energy coming from renewables," (EPA 2018). Demand from competitive pricing will continue to spark interest in renewable energy sources ultimately achieving even lower costs.

In summary, emissions from EVs are lower than gas-powered cars for several reasons. EV battery research has gained momentum contributing to increasing mileage capacity. Battery production methods and materials continues to evolve decreasing emissions. EVs outperform gas-powered cars in their efficient use of energy when driving and over the lifetime of the vehicle. And finally, the electric grid is getting cleaner, reducing emissions for both charging and manufacturing (Nealer, R., Reichmuth, D., Anair D., 2015).

Battery Recycling

One issue raised as a concern at the February 2020 Town Board Meeting is the potential for excess battery waste with the expansion of EV use. It is important to ensure that the overall net effect on the environment is a positive one. I found that research on EV batteries is vast with some raising alarms and other pointing to demonstrated research and practical solutions. I have identified two predominant approaches to handling used electric vehicle batteries. They are re-use (also referred to as "re-purpose" or "second life") and recycling (or essential materials recovery). Practically speaking both can be utilized. Repurpose first, then once "second-life" ends, recycling battery materials can further extend usability and reduce costs.

"Batteries for EVs are designed for extended life, and a study by DOE's National Renewable Energy Laboratory suggest these batteries may last 12 to 15 years in moderate climates and 8 to 12 years in severe climates," (FuelEconomy.gov). According to this study,

years 13 to 17 offer second battery life options. By 2025, “about three-quarters of spent EV batteries will be reused and then recycled to harvest raw materials,” Melin said (Stringer and Ma, 2018). This means automakers and battery producers can profit from the same component several times.

In the 2019 study (Harper, G., Sommerville, R., Kendrick, E. et al.), highlight preferences for recycling approaches. They state, “In the waste management hierarchy, re-use is considered preferable to recycling, in order to extract maximum economic value and minimize environmental impacts. Many companies in various parts of the world are already piloting the second use of electric-vehicle LIBs [lithium ion batteries] for a range of energy storage applications,” (Harper, G., Sommerville, R., Kendrick, E. et al., 2019).

Creative approaches can also be found in the EV industry literature. For example, “Toyota, maker of the Prius hybrid, will install retired batteries outside 7-Eleven stores in Japan next year. The hybrid batteries will store power from solar panels, and then use the juice when needed to help run the drink coolers, fried chicken warmers and sausage grills inside the stores. A typical EV battery retains about 50 percent to 70 percent of its power capacity upon removal, said Tom Zhao, managing director of global sales for BYD’s battery group,” (Stringer, D., Ma, J., 2018). This example illustrates a practical opportunity for additional use.

From the literature, companies are paying attention to the need for safe, commercialized processes for recycling or extracting materials from EV batteries. Some life-cycle analysts have said, “more efficient processes are urgently needed to improve both the environmental and economic viability of recycling, which at present is heavily dependent on cobalt content,” (Harper, G., Sommerville, R., Kendrick, E. et al., 2019). They say that careful handling and physical separation of battery materials will, “surely hold the key to the sustainability of the

future automotive industry," (Harper, G., Sommerville, R., Kendrick, E. et al., 2019). They cite EV batteries as a future resource for minerals not available in some countries. Tesla, as a standard practice, recovers materials from batteries for re-use in other vehicle batteries.

Here, I've identified a lithium ion battery recycling flow practiced by companies in five countries: Finland, France, Belgium, Germany and the U.S. illustrated in Figure 7.

Figure 7. Five Approaches for Lithium Ion Battery Recycling

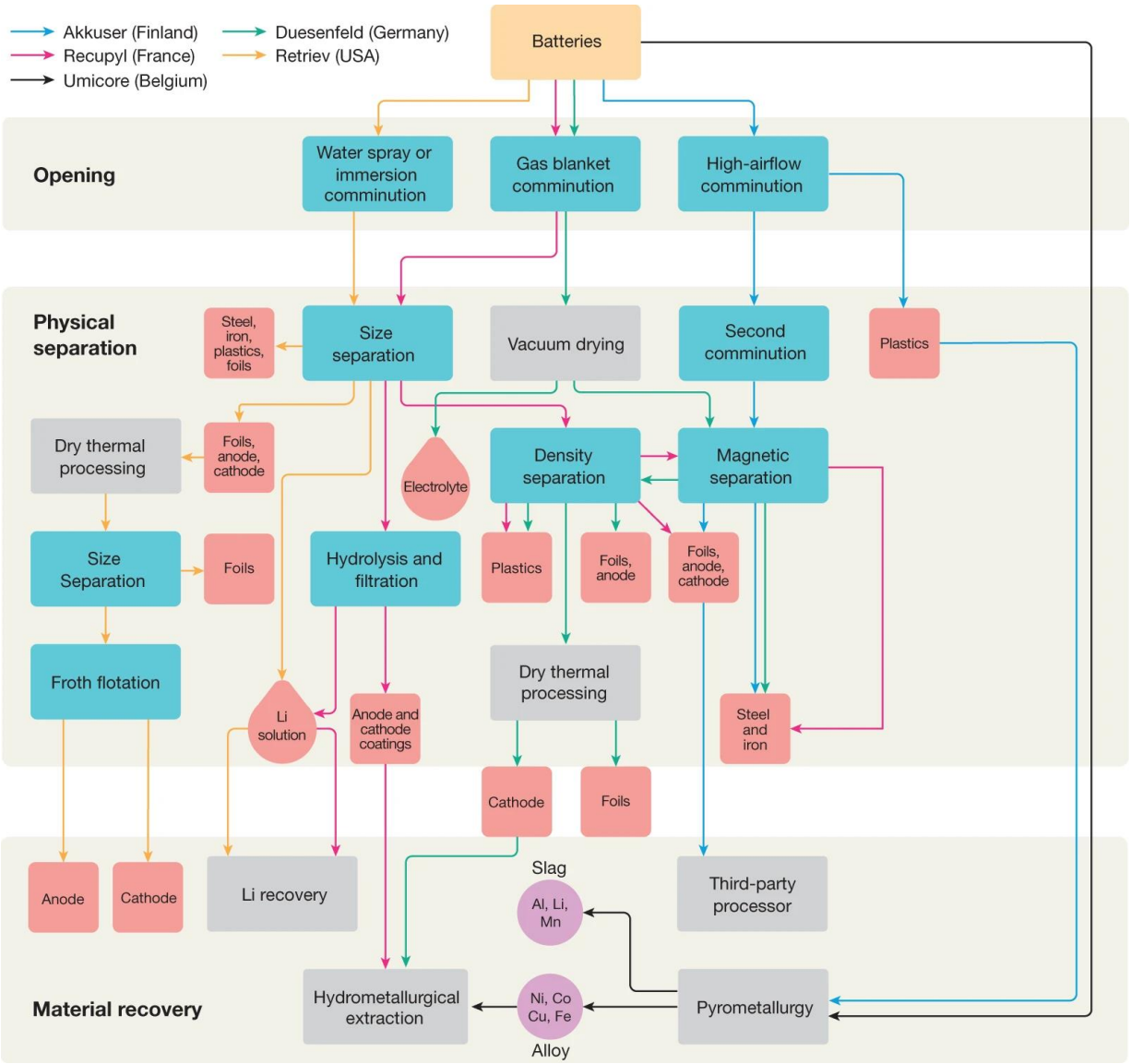


Figure 7. Lithium Ion Battery Recycling Finland, France, Belgium, Germany and the U.S.

The varied practices show distinct approaches to opening, physical separation and material recovery. Significant research on these methods are available in the literature for further exploration. “Uncertainty on the fate of used electric vehicle batteries is often cited as a challenge to future vehicle electrification efforts... Batteries can be recycled economically with technologies available today. Future systems could further reduce pollution, climate emissions, and finite resource depletion associated with the battery life cycle,” according to Broom, (2020). While challenges have been raised, much attention is being given to addressing these challenges in constructive ways paving the way for continued EV adoption and significant reductions in emissions.

Research Question: ***What are the anticipated demands for EV infrastructure?***

Projecting Electric Vehicle Charging Infrastructure Demand

Battery prices keep falling.

As a result, we expect price parity between EVs and internal combustion vehicles (ICE [gas-powered]) by the mid-2020s in most segments, though there is wide variation [globally] between geographies and vehicle segments.

Electric Vehicle Outlook 2019, BloombergNEF

“When considering the typical diffusion of technology, electric vehicles are still very much in the early adopter stage,” according to Holland, Liebman, and Teixeira, (2019). Figure 8 illustrates the stages of adoption for technological innovations. Innovators (2.5% of the

population) are generally risk-takers and prefer the newest technology. Early adopters (13.5%) begin to see the benefits that innovators are enjoying and are willing to try out new technology once they've seen the initial benefits. The early majority (34% of the population) waits until a technology is more mainstream before they make a purchase. Late majority and laggards follow.

Figure 8. Diffusion of Innovation – Adopter Categories

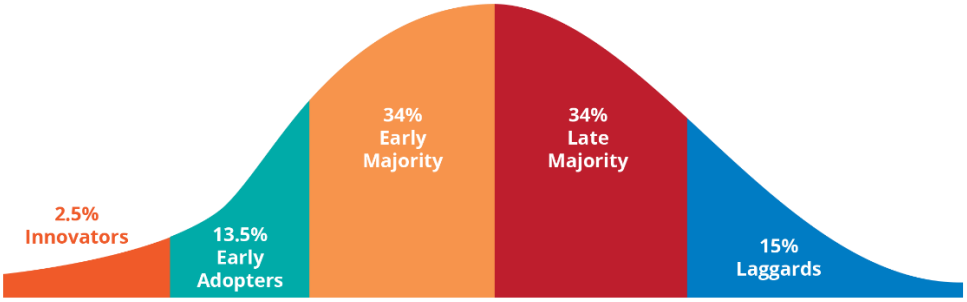


Figure 8. Technology Adopter Categories

Since up-front costs have been a barrier for many, the EV will become more appealing when it reaches parity with gas-powered vehicles. According to Plumer, between 2025 and 2030, "plug-in vehicles will become cost competitive with traditional petroleum-powered cars, even without subsidies and even before taking fuel savings into account. Once that happens, mass adoption should quickly follow," (2017). Purchases of electric vehicles grew 81% from 2017 to 2018 with the increase of available models. Nearly 1.2 million EVs on U.S. roads today contribute to energy-efficiency. Owners also have one big worry in common: where to plug in. (Pew, 2020).

According to Bloomberg NEF, individuals are more likely to adopt EV technology when there is charging ability at home. Workplace, public charging and highway fast charging are other needed infrastructure components. Nicholas, Hall and Lutsey refer to an, "ecosystem of charging outlets… matched to complex driver charging behavior. While the vast majority of

electric vehicle charging is and will continue to be at home, public and workplace charging options allow drivers to take advantage of the times and places where electric vehicles are parked," (2019).

An estimated 78% of homes within the Town of Manlius are owner-occupied according to the U.S. Census Bureau 2018 statistics. This indicator suggests that many of our Town of Manlius residents will have the option to install EV home charging. This helps to cross one barrier to having a consistent and reliable source for power. Again, incentives to assist with this step are found in Table 6. To complement home charging and build a comprehensive charging ecosystem for residents and travelers, varied charging options are needed.

To look at expected demand I reviewed a national study conducted in 2019 by the International Council on Clean Transportation (ICCT). The authors utilized expected electric vehicle growth rates and applied charging assumptions based on observed behavior across metropolitan areas. They then quantified the amount of charging infrastructure required to serve the growing U.S. electric vehicle market. The study has been described as, "a metropolitan area-level model to estimate the needed growth in the charging infrastructure," (Nicholas, Hall, Lutsey, 2019).

Using the ICCT model, infrastructure demand was projected for all 100 markets reviewed for 2025. Areas were assessed to determine how their infrastructure measured against projected need. According to the study, most of the U.S. top 100 metropolitan areas are behind in meeting projected infrastructure needs for 2025, (Nicholas, Hall and Lutsey, 2019). Across the top 100 metropolitan areas, the necessary average annual growth rate for all charge points would have to be 20% to meet 2025 targets. "Examining the various charging types separately, the annual growth rate would have to be 15% for DC fast charging, 16% for public Level 2, and 28% for

workplace," (Nicholas, Hall and Lutsey, 2019). This represents a significant national investment in infrastructure.

Infrastructure for Syracuse/Central New York shows a sizeable gap between estimated need compared to what is available in our area. According to Nicholas, Hall and Lutsey, (2019) our region currently has 21 to 30% of charging stations in place to meet the need in 2025 – a mere five years off. This can be seen in the peach-colored area on the map in Figure 9. Achievement of this goal will require comprehensive planning and execution to meet this need.

Figure 9. Five Year Charging Infrastructure Percentage of Need for 2025

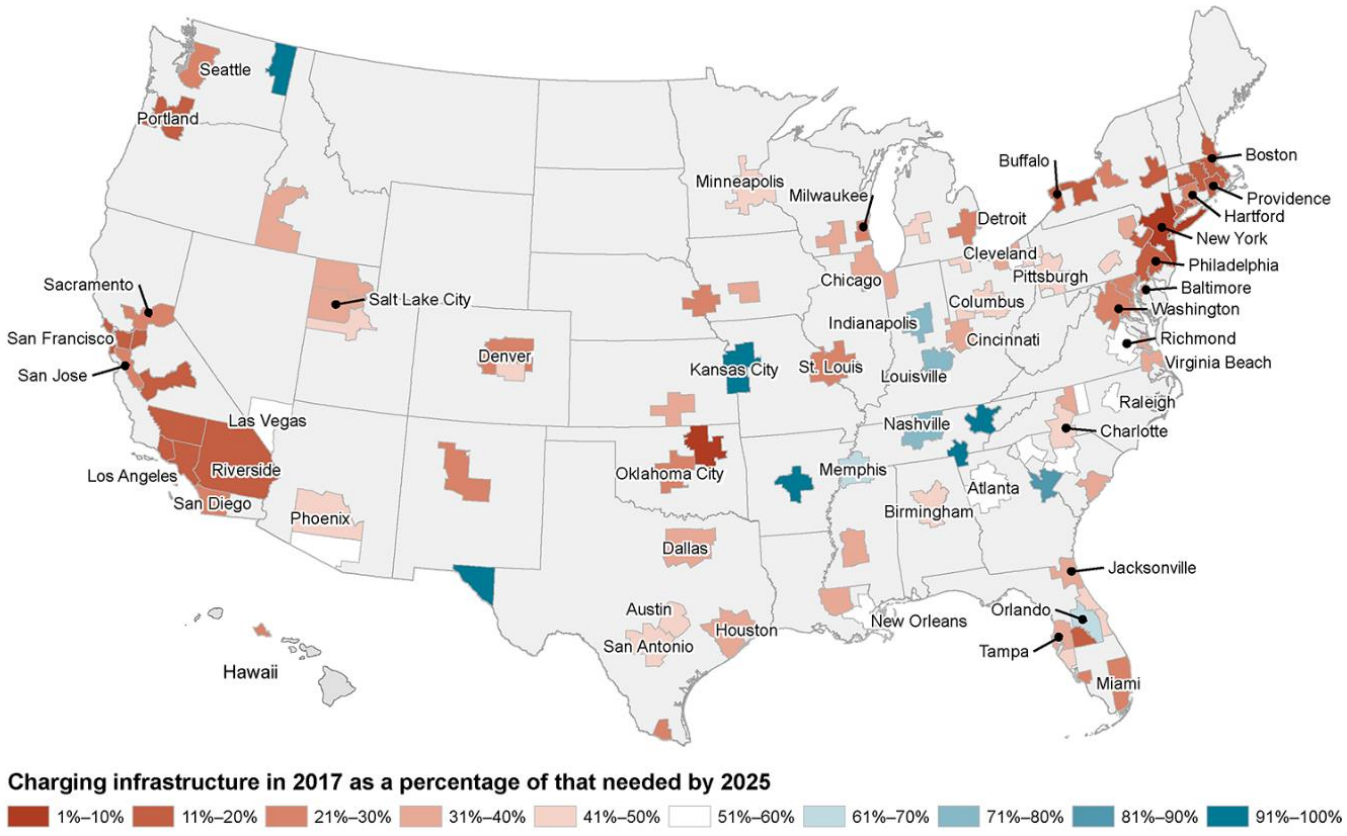


Figure 9. Charging Infrastructure Nationwide as a Percentage of What's Needed in 2025- International Council on Clean Transportation – ICCT - 2019

For a region that relies heavily on tourism for revenue, available charging infrastructure for visitors is imperative for continued economic growth. According to the NYS Regional Council 2019-2020 Central New York Progress Report, 13.6 million tourists visited Central New York in 2017. The tourism industry remains one of the largest employers in the region with 40,000 individuals employed. Efforts by the CNY Regional Development Council continue to place emphasis on this economic engine for future growth. Tourism remains a strategic focus and one of our areas strongest industry growth strategies according to the report. A well-networked infrastructure is appealing to EV owners seeking area amenities and natural resources including those in and around the Town of Manlius.

Research Question: ***What is the current landscape of EV infrastructure in the Town of Manlius and surrounding area?***

Existing Electric Vehicle Charging Infrastructure

In New York State there are currently 46,748 electric vehicles on the road according to NYS Registrations (NYSERDA). At the center of New York State, Central New York is an important travel area for traffic north to Canada, as well as south to Pennsylvania and NYC. Travelers navigating East and West pass through CNY between NYC and Buffalo. I researched the availability of DC fast-charging stations along the Syracuse region of the I-81 corridor and along the New York State Thruway.

The Alternative Fuels Data Center (AFDC) from the U.S. Department of Energy has recommended an allowance of 50 miles between DC fast-charging stations. The "Corridor Measurement Tool" available on the AFDC website provides DC fast-charger identification to assist travelers. If one looks for a NYS charging station along the I-81 corridor south of Syracuse using the, "Corridor Measurement Tool," you would find a charging station south of Syracuse at the Southern Tier Welcome Center (northbound lane). North of Syracuse you would find a fast-charging station in Alexandria Bay, one mile from the highway. The distance between these two stations along the primary north-south corridor in New York State is 177 miles, triple the federal recommendation. DC fast-charging options are insufficient on the primary north-south axis located in Central New York.

The NYS Thruway is the primary corridor for travelers east and west within New York State. If one looks for a NYS Thruway charging station using the, "Corridor Measurement Tool," for highway access to the east of Syracuse you would find a fast-charging station at the Denny's/Red Roof Inn in Herkimer. It is .2 miles off the highway. The fast-charging station to the immediate west of Syracuse off the Thruway located in Waterloo, NY is 5.1 miles from the highway at the Waterloo Premium Outlets. The distance between these two stations is 106 miles. These two stations located in the center of NYS are more than double the federal recommendation of 50 miles between accessible fast-charging stations. This is a significant deficit.

Matthew J. Driscoll, Executive Director of the Thruway Authority said**,** "The New York State Thruway's 570-mile system is essential to the vitality of our state's economy by providing safe and reliable travel through the Northeast, and with these additional charging stations, we hope to soon be one of the greenest superhighways in the nation. We are proud to support

Governor Cuomo's mission of getting more electric vehicles on the road through the Charge NY initiative."

While New York State's hopes are to achieve a green super-highway system, the current reality does not match. Table 8 provides a list of the available charging stations along the New York State Thruway - easily accessible at Welcome Centers and Service Areas. Charging station information available on the Thruway website include station in-use availability and lists a maximum charge of $8. All are located in the Albany-NYC corridor with the exception of the Mohawk Valley Welcome Center. This is an important, but limited corridor. For New York State to truly realize its green highway goals and foster EV adoption, it MUST expand available fast-charging stations along its main thoroughfare at multiple points West of Albany in accordance with federal recommendations.

Table 8. – Existing Charging Stations on the New York State Thruway

Location	Location Detail	Charger Description
Plattekill Service Area	I-87 NB between Exit 17 (Newburgh I-84) & Exit 18 (New Paltz)	Chademo and SAE Combined Fast Charger - 1 station
Malden Service Area	I-87 NB between Exit 20 (Saugerties) & Exit 21 (Catskill)	Chademo and SAE Combined Fast Charger - 1 station
Capital Region Welcome Center	I-87 NB between Exit 21B (Coxsackie/Rte 9W) & Exit 21A (Berkshire Section/Mass Pike)	Chademo and SAE Combined Fast Charger - 2 stations
Ulster Service Area	I-87 SB between Exit 20 (Saugerties) & Exit 19 (Kingston)	Chademo and SAE Combined Fast Charger -1 station
Modena Service Area	I-87 SB between Exit 18 (New Paltz) & Exit 17 (Newburgh I-84)	Chademo and SAE Combined Fast Charger - 1 station

Location	Location Detail	Charger Description
Mohawk Valley Welcome Center	I-90 WB between exits 28 (Fultonville) and 29 (Canajoharie)	Chademo Fast Charger -3 stations
Western New York Welcome Center	accessible from I-190 Exit 19 (Whitehaven Road) via Alvin Road	Chademo and SAE Combined Fast Charger - 3 stations

Table 8. Electric vehicle charging along the NYS Thruway

Research Question: ***Is funding currently available for municipalities?***

Municipal Funding

Research for federal, state-level, local and privately-owned resources to support municipalities yielded an array of options. Table 9 provides a snapshot of funding sources that include grants, rebates, technical assistance and financing. I've provided this information also in the Appendix by category as a guide for Town of Manlius officials.

Table 9. – Incentives for Municipalities to Expand Infrastructure

Source	Type	Specifications	Amount Available
NYSERDA Charge Ready NY	Rebate for Level 2 stations	For Level 2 stations installed in public, workplace, and multi-unit dwelling parking lots.	$4,000 per port (temporarily not receiving applications)
National Grid EV Charging Station Program	Level 2 and DC Fast Chargers	Offer up to 100% of electrical and charging equipment costs	TBD
Zero Emissions Vehicles (ZEV)	ZEV purchase or lease rebate Due 7/24/2020	NYS DEC Municipal ZEV funding provides cities, towns, villages and counties funding for ZEV purchases	$5,000 per vehicle

Source	Type	Specifications	Amount Available
Electric Vehicle Supply Equipment (EVSE)	Infrastructure Grant due 5/29/2020	NYS DEC Municipal ZEV funding provides cities, towns, villages and counties funding for infrastructure installation	$250,000 per facility
Building Blocks for Sustainable Communities	Technical Assistance	Strengthens local capacity to implement sustainable solutions – typically via workshops, public engagement, consulting for leadership and recommendations.	Technical assistance only
Clean Energy Communities – NYSERDA	Grants Due 9/20/2020	Grants to fund clean energy projects once 4 of 10 "High Impact Actions" are completed	$250,000
NY Green Bank	Energy Project Financing	Electric Vehicle Infrastructure is listed as an eligible technology	TBD
BUILD (formerly TIGER grants)	DOT national infrastructure investments	Merit-based program to fund transportation infrastructure projects.	TBD
NYS Pollution Prevention Institute	Grant	Funding available for collaborative projects for municipalities, non-profits, community organizations	$10,000 - $20,000
Rockefeller Family Fund – Environmental Projects	Grants	Emphasizes climate change public education efforts with national impact. Considers local approaches that can serve as national models.	TBD

Table 9. Municipal Incentives for Infrastructure

Research Question: ***What activities can the town undertake to promote and prepare for the growth of EV ownership?***

Recommendations Based on Project Findings

Based upon the research conducted in this study, I've developed recommendations in four categories. The categories are engagement, education, infrastructure and policy. The four areas work in tandem with each other. I'll describe options and considerations for each area.

Engagement

To support EV adoption and infrastructure development, public engagement in the process is important. From the survey data, 46 people provided their names and contact information in response to the question, "Are you interested in receiving more information or engaging in sustainability efforts in the Town of Manlius?" This represents 25% of the survey respondents. This offers an opportunity to involve residents in town government. Continued communication with this group is important to engage and sustain interest. This could include community discussions, events and planning efforts. These activities can take place in conjunction with the recently formed Sustainability Committee led by Town Councilors Kriesel and Denton. This committee has designated several sub-groups to address different aspects of sustainability. It includes an EV sub-group, as well as walking/biking trails, solar initiatives and other projects.

The newly introduced "open podium" forum prior to board meetings have fostered dialogue with the Town Board. Live-stream meetings have been successful in increasing

meeting attendance heightening public awareness of decisions. Combined, these actions help to give a voice to residents and provide a forum for positive action. EVs represent a change to what many residents are accustomed to seeing, driving and perceiving as typical. As part of any significant change process, communication and collaboration is important. When one considers change management principles, greater involvement increases the likelihood of making real, sustainable change.

Many experts live in our area with knowledge and interest in seeing their community grow and prosper. This capacity has not been tapped to its fullest potential and could be enhanced by tapping into the skills available with higher levels of involvement in town projects. For example, grant-writing professionals may be willing to donate time to assist with infrastructure grants preparation. Others may be willing to organize and promote events such as an EV-drive event. And others have the capacity to design and distribute educational information via social media and other avenues. Efforts to organize and utilize the talents of community members can bring greater capacity and results for the town. This can be achieved using volunteer management principles which I can describe in more detail in another forum.

The Syracuse Metropolitan Transportation Council (SMTC) points out that, “engaging the public early and often in the planning process is critical to the success of any transportation plan or program, and it is required by numerous State and Federal laws. Such legislation underscores the need for public involvement, calling on MPOs such as the SMTC to provide citizens, affected public agencies, representatives of transportation agencies, private providers of transportation, environmental organizations, tribal nations and other interested parties with a reasonable opportunity to participate and comment on transportation plans and programs. Metropolitan transportation planning public participation requirements are contained in CFR

450.316," (SMTC, 2019). In addition to meeting legal requirements, a collaborative approach leads to opportunities for connection, pride in one's community, as well as progress towards mitigating and reversing the effects of climate change.

Education

Educational efforts serve as a catalyst for change. One theme that clearly stood out in the research, is the lack of general information about EVs. Many non-EV owners are not familiar with how they work, how cost-effective they are or how they might be an important component of an overall solution to alleviate the impacts of climate change. Others have valid concerns about lack of infrastructure (addressed in the next section). "Reaching those broader audiences can be difficult due to a variety of real and perceived barriers. Cost, range anxiety, lack of charging infrastructure, unfamiliarity with the technology—these factors remain significantly more problematic in areas with comparatively lower exposure to, and availability of, electric vehicles (Holland, Liebman, Teixeira, 2019). Since EV's are not currently, "the norm" many are simply unfamiliar. Public education is the remedy for lack of information and familiarity.

Dealer education, however, is needed as well as consumer information. Muloughney points out that in order to equip dealers, "Education is key. One of the biggest impediments to putting more electric vehicles on the roads is the need for better education, both for the consumer and for the people tasked with selling the EVs. That's because electric vehicles are much different from their combustion counterparts, and potential customers have lots of questions," said Muloughney, (2020). PlugStar EV Sales Training Program, developed through a

partnership with James Madison University, is one potential resource. This online program provides dealerships with an overview of EVs, features, charging basics, utility rates and best practices. Utilizing this or other options helps sales staff knowledgeably address questions from the public.

The Town of Dewitt and other municipalities have offered opportunities in collaboration with EV groups for residents to view, ask questions, and test drive EV's. Test drive events may be combined with other educational initiatives. For example, informational displays about clean energy including the benefits of using solar or wind energy could also be available. Another example relevant to this study is EPA vehicle labeling. Labels are different for gasoline-powered vehicles, electric-powered cars and plug-in hybrids. This can be included in an educational program. Sample labels available through the EPA can be found in the Appendix of this document. Community forums provide the opportunity for conversation, EV education, interaction with the Town Board, committee recruitment, connection among town residents while advancing long-term sustainability efforts.

Infrastructure

Findings from the studies cited in this research paper demonstrate the need for a robust charging infrastructure or "ecosystem." This ecosystem is needed for current and future EV owners and is necessary to address both "range anxiety," and practical charging needs. The Nicholas, Hall and Lutsey study (2019) shows that our region capacity to meet 2025 infrastructure demands at a mere 21-30% of capacity. "Purchases of electric vehicles are

growing at an astronomical rate — an 81% increase from 2017 to 2018," (Pew). As a town, it's important to be prepared for an influx of EVs in our area in the next few years.

The Hall and Lutsey studies from 2017 and 2019 include the following important infrastructure themes as important considerations when local plans are developed.

- **Public charging infrastructure is a key to growing the electric vehicle market**.
- **There is no universal benchmark for the number of electric vehicles per public charge point. It varies market to market but must be at a level that provides reassurance.**
- **Multifaceted and collaborative approaches have been most successful in promoting early charging infrastructure buildout. (Hall and Lutsey, 2017)**
- **Much more charging infrastructure is needed to sustain the transition to electric vehicles.**
- **Planned infrastructure deployment activities are promising, but uneven.**
- **Increased charger utilization brings infrastructure investment opportunities. (Nicholas, Hall and Lutsey, 2019)**

The charging ecosystem should include available charging at all three levels to meet varied needs. Infrastructure provides charging capacity for individuals who do not have a charging station at home, and it allows people to supplement their home charging efforts. Comprehensive infrastructure creates a welcoming environment for EV drivers who live here and travel to our area. It's also an important component in supporting technological adoption. If potential EV drivers are fearful, they may wait to purchase an EV until greater buildout has occurred. To address climate change, an aggressive response with a comprehensive planning process is needed

to meet emissions targets. These efforts might be considered as part of the town's sustainability and comprehensive planning efforts.

Recommendations for Charging Station Locations

In this section I've addressed the question or where to place additional charging stations in order to build out infrastructure. The list of recommendations for charging infrastructure considers several elements from the research. It considers the need for building a charging, "ecosystem" that could incorporate multiple charging levels. It provides options in addition to home charging which are important in alleviating, "range anxiety." It includes recommendations at public facilities such as medical facilities, libraries and high-traffic shopping areas. It offers suggestions for workplaces, municipal buildings and highways. The recommendations that follow could be reviewed and discussed by the Sustainability Committee with a plan to prioritize and make recommendations to the Town Board. Recommendations provided are for the Town of Manlius (table 10) with additional recommendations in the adjacent Town of Dewitt (table 11). Both towns have an interest in supporting sustainability, making their communities a welcoming place for visitors, and a vibrant, thriving place to live. A robust infrastructure supports these goals. Locations within the town are listed with detail and descriptions.

Table 10 – Recommendations for Charging Stations within the Town of Manlius

Location	Location Detail	Description
Northeast Medical Center	4101 Medical Center Drive, Fayetteville	Medical facility and workplace
Fayetteville Public Library	300 Orchard Street, Fayetteville	Library
Manlius Public Library	1 Arkie Albanese Way, Manlius	Library

Location	Location Detail	Description
Minoa Public Library	242 N. Main Street, Minoa	Library
Carriage House and Suburban Park Apartments	Routes 173 & 92, Manlius	Apartment Complexes
Craftsman Inn and Suites, Craftsman Wood Grille	7300 E. Genesee St. Fayetteville	Lodging and Restaurant
Minoa Municipal Building	240 N. Main Street Minoa	Municipal Building
Lewis Park	Village of Minoa	Public Park

Table 10. Electric vehicle charging recommendations within the Town of Manlius

Table 11 – Recommendations for Charging Stations within the Town of Dewitt

Location	Location Detail	Description
Wegmans	6789 E. Genesee Street, Fayetteville	Shopping Center (also easily accessible from Route 481)
Marshalls Plaza	3401 Erie Boulevard E., Dewitt	Shopping Center
Dewitt Public Library	5110 Jamesville Road, Jamesville	Library
Excellus BCBS	333 Butternut Drive, Syracuse	Workplace
Bristol Myers Squibb	6000 Thompson Road East Syracuse	Workplace
Widewaters Group	Widewaters Parkway	Workplace
Route 481 Park and Ride	Off Thruway Exit 34A	Parking Area
Empower Federal Credit Union	900 Kinne St. East Syracuse	Bank with nearby shopping
Home Depot	5814 Bridge Street East Syracuse	Public shopping

Table 11. Electric vehicle charging recommendations within the Town of Dewitt

Workplace recommendations noted are for the Towns of Manlius and Dewitt only. Additional recommendations for charging infrastructure within the City of Syracuse would require additional data, conversations with City Officials and further research to best meet charging needs.

Public Policy

Public policy has the capacity to support EV adoption or discourage it. Popp, (2019) cites the importance of policy that supports green infrastructure. For example, research and development subsidies that support green technology promote innovation and new technology commercialization. Town officials can encourage, promote and support local green business ventures and work to communicate the benefits to the local community. Nearby sustainable municipal buildings include the Village of Skaneateles (net zero) and the Village of Minoa. The Syracuse University Center of Excellence combines green building technology, solar energy and EV charging capacity.

Policy makers at all levels of government can re-visit or adopt new policies and programs for increasing energy efficiency and the deployment of renewable energy. Options include renewable electricity standards, energy-efficiency resource standards, carbon-pricing mechanisms, tax incentives and other financial incentives.

At the local level there are options to review forms, procedures and accessibility of information for residents. The Sustainability Committee could gather information about sources for charging equipment and local electricians to install charging equipment. Documents and materials can be streamlined along with the permitting process for home charging installation.

Other efforts could include improving and supporting the process to install charging units at workplaces and apartment settings, providing information and serving as a resource. Working with utilities on electric rate pricing and clean energy also serves to provide a climate conducive to change.

Engaging the public with information and forums to learn are valuable contributors to bringing about change. "A major source of uncertainty is the extent of climate change over the next several decades, which depends largely on future policy choices and economic developments—both of which affect the level of total carbon emissions. As noted earlier, this uncertainty justifies more aggressive action to limit emissions and thereby help insure against the worst potential outcomes," (Hamilton Project on Climate Change, 2019).

Project Implementation Plan

The following guidance serves as a starting point and as a catalyst for further brainstorming. Recommendations can be discussed among the sustainability groups, town board and public forums. Recommendations include developing a tracking method for all plans and activities to effectively facilitate progress in the four key areas: engagement, education, infrastructure and public policy.

Table 12. – Implementation Plan Recommendations

Category	Suggested Action	Suggested Individual(s) Responsible
Engagement	Identify sub-group to work on public engagement	Sustainability Committee
	Develop and prepare communication to go to interested survey responders	Sustainability Committee
	Post information about Sustainability Meetings	Staff/Town Clerk
	Develop a list of area activities to engage the public with information	Staff and Committee
Education	Identify sub-group to work on educational efforts	Sustainability Committee
	Develop an educational implementation plan	Sub-group
	Prioritize educational topics such as cost-savings, vehicle labels, charging information, etc.	Sub-group
	Identify EV owners willing to share their “stories”	EV sub-group

Category	Suggested Action	Suggested Individual(s) Responsible
	Identify and/or develop educational materials	Sub-group
Infrastructure	Prioritize and make recommendations for charging station locations	Town staff in conjunction with committee
	Partner with area business owners to collaborate on grant proposals or other funding	Town staff in conjunction with committee
	Identify grant writing team and specific funding sources to target	Town Staff in conjunction with Sustainability Committee
	Identify area licensed electricians for EV charger installation	Town Staff
	Identify vendors for EVSE/ charging equipment procurement	Town Staff with EV sub-group
Public Policy	Prepare a policy brief	I Gonzalez-McCurdy
	Review permitting process for EV chargers	Sustainability Committee
	Review forms and accessibility	Sustainability Committee
	Reach out to National Grid government affairs liaison	I Gonzalez-McCurdy
	Identify potential partners for policy initiatives and projects	Committee and Town Board

Other Potential Partners and Stakeholders

- Central New York Regional Transportation Administration/CNY Energy Challenge
- Center State CEO
- Villages of Minoa, Fayetteville and Manlius
- Town of Dewitt
- Clean Communities of Central New York

- Drive Change, Drive Electric
- Energetics Incorporated
- Federal Highway Administration
- Highway Safety Improvement Program (HSIP)
- New York State Department of Transportation
- New York State Energy Research and Development Authority
- Onondaga Department of Transportation
- Syracuse Community Geography
- Syracuse Metropolitan Transportation Council and DOT
- Urbanized Area Formula Grants

Appendices

Appendix A: EMPA Reflection

My initial interest in the EMPA program came from my desire to fine-tune my conflict resolution skills. As a career professional in workplace learning I have been called upon to facilitate dialogue and reconciliation among teams. Once at Maxwell I completed courses in Fundamentals in Conflict Studies, Interpersonal Conflict Resolution Skills and Mediation: Theory and Practice. This training proved useful to me both professionally and personally. It shed light for me on reasons for the polarization we see today. It also encouraged me to continue to utilize active listening skills and strive for collaboration.

As I progressed in my EMPA program I recognized that I could also explore a life-long interest in making the world a better place for more people. I was able grow and learn through the study of Governance and Global Civil Society, Ethics and Morality in Public Affairs, Mid-Career Training, and Public Diplomacy and Communication through the Newhouse School. Decisions and actions in one organization or locale has impacts that are felt as ripples across the

globe. As leaders and public officials, it is our obligation to consider our words and decisions carefully and thoughtfully.

The two courses most directly related to my research project include: Management and Planning of Public Infrastructure and Fundamentals of Policy Analysis. Both provided a macro-framework of how to consider public policy issues through principles, research and data analysis. By looking from a systems perspective it's possible to assess impact on other sectors. In both courses we looked at data-driven costs and benefits carefully to inform decision-making. I'm grateful to my employer Elmcrest Children's Center, and to Syracuse University and the Maxwell School for the opportunity to connect with and learn from brilliant, caring people. My world has been greatly enhanced by this experience. The information shared here briefly touches on ideas to consider for the sustainability of our community and our planet. It is my hope to continue this work and serve others for the greater good.

Appendix: EV Survey Questions for Town of Manlius Residents

Syracuse

Town of Manlius Residency

This survey applies to residents within the Town of Manlius. Please click "ok" to proceed. Click "Next" when you've finished answering a question. The survey will take 2 to 3 minutes to complete.

* 1. Do you live within the Town of Manlius? (This includes Kirkville, Fremont, the Villages of Fayetteville, Minoa, Manlius and the Town of Manlius). We are sorry we not able to gather input from other areas at this time.

- ◯ Yes
- ◯ No

Town of Manlius Electric Vehicle Survey

2. Do you own a plug-in electric-powered vehicle (PEV)?

- ◯ Yes
- ◯ No

Electric Vehicle Owners Only

Syracuse

Would you recommend an electric-powered vehicle to a friend?

(1 star is less likely, 5 stars is most likely)

What (if any) concerns do you have about owning an electric-powered vehicle. Check all that apply.

- ◌ # of available charging stations
- ◌ Location of charging stations
- ◌ Range of electric vehicles (# of miles the car can go when fully charged)
- ◌ Distance to work compared to distance on a fully charged battery
- ◌ Initial cost of an electric vehicle
- ◌ Other Factors (please specify):

Non-Electric Vehicle Owners

How familiar are you with electric-powered vehicles (PEV)?

- Extremely familiar - for example, "I have considered
- Very familiar - for example, "I've
- Somewhat familiar - for example, "My
- Not so familiar - for example, "I have
- Not at all familiar - for example, "What's an
- Other (please

A gas-powered car costs 2.3 times as much as a battery-powered car per mile. How interested are you in learning more about electric-powered vehicles?

- Extremely interested
- Very interested
- Somewhat interested
- Not so interested
- Not at All interested

A gas car would have to get 57.6 mpg to be comparable to the cost of operating a plug-in battery-powered car. How likely would you be to consider leasing or buying a plug-in battery-powered electric vehicle (PEV)?

- ○ Extremely likely
- ○ Very likely
- ○ Somewhat likely
- ○ Not so interested
- ○ Not at All interested

Which options would encourage you to lease or purchase a battery-powered electric vehicle? (Please choose up to three options that are appealing to you.)

- ○ Available charging stations at my workplace
- ○ Available charging stations where I shop.
- ○ Charging stations easily accessible by highways or main roads.
- ○ Preferred parking – parking for electric-powered cars closest to an entrance.
- ○ Discounted annual car registration fees.
- ○ Rebates – Cash back when I buy my car.
- ○ Tax deductions when I file my taxes.
- ○ A subsidy (cash) to pay for a charger at my home.
- ○ Other:

EV Survey Questions for ALL Respondents

How many miles is your round-trip commute to work?

- ○ I don't work outside the home
- ○ I work from a home office
- ○ 5 to 10 miles
- ○ 11 to 20 miles
- ○ 21 to 50 miles
- ○ Over 50 miles

What is your home zip code?

- ○ 13057
- ○ 13066
- ○ 13082
- ○ 13104
- ○ 13116

Please enter your work zip code (if applicable)

Are you interested in receiving more information or engaging in sustainability efforts in the Town of Manlius? If so, please enter your name and contact information. If no, please click "Next" to complete the survey. Thank you!

Name

Comment

Email Address

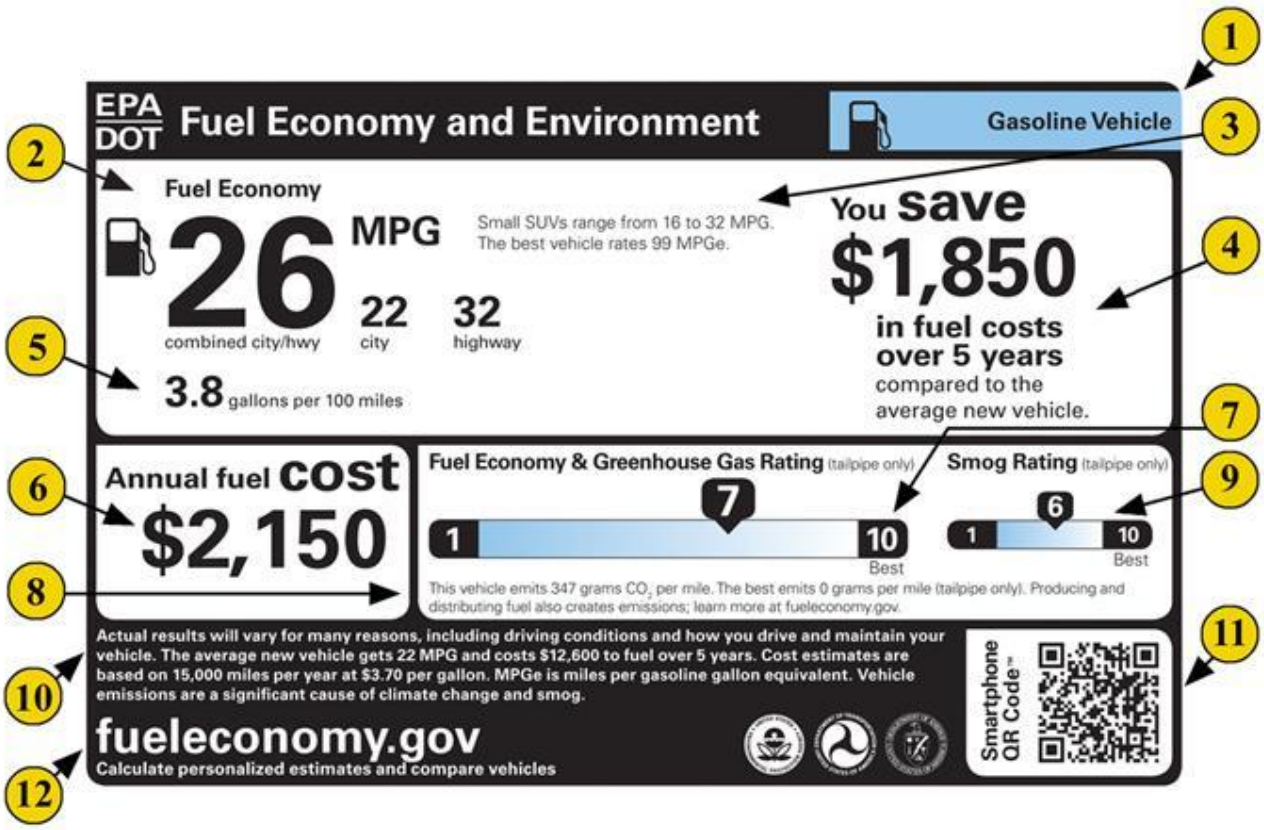
Phone Number

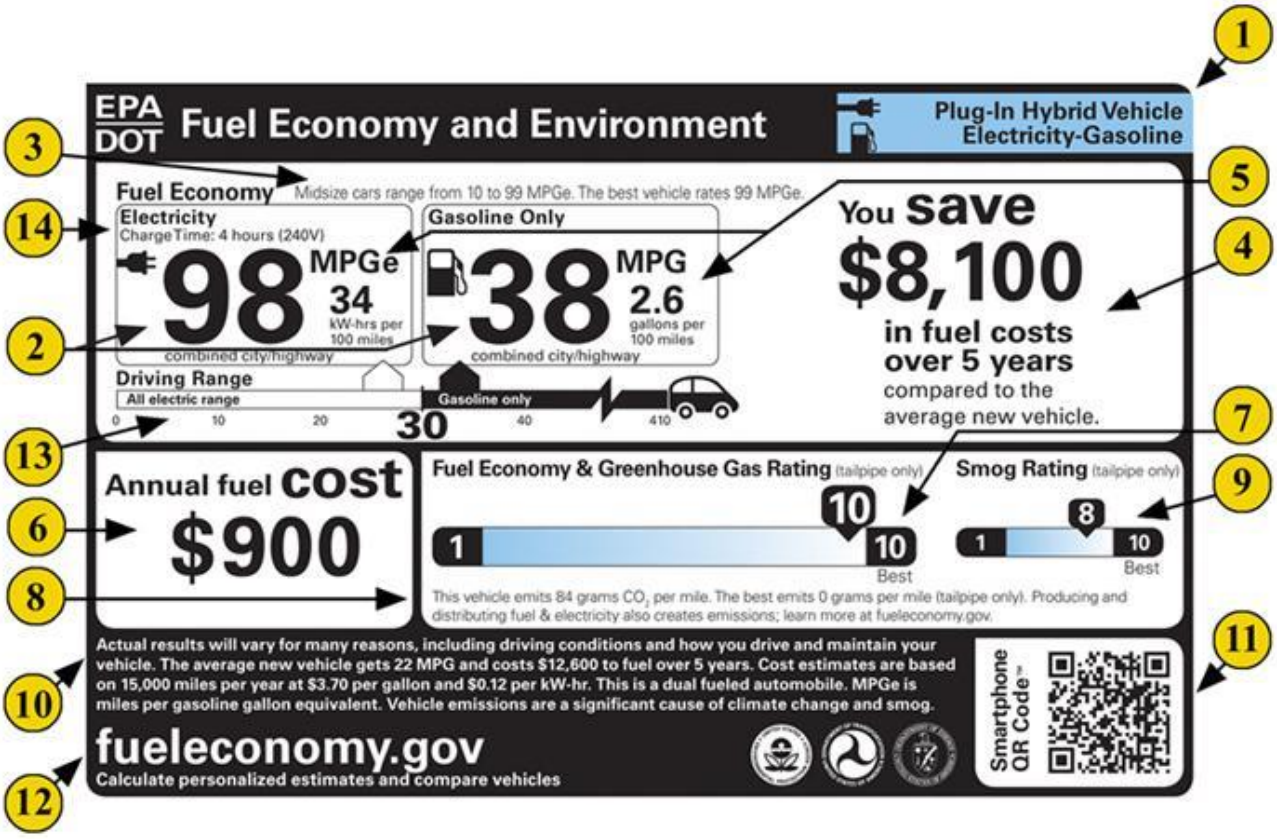
Appendix: EV Adoption Globally

Globally, over 2 million electric vehicles were sold in 2018, up from just a few thousand in 2010. Growth is expected to continue to rise steadily. Annual passenger EV sales are expected to increase to 10 million in 2025, 28 million in 2030 and 56 million by 2040 (Bloomberg ENF, 2019). All of this has implications on the energy sectors. By 2040, Bloomberg expects 57% of all passenger vehicle sales, and over 30% of the global passenger vehicle fleet, will be electric shifting the balance of electric vs. gas demand. Passenger car oil demand is expected to peak in 2028. Commercial vehicle oil demand is expected to peak in 2035. At the same time electricity demand will rise. While the electric power market is expected to handle additional demand, coordinated charging and time-of-use pricing will help to prevent localized grid capacity constraints. It will also contribute to cost-savings for people who time their charging accordingly.

Infrastructure hurdles are expected to be overcome globally in the 2030's. The increase of ride sharing options is another influencer that reduces the number of individually-owned EV's anticipated on the road. Today, EVs account for 1.8% of the shared mobility fleet globally. By 2040, Bloomberg expects EVs to account for 80% of the shared mobility fleet. In EV adoption overall, the United States is third, following China and Europe. The U.S. is ahead of India and the rest of the world.

Appendix: EPA Gasoline, Electric and Plug-in Hybrid Labels




EPA DOT Fuel Economy and Environment
Plug-In Hybrid Vehicle Electricity-Gasoline
Fuel Economy
Midsize cars range from 10 to 99 MPGe. The best vehicle rates 99 MPGe.
Electricity
Charge Time: 4 hours (240V)
98 MPGe
34 kW-hrs per 100 miles
combined city/highway
Gasoline Only
38 MPG
2.6 gallons per 100 miles
combined city/highway
You save $8,100
in fuel costs over 5 years
compared to the average new vehicle.
Driving Range
All electric range
Gasoline only
0 10 20 30 40 410
Annual fuel cost
$900
Fuel Economy & Greenhouse Gas Rating (tailpipe only)
1 10 Best
Smog Rating (tailpipe only)
1 8 10 Best
This vehicle emits 84 grams CO2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel & electricity also creates emissions; learn more at fueleconomy.gov.
Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 22 MPG and costs $12,600 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.70 per gallon and $0.12 per kW-hr. This is a dual fueled automobile. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.
fueleconomy.gov
Calculate personalized estimates and compare vehicles
Smartphone QR Code™
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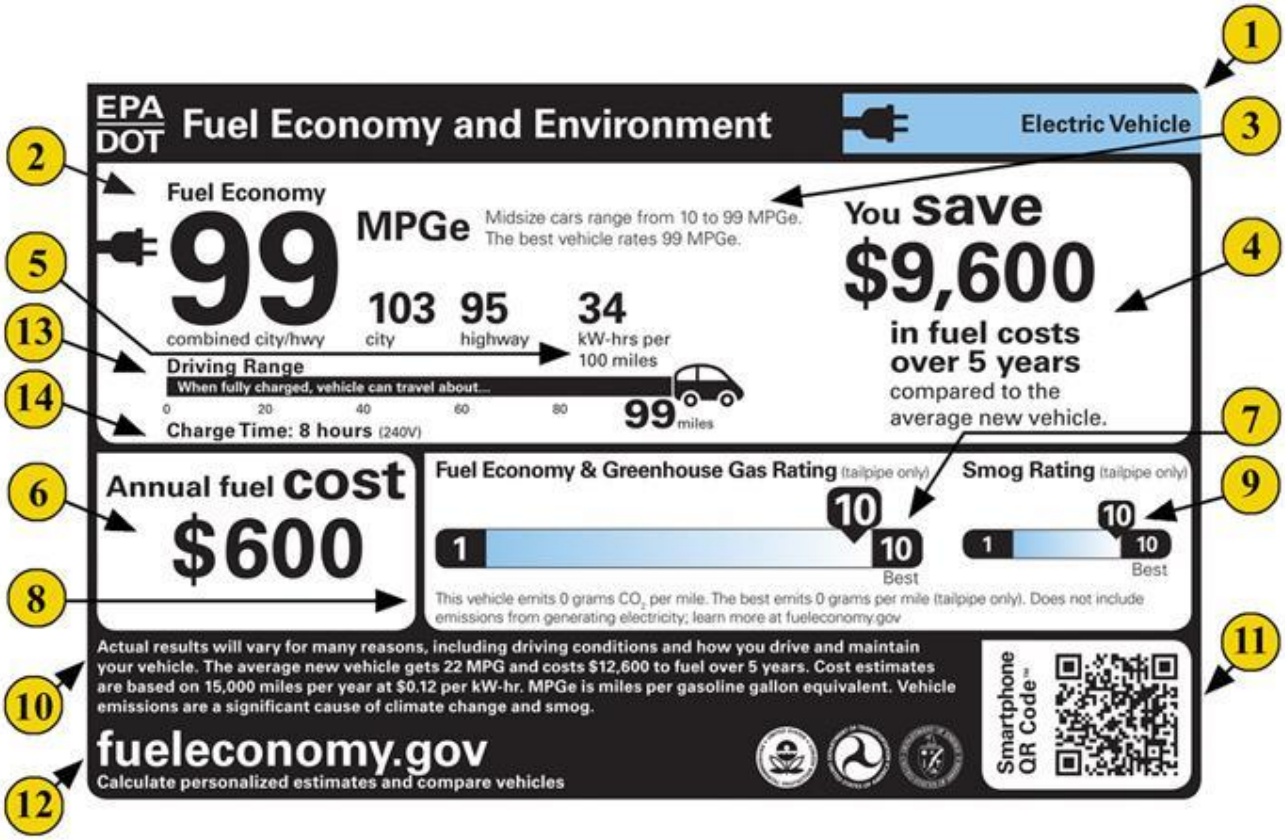
EPA DOT Fuel Economy and Environment
Electric Vehicle
Fuel Economy
99 MPGe
Midsize cars range from 10 to 99 MPGe. The best vehicle rates 99 MPGe.
combined city/hwy
103 city
95 highway
34 kW-hrs per 100 miles
You save $9,600
in fuel costs over 5 years
compared to the average new vehicle.
Driving Range
When fully charged, vehicle can travel about...
0 20 40 60 80 99 miles
Charge Time: 8 hours (240V)
Annual fuel cost
$600
Fuel Economy & Greenhouse Gas Rating (tailpipe only)
1 10 Best
Smog Rating (tailpipe only)
1 10 10 Best
This vehicle emits 0 grams CO2 per mile. The best emits 0 grams per mile (tailpipe only). Does not include emissions from generating electricity; learn more at fueleconomy.gov
Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 22 MPG and costs $12,600 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $0.12 per kW-hr. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.
fueleconomy.gov
Calculate personalized estimates and compare vehicles
Smartphone QR Code™
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Appendix: Town of Manlius Resource Information by category – separate document

Appendix: List of EV Cars Available for Consumers – separate document

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