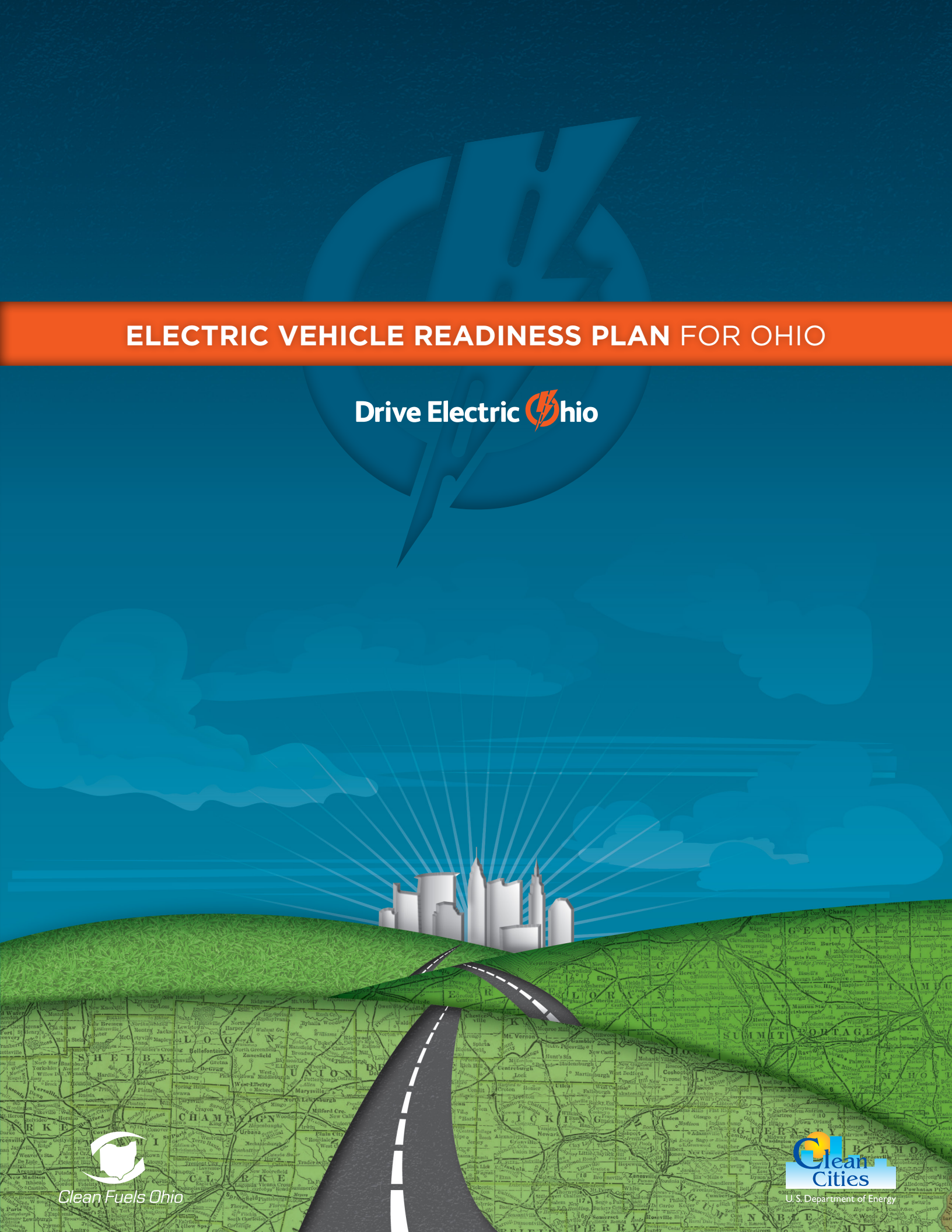
ELECTRIC VEHICLE READINESS PLAN FOR OHIO

Drive Electric Ohio



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DISCLAIMERS

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This document was prepared for informational purposes only, to serve as a resource and to assist the State of Ohio and electric vehicle stakeholders as they seek appropriate ways to plan for and implement EV technology and policies supporting such infrastructure. This report was prepared at a time when widespread adoption of EVs was in early stages and when policies and practices addressing electric vehicles and supporting technology have been evolving. The findings and recommendations included herein reflect this "snapshot" in time, although every effort has been made to anticipate and accommodate evolving technologies.

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DEFINITIONS

Vehicles

Electric Vehicle (EV), Battery Electric Vehicle (BEV), All-Electric Vehicle (AEV)
Example: Nissan Leaf

Electric vehicles are powered by an electric motor and battery alone. Electric vehicles can travel farther on electricity than plug-in hybrids, but their range is more limited. Electric vehicles never use gasoline and most models are designed to travel over 75 miles between charges.[1] *Except where otherwise noted, the term "EV" in this report refers to all types of plug-in electric vehicles.*

Plug-In Hybrid Electric Vehicle (PHEV) and Extended Range Electric Vehicle (EREV)
Example: Chevrolet Volt

Plug-in hybrid electric vehicles are powered by a gasoline engine and electric motor, but its battery pack, which is larger than that of a hybrid vehicle, can be recharged from the grid. This combination allows the vehicle to use electricity, and enables the vehicle to continue driving indefinitely after the battery is discharged.[2] After the electricity-only range is exceeded, the vehicle continues to operate as a hybrid vehicle. PHEVs can be configured to operate serially, or in a blended fashion. In a serial configuration, the vehicle runs on electricity alone at some points, like starting, and uses its other power source alone at others, for example, when accelerating. Alternatively, a plug-in hybrid may be configured for blended operation, with the battery and the conventional engine operating together.[3]

Extended Range Electric Vehicle (EREV)
Example: Chevrolet Volt

An extended-range electric vehicle (EREV) operates as a battery electric vehicle for a certain number of miles. After the battery has been discharged, a gas engine powers an electric generator for several hundred miles of 'extended-range' driving[4].

Hybrid Vehicle (Hybrid)
Example: Toyota Prius

Hybrids are powered by an internal combustion engine or other propulsion source that runs on conventional or alternative fuel and an electric motor that uses energy stored in a battery. The battery is charged through regenerative braking and by the internal combustion engine and is not plugged in to charge.

Fuel Cell Vehicles
Fuel cells offer an alternative to conventional vehicles which converts hydrogen gas into energy to power an electric motor. These vehicles were not considered as part of this study.

Electric Vehicle Refueling

Electric Vehicle Supply Equipment (EVSE)
Equipment used to transfer electric power from the grid or a solar panel to an electric vehicle, including the charging unit, its attachments and physical mounting infrastructure, such as the pedestal, barriers, and interface. In this report EVSE is also referred to as "charging stations."

The rate at which charging adds range to a vehicle depends on the vehicle, battery type, and type of EVSE. The following are typical rates[5] for a light-duty vehicle.

- Level 1: 2 to 5 miles of range per hour of charging
- Level 2: 10 to 20 miles of range per hour of charging
- DC Fast Charging: 60 to 80 miles of range in 20 minutes of charging

Level 1 Charging
Level 1 charging uses a common 120-volt, single-phase outlet for a three-prong grounded (NEMA 5-15R) connector with ground-fault circuit interrupt[6]. Level 1 charging requires 8 to 14 hours to charge a fully depleted EV battery, depending on the EV and battery type, however, charging time can be much shorter for EVs with smaller electric battery size. All EVs come equipped with Level 1 charging equipment at purchase.

[1] Electric Power Research Institute. *Plugging In: A Consumer's Guide to the Electric Vehicle*, Palo Alto, 2012
[2] *Ibid*
[3] 'Plug-In Hybrid.' Electric Drive Transportation Association, 27 Mar 2013
[4] *Ibid*
[5] Alternative Fuels Data Center, "Fuels and Vehicles, Electricity" US Department of Energy
[6] Pacific Gas & Electric. *EV Infrastructure Installation Guide. n.d.*

Level 2 Charging
Level 2 charging requires 208–240 volts AC single-phase maximum nominal supply and 32 amps maximum continuous current with 40 amps branch circuit protection. Other required features for Level 2 charging include grounding or electrical isolation, personnel protection from shock, a no-load make/break interlock, and a safety breakaway for the cable and connector. When using Level 2 charging, a fully depleted EV battery can be charged in 4 to 6 hours, depending on the EV, battery type, and capacity.

DC Fast Charging
DC fast charging requires high levels of voltage and current to replenish more than half of an EV's battery capacity in as quickly as 10 minutes. DC chargers use a 480-volt AC, 400-amp, three-phase electrical service. DC fast charging can provide 80% of a full charge in fewer than 30 minutes. The vehicle must be properly equipped to accept DC fast charge[7].

Inductive (Wireless) Charging[8]
Inductive (wireless) charging uses the electromagnetic field to transfer energy between two objects in close proximity. A charging station sends energy through inductive coupling to an electrical device, which stores the energy in the batteries.

Battery Exchange Facility
A service location similar to a conventional gas station where an electric vehicle can exchange a depleted battery for a fully charged battery. Such service stations have not yet entered the US market and were not considered as part of this study.

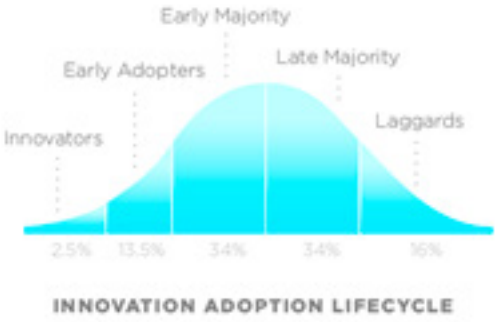
Connectors and Plugs
SAE International released its new fast charging combo coupler standard (SAE J1772) for PEVs in October 2012. The preceding version of the standard, adopted in 2010, spelled out the specifications for the J1772 connector that is used for charging with AC power at comparatively lower levels. The connector is used by all OEMs except for Tesla (Tesla has rolled out the Tesla Supercharger – a high speed network that is only compatible with Tesla and free to their drivers). The revised standard, the combo connector, maintains all of the functionality of the previous version of the connector but includes two extra pins for the optional delivery of DC current for fast charging – so that one receptacle is on the vehicle. It has been adopted by European and US auto manufacturers. However, the Japanese OEMs (Nissan and Mitsubishi) use the legacy CHAdeMO connector, which requires a separate receptacle.

Other Terminology
Metropolitan Statistical Area (MSA)
Metropolitan statistical areas are geographic entities defined by the U.S. Office of Management and Budget (OMB) for use by federal statistical agencies in collecting, tabulating, and publishing federal statistics. The general concept of an MSA is that of an area containing a large population nucleus and adjacent communities that have a high degree of integration with that nucleus. The classification provides a nationally consistent set of delineations for collecting, tabulating, and publishing federal statistics for geographic areas. The Cleveland, Ohio MSA includes the counties of Cuyahoga, Geauga, Lake, Lorain, and Medina. The Columbus, Ohio MSA includes the counties of Delaware, Fairfield, Franklin, Licking, Madison, Morrow, Pickaway, and Union.

Early Adopter, Early Majority – See Technology Adoption Lifecycle below

Technology Adoption Lifecycle
A theory describing the use or acceptance of a new product or innovation, according to the demographic and psychological characteristics of defined groups, typically illustrated as a "bell curve." Generally, the groups are defined as follows:

- Innovators – more educated, more prosperous and more risk-oriented
- Early Adopters – younger, more educated, may be community leaders
- Early Majority – more conservative but open to new ideas, active in community and influence to neighbors
- Late Majority – older, less educated, fairly conservative and less socially active
- Laggards – very conservative, lower overall wealth, oldest and least educated



Everett Rogers Technology Adoption Lifecycle

[7] Technologies. DC Fast Charging." EVSEReady.com. n.d.
[8] Schneider, J. "Wireless Charging of Electric and Plug-in Hybrid Vehicles"

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Executive Summary

Eleven billion dollars ($11,000,000,000). That's how much money Ohioans spend on gasoline every year[9]. If only 5% of Ohio's gas-only vehicles were replaced with electric vehicles – even a combination of all-electric, plug-in hybrid, and extended-range electric – Ohio consumers would save nearly $600,000,000 annually. For every dollar spent on gasoline in Ohio, only 16.4 cents continues to circulate in the state economy, meaning that nearly 84 percent leaves Ohio immediately to pay for distributors, wholesalers, transportation, production, etc. Imagine what $600 million could do for Ohio if it were used to purchase or renovate homes, on entertainment, and education?

The result of this study asserts that this scenario is quite possible for Ohio by 2030, with many notable gains along the way. For Ohio to maximize the opportunities that electric vehicles present – jobs , a manufacturing boom, regional leadership – the state must encourage widespread acceptance of this new technology, and municipalities must prepare to serve their residential and commercial sectors which will soon embrace EV ownership in significant numbers.

As electric vehicle penetration grows it will be essential for the statewide automotive assembly cluster[10] (manufacturers of vehicles and parts) to adapt and support this evolving market opportunity. According to AECOM's analysis[11], a renewed focus on Ohio's auto industry emboldened by electric vehicles could have a tremendous ripple effect throughout the statewide economy.

- For every $1,000,000 of economic output (i.e., sales) in automobile manufacturing, the economy grows an additional $602,000 in ripple effects.
- For every worker added to auto manufacturing in Ohio there is an additional $836,400 generated in sales/output.
- The total economic impact per auto worker on the state is estimated at $1.31 million.
- Saving 100 auto jobs in Ohio generates $83.6 million in direct economic activity and $47.7 million throughout the rest of the state economy, a total economic impact of $131.4 million.
- For every 100 jobs added in the auto manufacturing sector, there are 275 jobs added in other parts of the state economy in support industries, service sectors, retail, etc.

> The net change from adding 1,000 EVs to Ohio is $1,320,000 in economic impact and supports 20 additional jobs paying $508,000 in wages.
>
> Source: IMPLAN, AECOM

Clearly, the economic benefit of electric vehicles to the State of Ohio will be so much greater if they are not only purchased by Ohioans, but also manufactured by Ohioans. The campaign to promote electric vehicles in Ohio is not just about "selling it" to the average consumer. It is about broader economic development and job creation on a statewide level, linked to the importance of Ohio's automotive industry (3rd in the nation[12]), including the manufacturers as well as suppliers who are embedded in communities across the state.

BACKGROUND

Clean Fuels Ohio (CFO) is a statewide non-profit organization dedicated to promoting the use of cleaner, domestic fuels and efficient vehicles to the transportation industry, government, and the general public. The organization provides technical support to transportation professionals, advocates for sustainable transportation energy policies, and serves as a resource clearinghouse for fleets, policy makers, and the public. CFO is headquartered in Columbus, Ohio and works extensively around the state in collaboration with local partners. CFO developed the Drive Electric Ohio initiative to spur the growth, adoption and deployment of electric vehicles and the electric vehicle industry in Ohio.

[9] Please see Table 1 in the appendix for the full calculation.
[10] Original Equipment Manufacturers (OEMs) as well as Tier 1, 2 and 3 suppliers
[11] The analysis used pre-recession (2007) data from IMPLAN to examine Ohio's optimal performance scenario
[12] "The Auto Industry in Ohio," Innovation Ohio.

In 2010, Clean Fuels Ohio and Ohio Department of Transportation began convening a statewide EV stakeholder group representing organizations engaged in diverse electric vehicle planning activities throughout Ohio. In September 2011, Clean Fuels Ohio was awarded $500,000, one of sixteen grants nationwide, under the US Department of Energy's Clean Cities Community Readiness and Planning for Plug-In Electric Vehicles and Charging Infrastructure program to conduct a study that would result in an electric vehicle readiness plan for the State of Ohio. The DOE's objective for this program is to reduce U.S. petroleum dependence and build the foundation for a modern and resilient transportation system that responds to emerging innovations in mobility systems[13].

The Electric Vehicle Readiness Plan for Ohio is the culmination of over two years of collaborative work of a large coalition, led by Clean Fuels Ohio, that has grown to over 200 stakeholders including all major electric utilities, state agencies, metropolitan planning organizations, automobile manufacturers, industry representatives, local governments, universities and research firms. These stakeholders have been assembled to provide work, support, technical information and feedback necessary to complete a detailed statewide EV and EVSE readiness plan and supporting resources. The stakeholder group determined that the two primary priorities of the statewide plan were (1) infrastructure planning, and (2) education and outreach.

The central focus of the Ohio EV readiness grant project involved creating a detailed EV readiness plan that would feature community readiness templates including those relating to permitting and zoning that can be readily implemented by communities of varying sizes and characteristics. This EV readiness plan has included work to evaluate EV market demand; assess grid and utility readiness; recommended updates to local zoning, code, and permitting policies that would streamline EV adoption; provide a targeted EV marketing plan, first responder safety training plan and educational activities for the general public and fleets.

METHODOLOGY

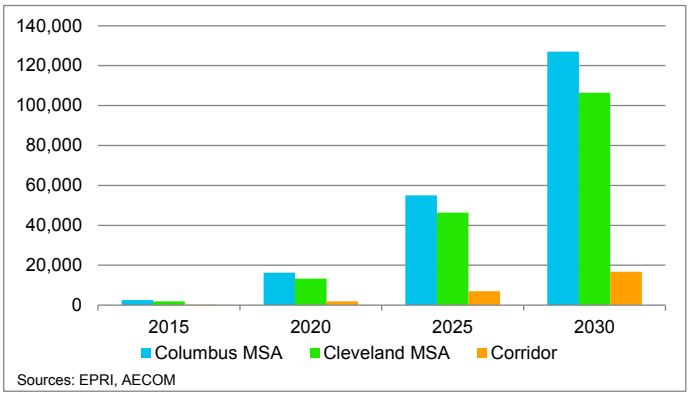
This report is the result of a full year's worth of research, data analysis and stakeholder engagement. Specifically, the consulting firm AECOM (retained by CFO for this project) examined the metropolitan statistical areas (MSAs) of Cleveland and Columbus, Ohio, and the I-71 corridor between them. While the figures in this report are specific to those areas, the process for deriving these results is intended to be replicable by other Ohio communities. A supplemental section also provides recommendations for municipal codes and permitting that are designed to be easily applicable to any Ohio community.

Additional research incorporated into this report was conducted by the Electric Power Research Institute (EPRI), Communica (a marketing firm), Governing Dynamic (a research firm), the University of Akron and the Ohio State University's Center for Automotive Research (OSUCAR), all of which were also contracted by CFO for this study. The statewide stakeholder groups were consulted throughout the process and provided vital feedback in the development of this report.

KEY FINDINGS

- **Driving Range:** Over 70% of drivers in the study areas of Cleveland and Columbus commute less than 20 miles round trip each day, and over 80% of drivers commute less than 50 miles, distances which are well within the range limit of even the all-electric vehicles on the market today.
- **Projected EV Ownership:** By 2030, ownership of all types of plug-in electric vehicles in the Cleveland and Columbus MSAs is projected to number over 250,000.

Figure 1: Projected Vehicle Ownership per MSA, EV and PHEV Combined



- **Residential Charging Station Demand:** By 2030, approximately 125,000 charging stations will have been installed at the homes of EV owners in the Cleveland and Columbus MSAs combined[14].
- **Non-Residential Charging Station Demand:** By 2030, the Cleveland and Columbus MSAs combined will need over 50,000 non-residential charging stations installed at workplaces and destinations[15].
- **Likely EV Owners:** Households with incomes $175,000 and above and fleet owners are likely EV candidates in the short term, with households in the $100,000 income range becoming EV owners by the early 2020s.
- **Grid Impact:** Based on projections showing that electric vehicles will not constitute a majority of on-road vehicles, increased demand for electricity due to electric vehicles will not outpace production capacity or the ability of the existing grid infrastructure to deliver power.

RECOMMENDATIONS

1. Prepare municipalities to enable a proactive approach to permitting

Focus funding and advocacy efforts on the communities predicted to have the highest number of early EV owners. Share the outcomes statewide to benefit all communities.

By 2030, 60% of Gates Mills households may have EVs, resulting in over 500 vehicles, but Parma is predicted to have close to 5,000 EVs within only 12% of its households.

2. Modernize the utility grid

Utilities should maximize planning opportunities over the next decade before EV ownership is widespread. The dawn of a new technology is a prime opportunity to examine transformer capacity and modernize the system.

Some communities will see more rapid EV ownership than others, which may impact local transformer capacity.

[13] "Clean Cities – Community Readiness Projects." Energy Efficiency & Renewable Energy. US Dept. of Energy. 09 Sept. 2011.
[14] This forecast assumes that half of EV owners will install at least a Level 1 charging station at home, while half will plug their vehicle into an existing outlet without an additional charging station.
[15] This forecast assumes a ratio of one non-residential charging station for every five electric vehicles.

3. Identify likely consumers statewide

Replicate the demographic analysis and EV adoption projections in this report for other Ohio MSAs including Cincinnati, Akron, Toledo, and Dayton, which will help prepare municipalities and support the utilities' need for information relevant to their infrastructure.

> Statewide EV adoption figures will be significantly larger when MSAs other than Cleveland and Columbus are taken into account.

4. Site charging stations strategically

Thoughtful and purposeful placement of charging stations within metro areas and across the state will encourage greater and faster EV adoption. Haphazard or unplanned deployment of charging stations could have the opposite effect, creating a chaotic approach that will deter an uninformed public wary to test a new technology.

> EPRI has identified 140 locations that would give 95% of all Ohio residents access to a charging station within 10 miles of home.

5. Commission a statewide economic impact study of the EV market in Ohio

Early indicators in this report demonstrate that electric vehicles can be a tremendous asset to Ohio's economic engine. A study focused on the economic impact and potential of electric vehicles could further refine the goals introduced in this report, and enable policy makers to create an environment welcoming to EVs and their statewide impact.

6. Educate consumers on the true cost and benefits of EVs

The results of the marketing study clearly demonstrate that while Ohioans are aware of electric vehicles, they are unaware of their competitive total cost of ownership and other benefits. Once consumers experience these vehicles and are provided tangible performance statistics, it is likely that more consumers will choose EVs for their next car.

7. Incentivize EV ownership

The State of Ohio and its utilities are alone among the five neighboring states in not providing any tax incentives, grants or rebates within the EV sphere – for vehicle purchase, manufacturing, research or equipment – meaning the state is not taking advantage of the job-creating engine that EVs and their supporting infrastructure can be. To demonstrate leadership and attract the robust resources that accompany EVs, the state must bolster its offerings or risk losing growth opportunities to neighboring states with policies and incentives that encourage EV adoption.

> According to a survey by Communica, 82% of commercial fleet managers say government incentives are necessary for transitioning to alternative fuel vehicles.

> Cleveland-based Eaton manufactures Level 2 charging stations in North Carolina and DC fast charging stations in Oregon.[17]

CONCLUSION

Ohio can realize significant short and long term benefits by accelerating the rate of EV ownership among its residents. In addition to helping advance the important national goal of energy security, the job creating opportunities are robust. As Ohio becomes more EV-friendly, and as adoption increases, the stage will be set for private sector investment in a variety of research, development and manufacturing opportunities that can leverage the range of Ohioans' skill sets – from manufacturing electric vehicles and charging stations to installing over 200,000 charging stations throughout the state, from conducting research on new battery technology to manufacturing EV batteries and components, and even creating business opportunities when those batteries still have capacity but can no longer perform for EVs. Ohio's jobs growth platform for the future will be based upon its ability to adapt to and embrace new technologies, and EVs are an important part of that platform.

This is an exciting time for Ohio. Its economy is faring better than the nation's, as is its employment rate[16]. The energy sector is experiencing a boom that includes Ohio, and the state is home to some of the best technical and automotive research institutions in the country, not to mention a legacy of automotive manufacturing expertise in virtually every community. Armed with the planning recommendations outlined in this report, Ohio's municipalities, clean fuel advocates, industrial leaders and legislative visionaries can propel the state into the electric vehicle movement's pole position.

[16] United States Bureau of Labor Statistics. December 2012 preliminary data lists Ohio's unemployment rate at 6.7%, while the national rate is 7.9%.
[17] "News Releases," Eaton Corp.

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The Case for Electric Vehicle Ownership



Overview

While it may appear that sluggish sales in Ohio's EV market to date indicate a lack of interest among consumers, this study finds evidence otherwise: auto manufacturers are only just now releasing EV models into the state, and as their sales efforts increase, so will the purchases. The initial purchase price comparison between electric and conventional vehicles continues to weigh in favor of the conventional, but as consumers become aware of the competitive total cost of ownership, their attitudes toward electric vehicles will become more favorable.

AECOM analyzed specific demographic metrics of the study MSAs to examine the existing characteristics and forecasted trends. Key metrics include population, households, income, age, educational attainment, commuting patterns, major employers, fuel impacts, vehicle makes and models, and geographic distribution throughout Ohio.

KEY FINDINGS

The pace of Ohio's economic recovery from "the great recession" will impact its electric vehicle adoption rate, and economic indicators for Ohio are trending upwards. The total cost of owning an electric vehicle – from the purchase price to re-fueling and ongoing maintenance – is already close to even with hybrid vehicles and surpasses conventional vehicles. This is a key message that needs to reach Ohio's consumers.

- Unemployment rates have continued to fall since their peak, with the Columbus and Cleveland MSAs performing better than the state and national averages. Ohio's GDP recovered in 2010 to above pre-recession levels.
- Potential owners of electric vehicles do exist in Ohio, and in significant numbers. In the Columbus MSA, nearly 48,000 households fall within the income range that can afford an EV today and the Cleveland MSA is similar, with 47,000 households earning at least $150,000. There are close to 100,000 additional households in each MSA earning $100,000–$150,000, a group predicted to be considering EVs within the next 10 years.
- The majority of daily commuting distances are less than 20 miles, almost 70% of all commutes in the Columbus MSA and 54% in the Cleveland MSA. Further, in the communities with residents most likely to purchase EVs, over 80% of commutes are less than 50 miles round trip.
- The total lifetime cost to own an EV is at least on par with today's hybrid vehicles, and in most cases outperforms the ownership cost of a conventional vehicle. Battery costs are expected to drop and their efficiency will improve, further driving down the cost of EVs.
- EV owners can expect significant fuel savings, ranging from $1,400–$2,000 per year depending on the price of gas, which is expected to continue to increase.
- Shifting consumer spending away from gasoline has a tremendously positive impact throughout the economy, including an increase in jobs statewide.

RECOMMENDATIONS

1. Focus initial EV awareness efforts on fleets and higher-income households.

2. Conduct similar demographic studies on other Ohio MSAs to refine the statewide EV ownership estimates and identify communities and employers with leadership potential.

RESEARCH

The Commute: Yes, EV Can!

The EVs available in Ohio in 2013, primarily the Nissan Leaf and Chevy Volt, are able to drive 92[18] and 38[19] miles respectively on a single charge, and the Volt can continue driving 380 miles when it switches to gas mode. AECOM examined the Cleveland and Columbus MSAs to determine which communities were within 25 miles of the downtown which would result in a maximum 50 mile round trip on a single charge, meaning that a vehicle likely would not need to plug in at its downtown location in order to return home. If an EV owner had access to a charging station at their destination (i.e., work), then the outer ring of EV-capable communities could be further away from the city center.

[18] "Leaf Electric Car" Nissan USA n.d., 02 Feb 2013
[19] "Volt Electric Car" Chevrolet n.d., 02 Feb 2013

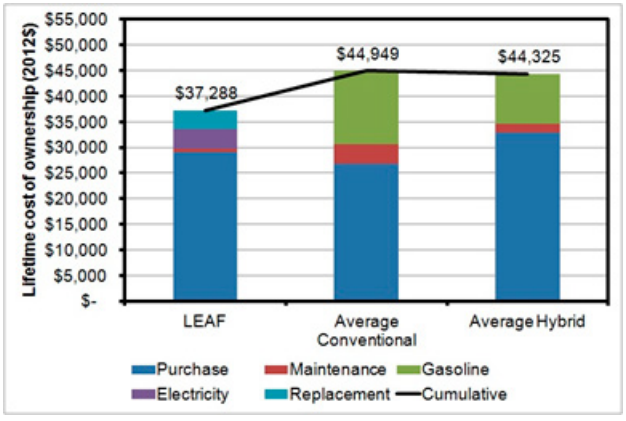
In the Columbus area, a commuter could drive from as far out as the town of Delaware and still be within 25 miles one way of the city center. Similarly for the Cleveland MSA, a commuter could drive from as far east as Mentor and still be within 25 miles one way of downtown.

Ownership Cost: EVs are Competitive

A total cost of ownership analysis was performed by EPRI for current plug-in electric vehicles in which the 2012 Nissan Leaf and 2012 Chevrolet Volt were examined to show how the two performed over the life of the vehicle. The two vehicles are shown compared to an average gas-only hybrid model and an average conventional vehicle. Vehicle purchase, maintenance, gasoline, electricity, and replacement costs (for days when the Nissan LEAF cannot complete the day's driving on one charge) are compared across each vehicle.

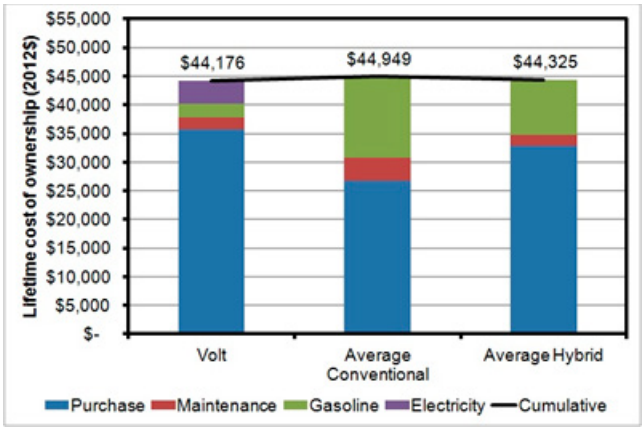
In the figure below, the average hybrid vehicle is the average of four popular hybrid models: Toyota Prius, Honda Civic Hybrid, Toyota Camry Hybrid, and Ford Fusion Hybrid. The average conventional vehicle is based off of four mid-size sedans, the Honda Civic EX, Chevrolet Cruze LTX, Ford Focus Titanium, and the Volkswagen Passat, which were picked because of their size and amenities. Fuel economy and price were averaged between each set to arrive at two 'average' cars. The Nissan Leaf is shown to have a total cost of ownership of $37,288[20], lower than both the conventional vehicle and the hybrid. The replacement cost for the Nissan Leaf's battery factors into the cost of ownership. The chart shows the clear impact of gasoline on the cost of vehicle ownership and the trend of gas price increases will continue to improve the ownership cost relationship of EVs.

Figure 2: Nissan Leaf Total Cost of Ownership, 2012[21]



The Chevrolet Volt's total cost of ownership is shown in the figure below, and similar to the Nissan Leaf, the vehicle is shown to be competitive to other vehicle types. The significantly smaller portion of total cost allocated to gasoline is a clear advantage of the vehicle, and offsets some of the increase in the initial purchase price.

Figure 3: Chevrolet Volt Total Cost of Ownership, 2012



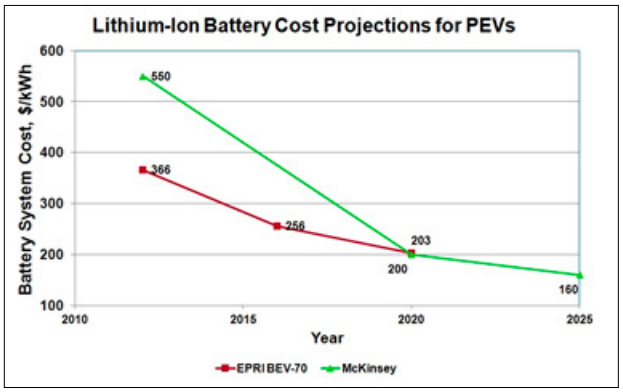
These two total cost of ownership comparisons highlight that the alternatives to conventional internal combustion engine vehicles already can compete over the life of the vehicle, and as the cost of fuel continues to increase and the purchase price comes down with declining battery costs and manufacturing efficiencies, they will become even more competitive for consumers.

In spite of this positive comparison, EV sales will face the same challenges as other vehicles: in 2010, Midwest spending on new vehicles was the lowest of any region. Today's Ohio households are focused more on saving than on spending, and Midwest households generally keep cars in service for more years than other areas of the country[22]. These points indicate that motivation for purchasing any new vehicle, let alone an electric vehicle, will be slower in Ohio than in other states.

The Battery: Cost will come down

In the figure below, cost projections for lithium-ion batteries on a $/kWh has been developed by both EPRI[23] and McKinsey[24]. By 2020, both project that battery costs will decline to approximately $200/kWh, a significant decrease from current levels (ranging from $366-$550/kWh).

Figure 4: Battery Cost Projections



[20] This number is based on the 2012 pricing of the Leaf. The purchase price fell by over $4,000 for the 2013 model, as production has increased in scale and moved to Tennessee. The total cost of ownership of the Leaf is expected to fall significantly.

[21] Electric Power Research Institute (EPRI). *Total Cost of Ownership for Current Plug-in Electric Vehicles.* Palo Alto, CA: 2012. 1025848

[22] See Appendix for research detail

[23] Electric Power Research Institute. Plug-in Electric Vehicle Lithium-Ion Battery Cost and Advanced Battery Technologies Forecast. Palo Alto, CA: 2012. 1023094

[24] Hensley, R., Newman, J., Rogers, M. (07/2012) Battery technology charges ahead. McKinsey Quarterly

Battery prices are continuing to improve in efficiency and range as the technology progresses. One example of this is the 2013 Chevrolet Volt versus the 2012 Chevrolet Volt; the 2013 model had a roughly 10% increase in EPA rated range, with the same sized battery pack. The increase comes from efficiency gains and battery cell performance improvements.

Tax Credits: Cutting the purchase price

Plug-in electric vehicles qualify for between $2,500-$7,500 in federal tax credits[25] depending on range. Longer range vehicles such as the LEAF, Volt, and Focus BEV qualify for $7,500 in federal incentives and lower range vehicles such as the Ford C-Max Energi qualifies for $3,750. The Prius Plug-in qualifies for $2,500.

These credits are scheduled to be phased out as electric vehicle sales increase, specifically until 200,000 vehicles are sold per manufacturer. With most manufacturers introducing EV models over the coming years, each with its own 200,000 EV model limit for the federal tax credit, it is unclear how long the tax credit will last.

At this time, there are no state-sponsored incentives in Ohio that would reduce the cost to purchase an EV. This is discussed in greater detail in Section 5, *Statewide Electric Vehicle Considerations*.

Charging: The cost to fuel up

The vast majority of EV charging will be conducted at home or in the fleet yard. The cost of installing a charging station depends upon the type of charging station that the EV owner decides to install, a Level 1 or Level 2 charging station, or simply plugging into an available outlet. The costs include the charging station itself and the cost for an electrician to install it.

An EV owner could simply plug in to an available socket using the cord set that comes with the vehicle to achieve Level 1 charging with no additional cost for equipment or electrical work. Alternatively, this same owner may have to pay an electrician for electrical work (i.e., running conduit to a garage without power) and may choose to purchase a Level 1 charging station which generally costs between $500-$1,000, plus installation.

Installing a Level 2 charging station is more expensive than Level 1 because they require an electrician for site inspection and installation, additional voltage (240V) and the equipment is more expensive. The charging stations themselves can cost up to $2,800 and, if additional circuitry is needed, an electrician will cost an average of an additional $1,500 or more depending on the complexity of the project.

Once an EV owner is able to charge at home (or a fleet parking facility), the cost to charge is simply the same rate the owner pays for electricity. In Ohio, the average electricity rate is $0.06 per kWh[26]. On an empty battery charging at Level 2, a Volt would require four hours to charge for a total of $0.96, and a Leaf would need seven hours for a total cost of $1.44. However, most EVs will only need to "top off" daily, and some owners may only charge a few days per week. EPRI has found that nationwide, the average EV owner is currently adding around 3,000 kilowatt hours (kWh) to their normal annual household electric bill.

Based on Ohio's residential rate of $0.06/kWh, the average EV owner could expect to pay only $11 extra per month to charge their vehicle[27].

Lordstown, Ohio Solar Canopy Station – http://www.cleveland.com

Another option for locations offering charging for multiple vehicles is a solar canopy EV charging station . Numerous manufacturers currently offer different designs, and generally include the following components: multiple parking spaces for electric vehicles to sit while charging, an overhead canopy of solar panels to generate electricity, and charging stations to plug in the EVs. A solar canopy could be an ideal option for fleets that not only have multiple electric vehicles, but also desire to offset the electrical costs through the use of solar power for energy generation. GM has already installed solar canopy EV charging stations at two Ohio facilities in Lordstown and Parma[28], and a mall in Indianapolis[29] has installed one that includes both Level 2 chargers and DC fast chargers.

Vehicle Fuel

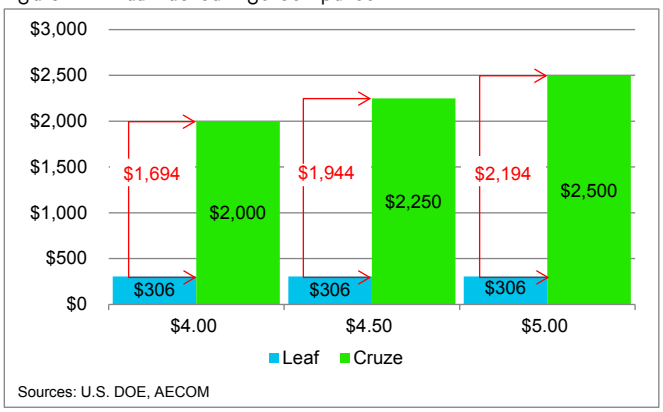
By choosing an EV, the consumer removes (for all-electric vehicles) or reduces (for PHEVs) the volatility of gasoline prices, which are likely to continue rising for the foreseeable future. An estimate of the savings from using electricity instead of gasoline is provided below, comparing an all-electric vehicle over the course of a year to a conventional vehicle of similar size. For this example of fuel savings, a 2012 model Nissan Leaf is compared against a comparably sized Chevrolet Cruze to illustrate the difference in fuel consumption.

According to the DOE, the average car is driven 15,000 miles per year; for the Chevrolet Cruze that equates to approximately 500 gallons of gasoline using the vehicle's standardized MPG rating. For the Nissan Leaf, an equivalent in electricity consumed uses the Ohio average of $0.06 per kWh for calculating the cost for one year of charging.

Given that gasoline prices fluctuate regularly throughout the year and over time have been rising, the analysis provided below gives three hypothetical examples at the $4.00, $4.50, and $5.00 price for a gallon of gasoline. The figure below shows the difference in spending for one year of driving using an EV at those price points for gasoline. At an average of $4 per gallon, over the course of the year, the EV would save its owner just under $1,600. For each $0.50 increase in the average cost of gasoline that savings increases by $250 over the course of a year.

[25] United States. Internal Revenue Service. Notice 2009-89. IRS Dec. 2009
[26] "Apples to Apples Rate Charts" The Public Utilities Commission of Ohio. 04 Feb 2013
[27] EPRI/AECOM calculation
[28] "News – United States" General Motors. 12 Sept. 2012
[29] Motavalli, J., "Plug-In Ecosystem' Available at Indiana Mall," New York Times. 02/05/13

Figure 5: Annual Fuel Savings Comparison

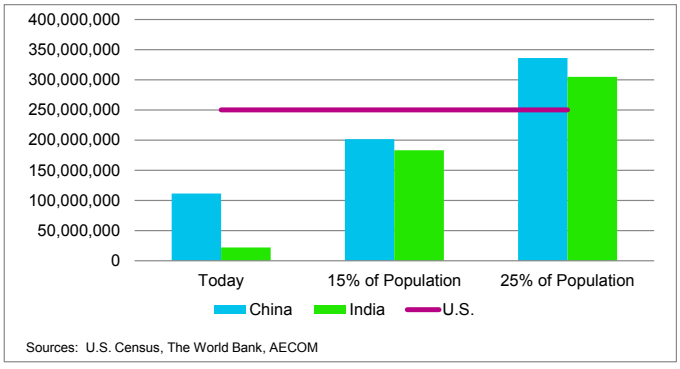


Worldwide Demand for Gasoline

Current gas prices are low enough to be a disincentive to EV ownership, and the increasing fuel efficiency of conventional vehicles further exacerbates this competition. However, worldwide demand for fuel is expected to increase year after year, which will result in gas price increases in the US. The following is a simple example of this pending demand.

Total vehicle ownership in the United States is relatively stable (80% of the population are car owners), whereas in China and India, car ownership is very low but growing rapidly. In China, only 8% of the population currently owns a car, but its vehicle sales are increasing 16% per year, and its total population far exceeds that of the US. A similar trend is occurring in India. The chart below illustrates how many additional vehicles would be on the road if 15% and 25% of the current population in China and India had gasoline-powered vehicles. This simple exercise – which does not account for the other 140 nations of the world – demonstrates that with only 15% of these two countries owning a car, their demand for fuel would far outpace that of the US.

Figure 6: Vehicle Ownership Projections, U.S., China and India



Consumer Spending: Less Gas = More Jobs

The entire Ohio economy benefits as users move from conventional vehicles to EVs. Over the life of the car, users will save money on gasoline and maintenance costs. Although their electricity cost rises, this is more than offset by the other savings. The following economic impact analysis determined that for every EV added in Ohio, the economic impact to the State is $1,300.

The following analysis uses 2011 Consumer Expenditure Survey data for Midwest residents from the Bureau of Labor Statistics. Spending was adjusted to reflect changes associated with owning an EV; costs associated with gasoline were removed and maintenance costs were lowered. The calculation assumes that these "new" dollars would be spent elsewhere in the economy on retail, household expenses, entertainment, etc.

The net change from adding 1,000 EVs to Ohio is $1,320,000 in economic impact and supports 20 additional jobs paying $508,000 in wages.

The analysis then used 2007 economic multipliers for the State of Ohio from IMPLAN (a software program for economic impact analysis) to determine the economic impact from the shift in spending, considering both the negative change occurring from the decreased gasoline/maintenance spending, as well as the positive change from that spending occurring elsewhere in the local economy. The economic multipliers found in IMPLAN measure the re-spending of dollars in an economy and are used to calculate indirect and induced impacts, i.e., the 'multiplier effect.'

Table 1: Economic Impact of Shift in Spending for 1,000 EV Owners

	Output	Jobs	Wages	Value Added
Change in spending patterns	$2,005,000	30	$754,000	$1,216,000
Loss of gasoline impacts	-$685,000	-10	-$246,000	-$454,000
Net change in impact	**$1,320,000**	**20**	**$508,000**	**$762,000**

Sources: U.S. Bureau of Labor Statistics, IMPLAN, and AECOM

Fleets

The business case for institutions with fleet vehicles to lead the way in establishing viable economic models for the installation, operation, maintenance and delivery of charging services is perhaps the most significant opportunity presented to Ohio to enable widespread EV preparedness. Fleets offer the type of scale that enables them to take a strong posture in negotiating with EVSE providers. Many state and municipal agencies and school systems, as well as large institutions like universities and hospitals, and employers offering large scale taxi or delivery services, will assess the benefits of transitioning away from conventional gasoline power, and realize significant cost savings over the long term by investing in EVs and charging infrastructure. Benefits include:

- Infrastructure costs spread over a large pool of vehicles
- Reduced fuel costs for short route and routine trip vehicles
- Removes volatility of fuel prices from long-term operations planning
- Reduced maintenance costs

Municipal Fleet Fuel Use Reduction[30]

Nearly 50% of local governments in Ohio indicate they are actively considering introducing alternative fuel vehicles into their fleet, however there is no strong consensus on what types should be included. Natural gas, hybrid and electric vehicles are the top contenders, although nearly half of officials admit they just aren't sure what types to consider as of now. Cities show the most interest, with 68% actively considering changes to their fleets, while only 23% of townships are presently focused on the issue.

Hybrids are currently the vehicles of choice for the 20% of jurisdictions that report they have already incorporated alternative fuel vehicles in their fleet. While only 1% of responding jurisdictions indicate they currently utilize electric vehicles in their operations, 49% believe doing so would save money over time and 41% believe EV integration should be a priority.

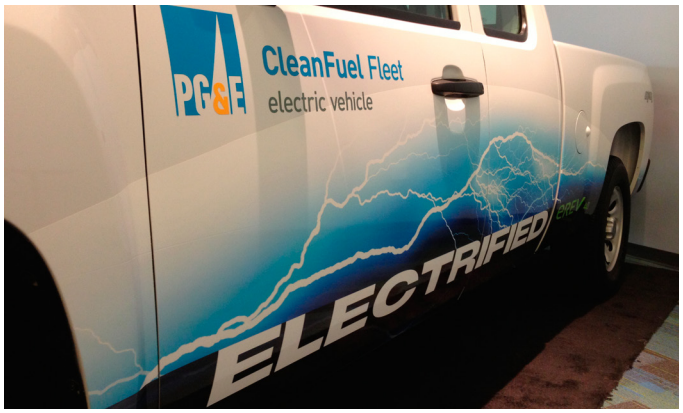
Overall, 62% of local governments believe the integration of alternative vehicles in their fleet would serve as a cost saving measure. Moreover, 57% of local government officials statewide, 75% of cities and 70% of counties believe integrating alternative fuel vehicles into their fleets should be a priority.

Considerations and advantages for specific types of fleet owners are discussed below.

- Government: EVs in public fleets not only reduce operational costs, but also demonstrate the viability of EVs to the general public. Larger vehicles such as snowplows, garbage trucks and heavy equipment are more likely to utilize alternative fuels such as natural gas, but smaller vehicles used for daily short-distance trips such as code enforcement, inspections and para-transit services are ideal for the EV switch.

  The City of Indianapolis recently set an ambitious goal of transitioning its entire non-emergency vehicle fleet from conventional fuels to alternative powertrains, which will include plug-in hybrid and all-electric vehicles[31]. The City calculates that this switch would save taxpayers over $10 million, and the City is also hoping to work with an auto manufacturer to develop the first plug-in hybrid police vehicle which would save an additional $10 million.

- School Districts: School buses traditionally travel a daily fixed route to deliver students to and from school and are otherwise idle during the day and overnight, providing plenty of opportunity for charging. All-electric school buses are also appealing to educators and parents because of zero tailpipe emissions. Some school bus fleets have converted to propane, compressed natural gas and hybrid. All-electric school buses are just entering the market and incremental costs are high at present, though costs should come down as battery costs come down and battery efficiency increases.
- Universities: Vehicles used for maintenance, distribution, campus police, and shuttle transit which stay on campus or within close proximity will not have issues of range anxiety, benefit from low speed areas found on many campuses, and can have a dispersed EV infrastructure in both public areas like garages and lots, and private areas designated only for campus vehicles. Similar to public agencies, the volume of pedestrian and vehicular traffic makes visibility of the EV infrastructure a strong 'green' marketing piece and shows the forward thinking nature of the campus.
- Emergency Services: Non-emergency vehicles are early candidates for EVs, such as those used for code enforcement, ticketing, and non-emergency healthcare trips. Standard emergency vehicles, such as squad cars, fire trucks and ambulances, have a unique set of requirements to ensure public safety and efficient, reliable service; EV technology is still emerging in this sector.
- Car Sharing: Car-sharing fleets are businesses that provide vehicles to members for short periods of time, often for trips of less than a few hours, and locate vehicles in small clusters throughout a geographic area. These fleets can disperse the infrastructure costs among vehicles if the incorporation of EVs is well executed. Electric vehicles may be ideal for car-sharing as the majority of trips are short distances and time, well within the range of most EVs. Currently, there are no car-sharing firms in Ohio except for a handful of systems that serve specific university campuses.
- Car Rentals: Rental fleets are likely to lag other commercial entities in EV adoption as their business model involves driving distances that can exceed the range of existing EVs and the regional charging infrastructure to support distance driving does not yet exist. As that network expands, rental companies can spread the infrastructure costs among numerous vehicles as is the case with other fleets. Avis recently acquired Zipcar, indicating an interest in the car-sharing model of vehicle rentals, and Hertz offers EVs in its car sharing program in New York City, Washington, D.C., and San Francisco.
- Delivery Businesses: PepsiCo, FedEx and UPS have large fleets which travel a fixed area throughout the day, with generally lower speeds, frequent starts and stops, and idle time overnight. The shock of a volatile oil market on fleet operational costs is significant, which is why FedEx is dramatically shifting its fleet of delivery vans and heavy trucks to more electric vehicles. The delivery van fleet will shift to all-electric vehicles, which FedEx Founder and CEO Fred Smith says "will operate at a 75 percent less per-mile cost than an internal combustion engine variant," a significant cost savings for fleet operations. The vehicles will be able to recharge overnight, reducing the electricity costs and putting less strain on the electrical grid[32].



[30] *Ohio Survey of Local Governments*, 11/09/12, Governing Dynamic
[31] Basich, Greg. "Indianapolis to Require Plug-in Hybrid or EV Purchases for Its Non-Police Passenger Vehicle Fleet." *Government Fleet* 12 Dec. 2012. Digital edition.
[32] Ydstie, J. "Oil Scare Turns FedEx on to Energy Efficiency." *Morning Edition*. National Public Radio. 02 April 2012. Radio

Case Study: Frito-Lay

DESCRIPTION: Frito-Lay, A Division of PEPSICO employs a combination of people, processes and technologies to achieve long term sustainability goals. Alternative fuels and alternative vehicles are a key plank in the Frito-Lay sustainability program. Long term goals include reducing fuel consumption by 25% per pound of product and reducing greenhouse gas emissions by 25% before 2020.

As part of the ongoing sustainability program, the Frito-Lay Columbus Ohio Broughton Ave. location served as one of three sites launching the Electric Vehicle platform (EV). PEPSICO and Frito-Lay, in partnerships with Clean Cities programs across the nation, continue to expand the EV platform in its business with a total of 230 electric vehicles in daily use with 275 expected in use by June, 2013.

LESSON LEARNED: For Frito-Lay, the EVs are not only a key solution in our sustainability strategy, but are expected to deliver positive financial returns. However, the people impacted by the EV adoption will determine the ultimate success or failure of the program. Strong partnerships between sales, operation, and maintenance teams are required for the successful integration of any alternative fuels program. In the case of EVs, issues such as range/distance anxiety requiring understanding, empathy, and long term focus are lessened by effectively supporting the user (Driver).

Incorporating commercial EVs into an existing business will require an advanced level of engagement from all groups to ensure success. Having a dedicated Project Manager is recommended to monitor, track and address issues with the manufacturer. Original Equipment Manufacturer (OEM) communications and commitment to product support and education is necessary and prudent to ensure customer satisfaction is maintained.

Retail delivery and service within the 100 Air mile radius is within our currently basic operations. Access to existing customer docks and inbound supply chain operations is no different from when we began our EV operations two years ago. Success is a matter of EV commitment and customer (Driver) support. Ability to achieve both commitment and customer support in daily business will ensure success in efforts to advance an electrical vehicle solution for your business. To learn more please visit http://www.afdc.energy.gov/case/404.

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Tailpipes vs Smokestacks: Are EVs Really Green?

The environmental argument in favor of electric vehicles came under fire in 2012. An influential report by the Union of Concerned Scientists asserted the finding that pollution caused by an electric vehicle in Ohio was equivalent to that of a conventional vehicle that gets 42 MPG. The finding is based on the fact that the majority of electric power in Ohio is produced by coal-fired power plants that produce harmful air pollution, therefore power consumed by electric vehicles indirectly causes air pollution, just as a vehicle burning gasoline directly causes air pollution.

The Team researched and discussed this issue at length and developed two important observations. The first is that the nation's electrical grid is consistently getting cleaner due to regulations and technological innovations. During the same period of time that this study examined, through 2030, Ohio's grid will likely produce less air pollution through these conventional changes, and by the addition of cleaner sources of power, notably natural gas, wind and solar. The second observation is that it is a far simpler proposition to manage the air pollution produced by Ohio's 10 power plants than from its 10 million tailpipes.

Communities desire less direct air pollution within their borders, as evidenced by anti-idling campaigns, and emissions from vehicles have an immediate, direct, and negative impact on local air quality. The promise that electric vehicles hold is that more vehicles will be zero-emissions at the point of use. The indirect emissions from 100,000 electric vehicles can and will be reduced by improving and cleaning power plants, the single source of their energy.

Methods for Selecting EV Charging Locations

This report provides general suggestions for how Ohio's municipal and regional planners and developers can most effectively select locations for non-residential EV charging stations. During this same study period, Clean Fuels Ohio funded two additional efforts to develop more specific methods for siting charging stations.

The Ohio State University: Center for Automotive Research

TITLE: Deployment of Public Electric Vehicle Charging Stations in Mid-Ohio Region

AUTHORS: Xiaomin (Josh) Xi, Ramteen Sioshansi, Integrated Systems Engineering, OSU; Vincenzo Marano, OSU Center for Automotive Research

DESCRIPTION: The project's goal was to identify locational demand of public EV charging stations in mid-Ohio region, and to determine the impact of various location plans to understand level of service produced and cost implications.

METHODOLOGY: The study took data from Transportation Analysis Zones (TAZ), the U.S. Census, major retailers, employers, and detail parking supply to generate a model that examined the flow of vehicles between different TAZ and associated data to understand how consumer behavior differed between geographic locations. The resulting characteristics were then used to examine various models related deployment costs and objective goals in order to determine the best coverage of EV charging infrastructure that would be able to serve the population under the scenario constraints.

RESULTS: The analysis shows that siting charging stations at workplaces is best if the goal is for the driver to fill the vehicle's battery to capacity, while siting charging stations at shopping venues provides the most access to the greatest number of vehicle trips. While locations will vary based on the primary outcome goal, with a limited budget for installing charging stations the recommended locations are generally similar. For the mid-Ohio region the study suggests that the majority of charging stations should be located at sites that are either in downtown Columbus or within the I-270 beltway.

University of Akron

TITLE: PEV Demand Study and Charging Station Location Identification – A methodology study tested in the Greater Akron-Cleveland Area

AUTHORS: The University of Akron PEV Research Group

DESCRIPTION: The study focused on Level 3 Fast Charging EV infrastructure locations for non-residential charging and sought to determine best distribution of locations to cover the greatest possible population using a methodology similar to how consumers access gas stations.

METHODOLOGY: Using demographic and socioeconomic data from the U.S. Census and vehicle ownership data from Polk, the study sought to determine PEV demand in specific geographic areas and to forecast future demand. Future demand scenarios took into account variations in vehicle price, the cost of gasoline, battery capacity, incentives and the ability of the consumer to charge their vehicle at home.

RESULTS: By assuming that home charging would be best served through Level 2 charging stations, the study focused upon providing Level 3 charging infrastructure in a model similar to gas stations by distributing the stations throughout the greater Akron area. The study shows general locations which serve the greatest number of population, and also determined that the capacity of substations will limit the locations in which Level 3 charging stations could be located.

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Planning Ohio's Electric Vehicle Infrastructure

Overview

This is where "the rubber meets the road." In the previous section, the report confirmed that there is a sizable population in Ohio who will consider purchasing an electric vehicle in the coming years. This section of the report further identifies this population, specifically, where they live and work. This data will help municipal planners determine how quickly they need to address related codes and permits (discussed in the next section) and it will tell advocates and the providers of charging stations where to focus their efforts and funds.

If municipal planners and EVSE operators are two sides of the EV infrastructure triangle, then the third is the utility provider. The population data will be of critical importance to the utilities as well; by identifying now where the largest usage may be concentrated in the future, utilities can focus their efforts and funds on system upgrades and consumer education.

KEY FINDINGS

- The data in this study indicate that by 2030, ownership of all types of plug-in electric vehicles in the two study areas will number over 250,000, a fifty-fold increase from the 2015 anticipated number of EVs on the road of just over 5,000.

- Assuming a ratio of one non-residential (workplace and public) charging station for every five EVs, there will need to be roughly 50,000 publicly accessible charging stations in the Cleveland and Columbus MSAs by 2030, or an average installation of almost 3,000 charging stations per year (in addition to residential chargers).

- As large as these figures may be, this study only accounts for the greater metros of Cleveland, Columbus and the I-71 corridor. The actual numbers of plug-in electric vehicles, and the corresponding number of non-residential charging stations needed to serve them, will be significantly larger once Ohio's other major cities are taken into account.

RECOMMENDATIONS

1. Conduct similar demographic investigations of Ohio's other MSAs to develop a clear projection of EV adoption rates statewide, and identify additional likely Early Adopter and Early Majority communities.

2. Pro-actively manage the siting of charging stations on a regional basis with stakeholder representations, rather than leaving the process unmanaged.

RESEARCH

Forecasting Total EV Ownership

Using the new vehicle sales shares for hybrids, plug-in hybrid electric vehicles, and electric vehicles developed by EPRI at the county level, AECOM developed an MSA average that was then applied to vehicle sales forecasts to generate an annual new vehicle volume by type.

The table below shows the share of annual new vehicle sales.

Table 2: Percent Share of Annual New Vehicle Sales by Vehicle Type

	2015	2020	2025	2030
Plug-In Hybrid Electric Vehicles and Extended Range				
Columbus MSA	0.90%	3.40%	7.20%	11.40%
Cleveland MSA	0.80%	3.40%	7.20%	11.40%
Corridor	0.60%	3.00%	6.80%	11.00%
All-Electric Vehicles				
Columbus MSA	0.30%	1.10%	2.50%	3.90%
Cleveland MSA	0.30%	1.10%	2.40%	3.90%
Corridor	0.20%	1.00%	2.30%	3.70%

Source: EPRI, AECOM

New vehicle sales for PHEVs and EVs in 2015 are forecast to number just over 2,000 across the Columbus and Cleveland MSAs and the

corridor. By 2030 these figures are forecast to grow to over 33,000 PHEVs and EVs combined.

Table 3: Number of Annual New Vehicle Sales by Type

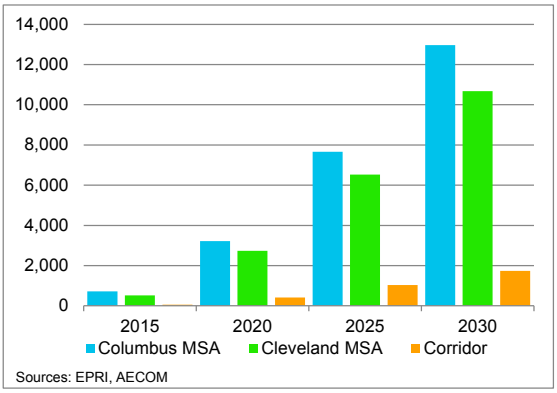
	2015	2020	2025	2030
Plug-In Hybrid Electric Vehicles and Extended Range				
Columbus MSA	770	3,250	7,360	12,600
Cleveland MSA	670	2,990	6,570	10,720
Corridor	80	440	1,030	1,740
	1,520	6,680	14,960	25,060
All-Electric Vehicles				
Columbus MSA	260	1,080	2,450	4,200
Cleveland MSA	220	1,000	2,190	3,570
Corridor	30	150	340	580
	510	2,230	4,980	8,350
Total EV/PHEV Annual Sales	2,030	8,910	19,940	33,410

Source: EPRI, AECOM

Plug-In Hybrid Electric Vehicles

PHEV annual sales volumes are forecast to grow rapidly in comparison to all-electric vehicles, contributing 75% of all new EV sales annually. The figure below includes the forecast growth in annual PHEV sales, showing that in 2030, over 12,000 PHEV vehicles are expected in Columbus, nearly 11,000 in Cleveland, and close to 2,000 in the corridor.

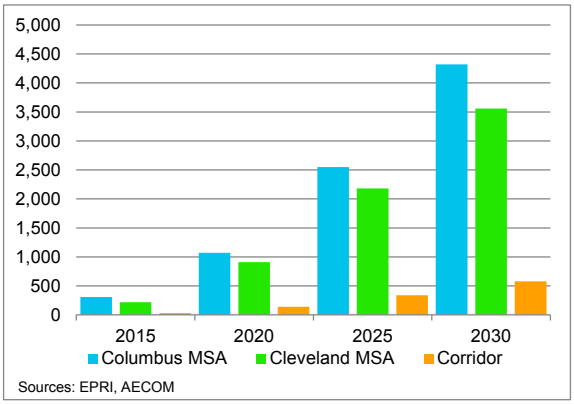
Figure 7: Annual Vehicle Sales, Plug-In Hybrid Electric Vehicles



Electric Vehicles

Sales of all-electric vehicles are forecast to number 500 annually for the combined study markets in 2015, growing to over 8,000 vehicle sales in 2030. The individual MSAs will contribute most of those with over 4,000 for Columbus and over 3,500 for Cleveland through 2030, with the corridor accounting for nearly 600 vehicles.

Figure 8: Annual Vehicle Sales, Electric Vehicles



Total Vehicle Ownership

While the annual vehicle sales (the number of vehicles sold in a given year) for PHEVs and all-electric vehicles is a small share of the overall vehicle market, over time total EV ownership (the number of vehicles on the road at a given time) in these markets will grow to be a significant number of vehicles. This is the key factor for determining the number of charging stations that will be needed to serve the state (discussed in more detail later in this section).

Table 4: Total EV/PHEV Ownership, Cumulative

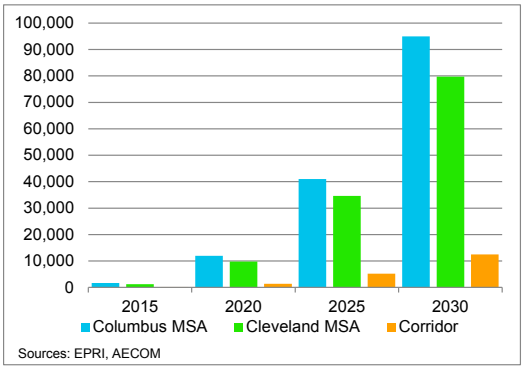
	2015	2020	2025	2030
Plug-In Hybrid Electric Vehicles and Extended Range				
Columbus MSA	1,950	12,620	40,570	92,850
Cleveland MSA	1,720	11,490	36,740	82,010
Corridor	210	1,580	5,470	12,740
	3,880	25,690	82,780	187,600
	2015	2020	2025	2030
All-Electric Vehicles				
Columbus MSA	650	4,210	13,520	30,950
Cleveland MSA	570	3,830	12,250	27,340
Corridor	70	530	1,820	4,250
	1,290	8,570	27,590	62,540
Total EV/PHEV Ownership	5,170	34,260	110,370	250,140

Source: EPRI, AECOM

Plug-In Hybrid Electric Vehicles

PHEV ownership (including extended range EVs) through 2020 is going to be relatively small in terms of total vehicles owned, with close to 13,000 vehicles in Columbus, and over 11,000 in Cleveland, but is forecast to grow to over 30,000 vehicles in Columbus in 2030, and over 27,000 in Cleveland. Ownership of PHEVs in the corridor is forecast to be nearly 13,000 vehicles by 2030.

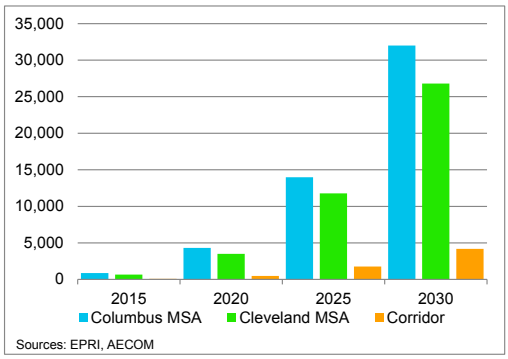
Figure 9: Total Vehicle Ownership, Plug-In Hybrid Electric Vehicles



Electric Vehicles

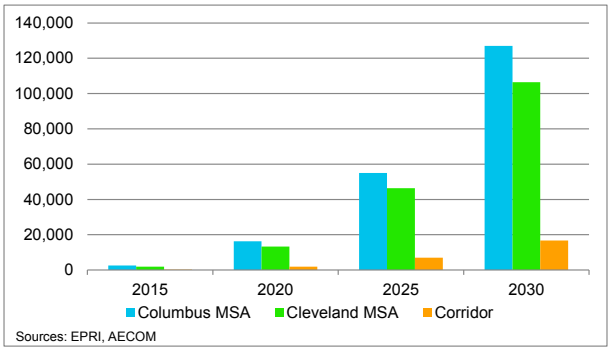
All-electric vehicles through 2020 will be a small number of total vehicles owned, less than 5,000 in each MSA. By 2030 growth in EV ownership is forecast to reach 31,000 in Columbus and 27,000 in Cleveland, with over 4,000 EVs in the corridor.

Figure 10: Total Vehicle Ownership, All-Electric Vehicles



Lastly, the figure below combines all PHEV/Extended Range and all-electric vehicles into a single unit, per MSA, clearly showing the strong projected growth in EV/PHEV ownership. By 2030, there will be nearly 124,000 such vehicles on the road throughout the Columbus MSA and 109,000 in the Cleveland MSA. Including the corridor, ownership of EVs is projected to grow an average of 29 percent annually from 2015 to 2030, adding 245,000 EVs in these market areas.

Figure 11: Total Vehicle Ownership per MSA, EV and PHEV Combined



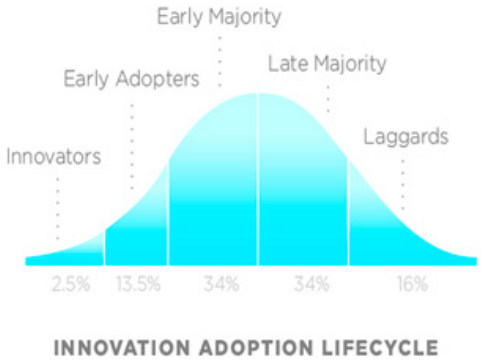
Identifying Likely EV Owners

Consumer adoption of new technology proceeds in phases. These categories are important as they describe the key consumers who will be the first to purchase or consider purchasing EVs, whose charging habits will influence the utilities as they upgrade the grid, and whose education and understanding of EVs will help spread adoption. A "bell curve" illustration of this technology adoption lifecycle is shown below, and is used in this report to identify likely owners of electric or plug-in hybrid electric vehicles.

- The **Innovators** are willing to take many steps to make the technology work and are more likely to view technology issues as a challenge to overcome. They constitute the majority of EV owners to date.
- The **Early Adopters** see themselves as pioneers or trendsetters willing to pay a premium for new technology. These consumers have begun purchasing electric vehicles.
- The **Early Majority** consumers will purchase when the EV market starts to flourish and adoption becomes widespread. These consumers have a more practical outlook on the technology and expect it to provide tangible benefits, and will begin purchasing EVs in small numbers now, with a greater number of consumers purchasing EVs by the early 2020's.
- **Late Majority** and **Laggards** are resistant to change and the costs of technology adoption. These consumers are the least likely to purchase electric vehicles.

This study is based on the understanding that EV purchases to date have been by the "Innovators" for whom cost is not an object, the "Early Adopters" have begun to enter the market and will be the dominant EV consumer for the next five to seven years, followed by the "Early Majority" who will carry EV purchases into the 2020's and beyond.

Figure 12 Technology Adoption Lifecycle



Source: Everett M. Roger's Diffusion of Innovation

AECOM examined consumer demographics as identified by the auto industry and other experts, and applied these with economic and demographic data specific to Ohio, to determine who will be its most likely EV owners, the Early Adopters and Early Majority. The following characteristics for Ohio's likely EV consumers are on par with industry expectations:

Ohio Early Adopter

- Young Baby Boomer or young, very high income individuals
- Median household income in excess of $150,000
- Previous hybrid owners
- Owns more than one vehicle
- College Educated
- Homeowner with garage in urban core or suburbs
- Drives less than 50 miles per day

Ohio Early Majority

- Median household income of $100,000–150,000
- Middle-aged households between 40–44 years
- More likely to be male
- Homeowner with garage in urban core or suburbs
- Drives shorter distances, closer to 20 miles per day

Knowing the characteristics of these potential EV households allows for identifying the communities in which they live. There are two ways to identify these communities, by the percentage of households which meet the demographics, or by the total number of households which meet the demographics. Both are illustrative; communities with a high percentage of likely EV-owning households are wise to prepare even though the total number of vehicles may be small, while those with high numbers of potential EV-owning households should definitely prepare, specifically educating front-line staff (permit offices, inspectors) and examining their codes and permit processes (as described in Section 4, Advancing EVs Through Codes and Permits).

The tables below identify each MSA's communities in which likely EV consumers live, both by the total number of households and by the percentage of households in the Early Adopter and Early Majority categories.

Table 5: Columbus MSA Early Adopters & Early Majority Communities

By Total Number of Households

	Early Majority (Income $100K+)		Early Adopter (Income $150K+)		Total	
	# HH	% HH	# HH	% HH	# HH	% HH
Columbus	29,915	9.00%	13,101	3.90%	43,016	12.90%
Dublin	3,261	21.40%	4,150	27.20%	7,411	48.60%
Westerville	2,955	21.20%	2,248	16.10%	5,203	37.30%
Upper Arlington	2,394	17.30%	2,684	19.30%	5,078	36.60%
Gahanna	2,506	19.10%	2,001	15.30%	4,507	34.40%
Hilliard	2,134	20.80%	1,264	12.30%	3,398	33.10%
Grove City	2,327	16.50%	1,052	7.50%	3,379	24.00%
Reynoldsburg	1,913	13.30%	634	4.40%	2,547	17.80%
Powell	1,036	26.80%	1,416	36.60%	2,452	63.50%
Delaware	1,794	13.60%	589	4.50%	2,383	18.00%
Total	50,235		29,139		79,374	

Source: U.S. Census, AECOM

By Total Percent of Households

	Early Majority (Income $100K+)		Early Adopter (Income $150K+)		Total	
	# HH	% HH	# HH	% HH	# HH	% HH
Powell	1,036	26.80%	1,416	36.60%	2,452	63.50%
New Albany	399	16.00%	885	35.50%	1,284	51.50%
Shawnee Hills	51	18.50%	85	30.90%	136	49.50%
Dublin	3,261	21.40%	4,150	27.20%	7,411	48.60%
Riverlea	49	22.00%	50	22.40%	99	44.40%
Granville	296	19.80%	265	17.70%	561	37.60%
Westerville	2,955	21.20%	2,248	16.10%	5,203	37.30%
Choctaw Lake	167	28.00%	54	9.10%	221	37.10%
Upper Arlington	2,394	17.30%	2,684	19.30%	5,078	36.60%
Bexley	776	16.40%	945	20.00%	1,721	36.40%
Total	11,384		12,782		24,166	

Source: U.S. Census, AECOM

Table 6: Cleveland MSA Early Adopters & Early Majority Households

By Total Number of Households

	Early Majority (Income $100K+)		Early Adopter (Income $150K+)		Total	
	# HH	% HH	# HH	% HH	# HH	% HH
Cleveland	6,047	3.70%	2,361	1.40%	8,408	5.10%
Strongsville	3,407	19.60%	2,442	14.00%	5,849	33.60%
Mentor	3,308	17.20%	1,402	7.30%	4,710	24.50%
Westlake	2,208	15.70%	2,365	16.80%	4,573	32.50%
Parma	3,164	9.20%	1,070	3.10%	4,234	12.30%
Shaker Heights	1,619	13.80%	2,353	20.10%	3,972	33.90%
Solon	1,623	19.40%	1,960	23.40%	3,583	42.80%
Cleveland Heights	2,061	10.30%	1,513	7.60%	3,574	17.90%
North Royalton	2,089	16.10%	1,007	7.80%	3,096	23.90%
Lakewood	2,194	8.70%	890	3.50%	3,084	12.30%
Total	27,720		17,363		45,083	

By Total Percent of Households

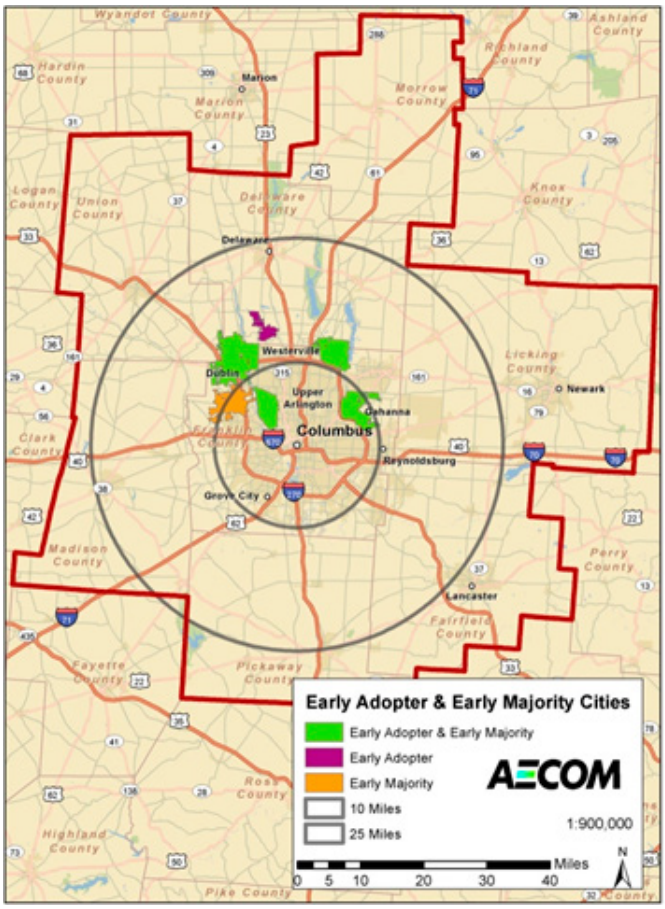
	Early Majority (Income $100K+)		Early Adopter (Income $150K+)		Total	
	# HH	% HH	# HH	% HH	# HH	% HH
Bentleyville	23	7.90%	159	54.80%	182	62.80%
Gates Mills	152	16.90%	399	44.30%	551	61.20%
Hunting Valley	18	6.70%	138	51.10%	156	57.80%
Pepper Pike	253	11.50%	1,017	46.10%	1,270	57.60%
Waite Hill	21	10.80%	83	42.80%	104	53.60%
Moreland Hills	160	12.60%	513	40.30%	673	52.90%
Kirtland Hills	39	15.50%	87	34.50%	126	50.00%
South Russell	261	18.90%	403	29.20%	664	48.20%
Orange	232	17.50%	399	30.20%	631	47.70%
Bainbridge	310	24.50%	286	22.60%	596	47.20%
Total	1,469		3,484		4,953	

Source: U.S. Census, AECOM

During the course of this study, robust discussions among stakeholders debated how best to allocate limited resources for efforts to raise consumer awareness, examine local codes, etc. The data in these tables clearly indicate that focusing efforts on communities with a higher number of households meeting the potential EV owner demographic will impact significantly more consumers than focusing on communities with a higher percentage of potential EV owners. However, working with a few communities with the higher percentage of potential owners would be appropriate for scaling the permit review and code process for lower population townships and villages.

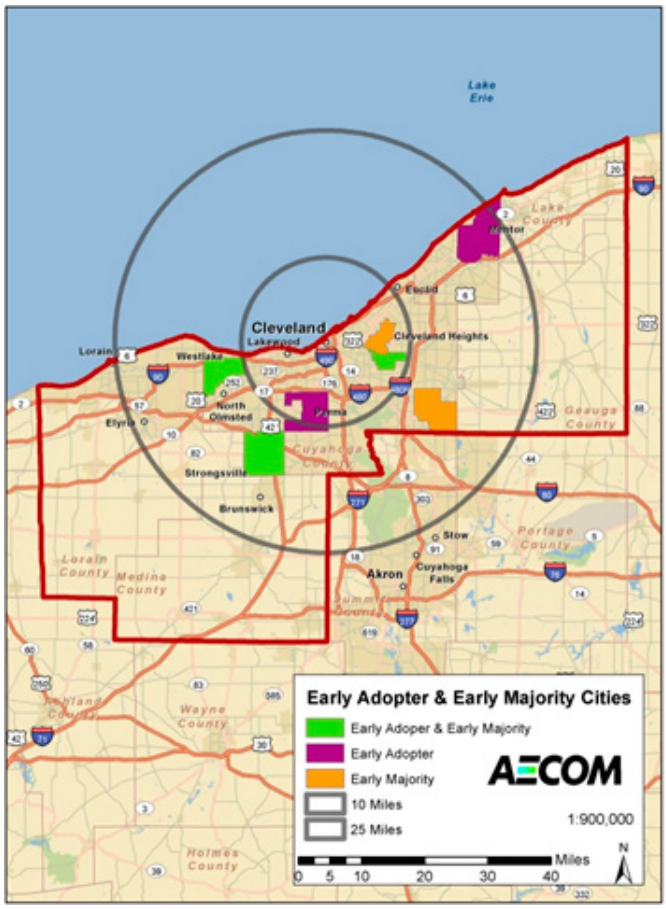
The figures below demonstrate that in both MSAs, most of the Early Adopter and Early Majority communities are located within 25 miles of the city center. This further supports the point of focusing advocacy and planning efforts in these areas; the residents not only can afford electric vehicles, but also the single-charge driving range is likely to meet the needs of their daily activities.

Figure 13: Distance to the City Center, Columbus



Source: U.S. Census Bureau, AECOM

Figure 14: Distance to the City Center, Cleveland

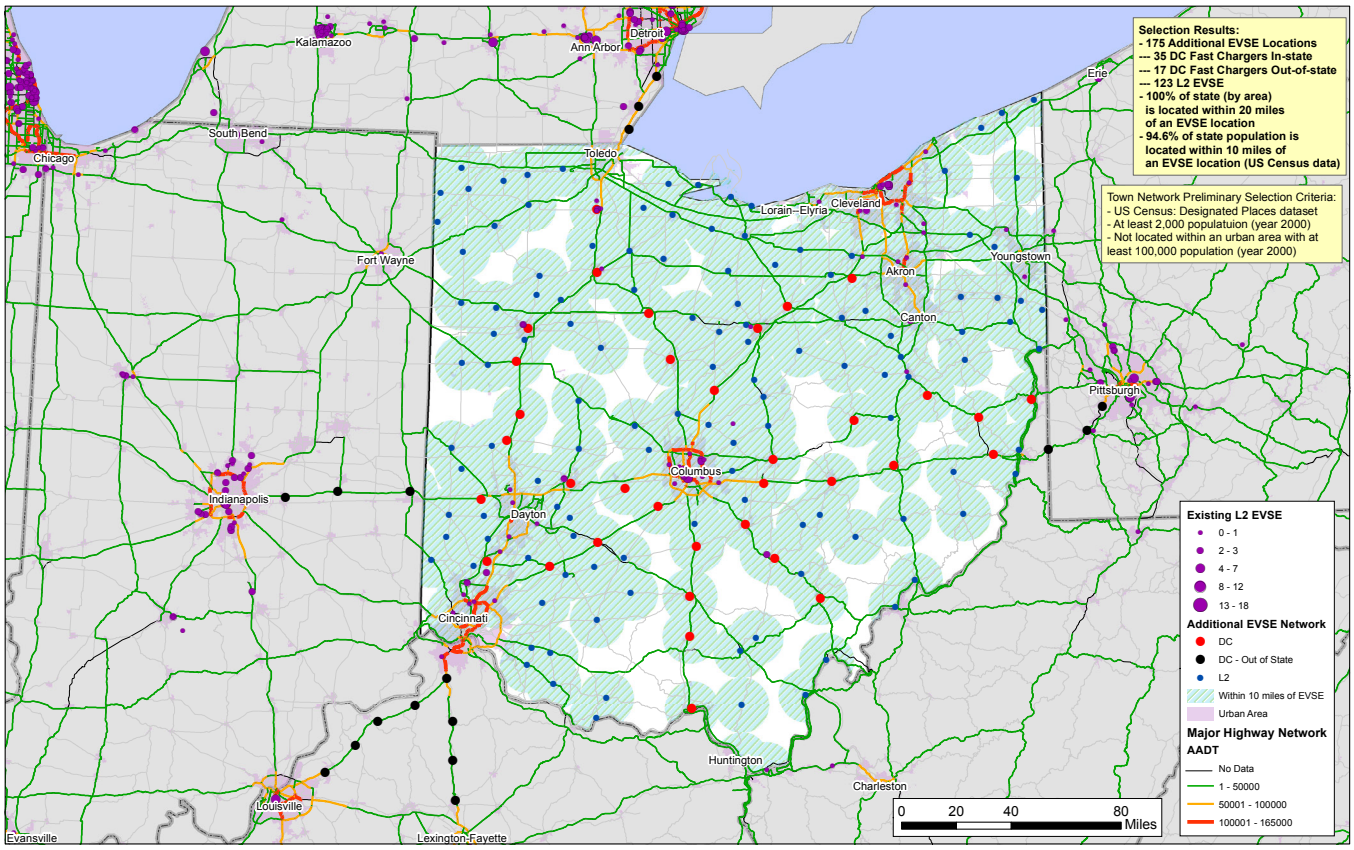


Source: U.S. Census Bureau, AECOM

EV Charging Away from Home

This study estimates that by 2030, the Cleveland and Columbus MSAs combined will require over 50,000 charging stations to serve EV drivers away from home. These "non-residential" charging stations will be located at workplaces, shopping centers, entertainment venues, schools, and many other places wherever people drive. EPRI developed the following map showing a model network where charging stations should be located in order to provide 95% of Ohio's population access to a charging station within 10 miles of home, and 100% of the land area within a 20 mile radius – based on city centers and traffic along major roadways. EPRI's map also indicates where DC fast chargers should be located to provide maximum access between destinations. The locations on the map do not indicate how many charging outlets should be provided at each location.

Figure 15: Ohio's EV Charging Network[33]



Non-Residential Charging Station Location Options

As municipal and regional planners consider how best to establish a convenient, efficient and effective network of EV charging stations, they should examine the location types available within the community or region. The following summary describes many types of locations which could each be prime candidates for EV charging stations.

Large Employers

A region's largest employers focus a considerable amount of activity and commuting into given areas of an MSA. In fields where the educational level and incomes of employees are higher, there will be more Early Adopters and Early Majority individuals, and these employees are likely to be the first to request workplace charging from their employers. In addition, large employers located further from the regional center will face greater demand as employees must travel further, and therefore use more battery energy, than those working in centralized locations. In the Columbus MSA, large employers outside the city center include Baker and Hass, JC Penney Store Support Center, VA Medical Center, Glatfelter Co. and Kenworth Truck Co., each with over 1,000 employees at a single location and are likely to see higher demand from employees for workplace charging. Similarly in the Cleveland area, the Ford Motor Co. Assembly Plant, Baldwin-Wallace College, and Ohio Farmers Insurance may see this same demand.

Clean Fuels Ohio will be working with CALSTART in 2013 and 2014 to address workplace charging in Ohio. The workplace charging initiative will include a survey of employers in Ohio that have already installed chargers or are investigating workplace charging. The goal of the survey is to better understand the primary barriers and needs of the local market. The analysis and results of the survey will set the baseline and provide information from early adopters of workplace charging in Ohio and identification of the barriers that need to be addressed to speed up

On February 7 the US Department of Energy announced the Workplace Charging Challenge, a collaborative effort to increase the number of U.S. employers offering workplace charging by tenfold in the next five years. Employers who join as partners commit to assess workforce PEV charging demands, and then develop and implement a plan to install workplace charging infrastructure for at least one major worksite location. The inaugural group of partners includes 3M, Chrysler Group, Duke Energy, Eli Lilly and Company, Ford, GE, GM, Google, Nissan, San Diego Gas & Electric, Siemens, Tesla, and Verizon.

Citation: "EV Everywhere Charges Up the Workplace." U.S. Dept. of Energy. 07 Feb. 2013

[33] EPRI, Palo Alto, CA. 2013

adoption of workplace charging. Clean Fuels Ohio will host a regional workshop for employers interested in workplace charging. The survey results will be presented at the workshop and key workplace charging issues will be addressed.

Office Parks

Office parks are larger than individual offices so their infrastructure capacity and concentrations of office workers who meet the Early Adopter and Early Majority profiles may be greater. Office parks are often managed by larger institutional/commercial property owners, an advantage for EV infrastructure planning; one owner can coordinate purchases, installation, and communication with utilities on behalf of multiple properties.

Hospitals

Hospitals employ a significant number of people at a single location, many of whom are highly educated and with greater than average incomes, likely in the Early Adopter/Early Majority demographic, and have significant visitor traffic. Road signage already provides directions to hospitals, so if EV owners are aware they are able to use these charging stations, hospital-based charging would serve as a reliable safety net for EV users. Outlying hospitals should be considered prime opportunities to extend the EV range and provide an element of re-fueling "peace of mind" to EV owners.

Colleges and Universities

Similar to hospitals, colleges and universities have an educated workforce likely meeting the early EV owning demographics, a large number of employees and students in a concentrated area, and are often host to public events (sports, culture) attracting additional visitors. In addition, some universities including The Ohio State University, Bowling Green State University, Northwest State Community College, and the University of Toledo are using charging station projects to educate students on the technology.

Government Buildings

Government buildings offer high visibility and demonstrate the commitment of a given agency to supporting EV adoption. By being early implementers of EV infrastructure, municipal, state, and federal agencies will be the first to understand and overcome the challenges involved in implementation and can help streamline the process for future users with regards to permitting, coordination with utilities, and managing associated costs.

Attractions

Regional attractions are locations that draw visitors from throughout the region and beyond, such as sports stadiums, museums, parks, convention centers, theatres, aquariums, and zoos. These venues often include large parking facilities and visitors usually stay for two hours or more on a single visit.

Event-based venues will have a volatile demand for EV charging stations based on the event schedule. Other venues such as museums, parks and zoos will have a more consistent demand for EV charging based upon

Case Study: EV Charging Stations at the Ohio Statehouse

DATE INSTALLED: October 2011

DESCRIPTION:
The Capitol Square Review and Advisory Board (CSRAB), the management agency that oversees Ohio's Capitol Square complex, installed six Level 2 charging stations in the facility's underground parking garage, located in the heart of downtown Columbus. The charging stations are conveniently located on the first level of the parking facility, and cost users $0.50 per hour to charge their vehicle. The Ohio Statehouse was the first statehouse in the continental United States to provide charging stations for public use.

FUNDING:
The charging stations were made possible through a grant from Clean Fuels Ohio and the U.S. Department of Energy, as well as contributions from Honda of America, General Motors, the Eaton Corporation and Professional Supply, Inc. No state funds were used to install the Ohio Statehouse PEV charging stations.

LESSONS LEARNED:
CSRAB recommends conducting basic market research to forecast the number of electric vehicles operated in a particular service area and to better understand the number of parking spaces taken out of regular service to develop an appropriate ratio of PEV charging stations to electric vehicles.

CSRAB also recommends exploring the technology in its entirety prior to installation. The Ohio Statehouse parking facility is underground, therefore the PEV charging stations could not utilize the standard satellite technology that is available for credit card charging. Alternate methods needed to be realized after the PEV charging stations were put into service.

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Capitol Square Review and Advisory Board
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hours of operation. These present different demands and challenges for venues that install EV charging infrastructure as the availability of charging stations to EV drivers varies in each case.

Retail Venues

Commercial locations such as shopping centers and individual retailers are generally local in nature, serving a relatively compact customer base within a few miles of the consumer's residence. As such, the economic viability for installing EV charging stations can vary based on the type of retailer, length of visitor stay, and geographic location of the business.

A number of retailers have begun implementing pilot programs to test out EV charging infrastructure including Walgreen's and Wal-Mart which each have charging stations at Ohio stores. There are multiple reasons why a retailer may choose to include EV charging stations on their property, such as cultivating a green image, to assist in LEED certification, and to entice higher-income customers to shop at and remain in their stores longer.

Large shopping centers, malls and strip malls may be prime candidates for EV charging stations. With large volumes of daily traffic and shoppers staying for an extended period of time, and pulling consumers from a wider geographic area, these locations offer convenience for users and benefit the retailers by encouraging drivers to leave their vehicles for longer periods than at individual retail outlets. At the time of this writing, Simon Property Group has two charging stations installed at five mall properties in Ohio, including The Mall at Tuttle Crossing in Dublin.

The business case for retail-based EV charging stations is still being built. For many retail locations, the consumer is not in the store long enough to provide much time for notable charging, and the return on investment for the retailer is unclear. However, the benefits of "being first," supporting sustainability, and attracting higher-income consumers are quickly being calculated by the retailers who are experimenting with EV charging.

Tollways, Interstates and State Highways

Charging stations along state and interstate highways can facilitate the EV owner's desire to travel to destinations outside of the single-charge range. The demand for this type of EV charging and the supporting infrastructure needed is different than other destinations, as the driver wants an immediate charge and a return to the road as fast as possible. A DC fast charging station can provide this service – generally in 30 minutes or less – but both Level 1 and Level 2 charging stations fall short.

The types of service amenities provided at rest areas vary widely; the I-71 rest areas (one at either end near the two cities and one off the highway near Mansfield) are un-staffed buildings featuring only restrooms and vending machines, whereas I-80/90 features grand "oases" rest stops offering shops, restaurants, and fuel. Drivers travelling along routes with only basic rest areas will appreciate the convenience of a DC fast charge outlet, but will find their 30-minute wait less engaging than the amenities available at the larger rest stops. The basic rest areas may not have the power capacity to offer DC fast charging without significant service upgrades.

Identifying where likely EV owners live is important for community readiness, and it is also important to identify where non-residential charging stations should be located. Strategic placement of charging stations within metro areas and across the state will encourage more and faster EV adoption, whereas haphazard or unplanned deployment of charging stations could have the opposite effect, creating a chaotic approach that will deter an uninformed public wary to test a new technology.

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Ohio's Utility Readiness

Overview

Ohio's electricity is generated by a handful of large utilities, and power is supplied to customers through scores of local and regional public agencies and private firms. The large utility corporations are actively studying electric vehicles and the impact they may or may not have on the capacity of Ohio's grid. The average consumer simply wants to be able to buy their electric vehicle, plug it in at home and enjoy the ride, but as EV adoption grows, the utilities need to know where EVs are plugging in so their infrastructure can perform without compromising the safety and comfort of all customers.

The utilities are already on a great start with their internal initiatives – experimenting with EVs in their own fleets, collecting data from employee users, collaborating with municipalities and advocates like Clean Fuels Ohio – and with superior data collection specific to the Ohio communities they serve, the utilities can play a strong and vital role in smoothing the road for EV adoption. Specifically, utilities and municipalities should collaborate to identify site-specific concerns and understand the transformer capacity of older communities which may not have been upgraded for many years.

KEY FINDINGS

- Research indicates that Ohio's electrical grid will be able to accommodate electric vehicles without disrupting regular service to customers well into the future.
- Contrary to popular assumption, stringent time-of-use rates are likely to have an adverse impact on the utility grid, whereas allowing EV owners to charge at-will results in a more even distribution of grid demand throughout the day, at least in the near term.

RECOMMENDATIONS

1. Assess transformer capacity in the communities where the Early Adopter and Early Majority households live and work, as described in Section 2, Planning Ohio's EV Infrastructure.
2. Use the resulting research to improve the power capacity in those areas with any necessary upgrades.
3. Coordinate with the power providers, specifically on consumer education efforts.
4. Encourage consumer and community notification of EVSE installation so that transitions are smooth.

RESEARCH

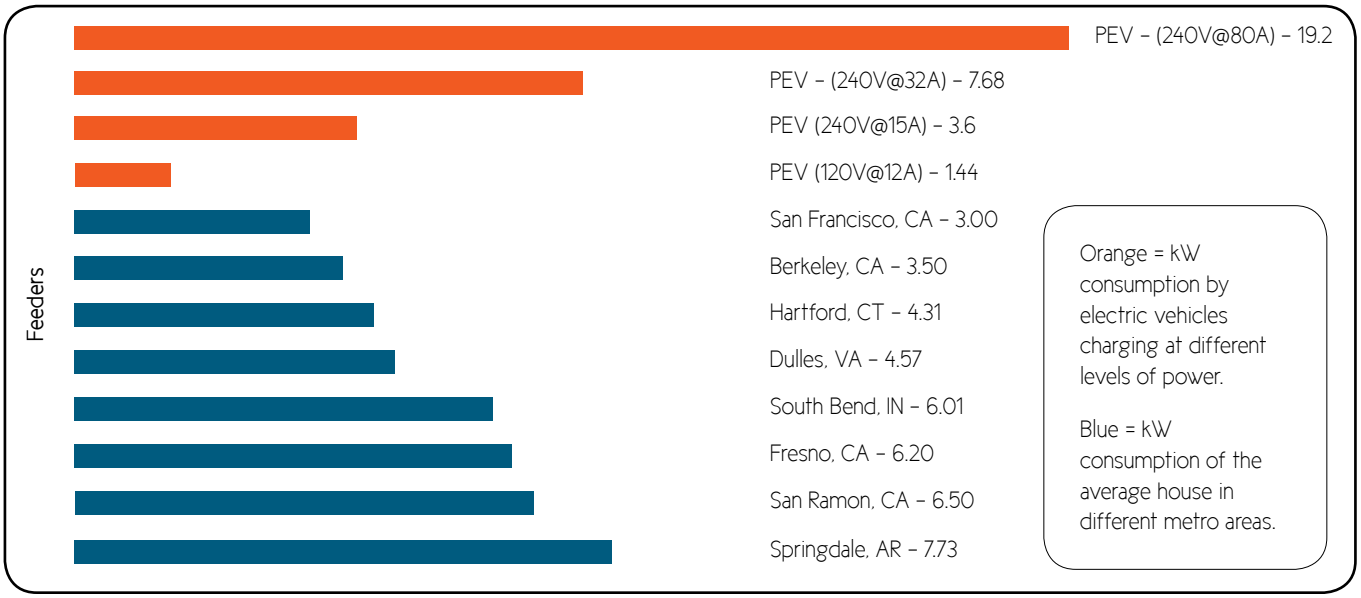
Localized Impact of Electric Vehicles on the Grid

Utilities, in general, have the generation capabilities to handle EV charging. However, informing the utility of charging high-power EVs (i.e., Tesla Model S) or the installation of Level 2 and DC fast charging equipment is important so that any necessary upgrades can occur. This segment briefly examines the impact that EV charging may have.

Plug-in electric vehicles have the unique ability to do most, if not all, of their refueling at home. Additionally, most vehicles drive short distances, arrive home in the evening, and remain parked for the remainder of the night. Vehicles then have a large block of time to charge, and generally are not completely drained of battery power when the charging begins. As a result there are two options for home refueling: (1) charge at a higher power with a shorter duration, or (2) charge at a lower power with a longer charge duration.

There are two levels at which vehicles currently can charge at the home. Level 1 is 1.44 kW, or about the same power as a hair dryer. Level 2 is between 3 and 8 kW; the low end of Level 2 is comparable to a clothes dryer which typically runs about 3 to 4 kW, whereas a central air conditioner is closer to the higher end Level 2 charging. The chart below shows the average house loads for several cities across the country, and compares them to EVs charging at varying powers; different vehicles have different charging capabilities, however most vehicles are limited to 3.6 or 7.6 kW.

Figure 16: Average Peak Summer Demand per Household (kW)[34]

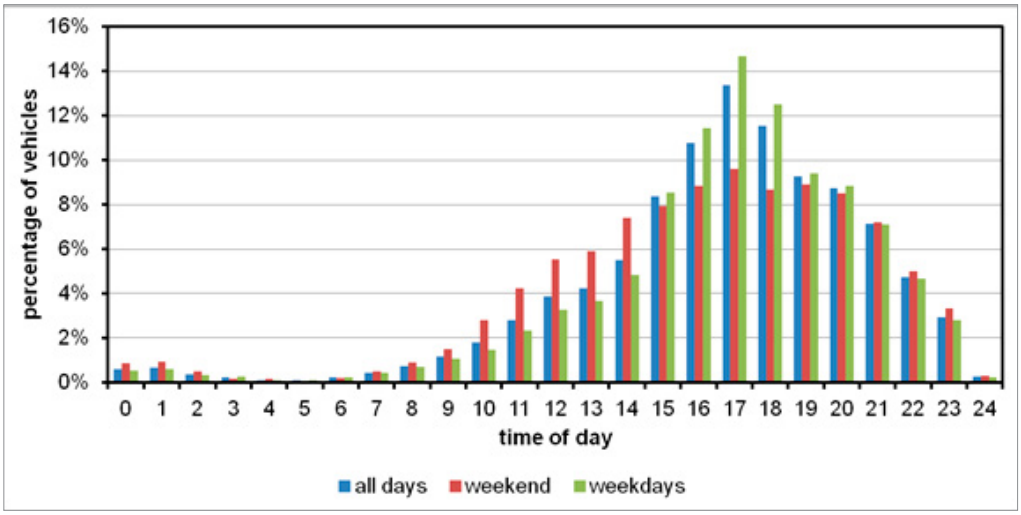


As this chart illustrates, electrical consumption by EVs (with the exception of the Tesla Model S and Roadster) are all within the range of a house. These loads, from a utility perspective, are all very manageable.

If utility loads from EVs are all manageable, then the next element to understand is whether or not there is a benefit to placing consumers on a charging schedule, such as a time-of-use (TOU) rate. TOU rates are rates structured so that consumers pay less during off-peak periods (generally at night), and pay more during times of high demand (mid-day to early evening). TOU rates can be very beneficial in areas with frequently high-peaking loads, such as air conditioning loads in the South or in manufacturing districts where equipment can be operated at different times.

Vehicles arrive home at a fairly even distribution throughout the day. This is shown in the following figure.

Figure 17: Distribution of Home Arrival Times by Day Type[35]

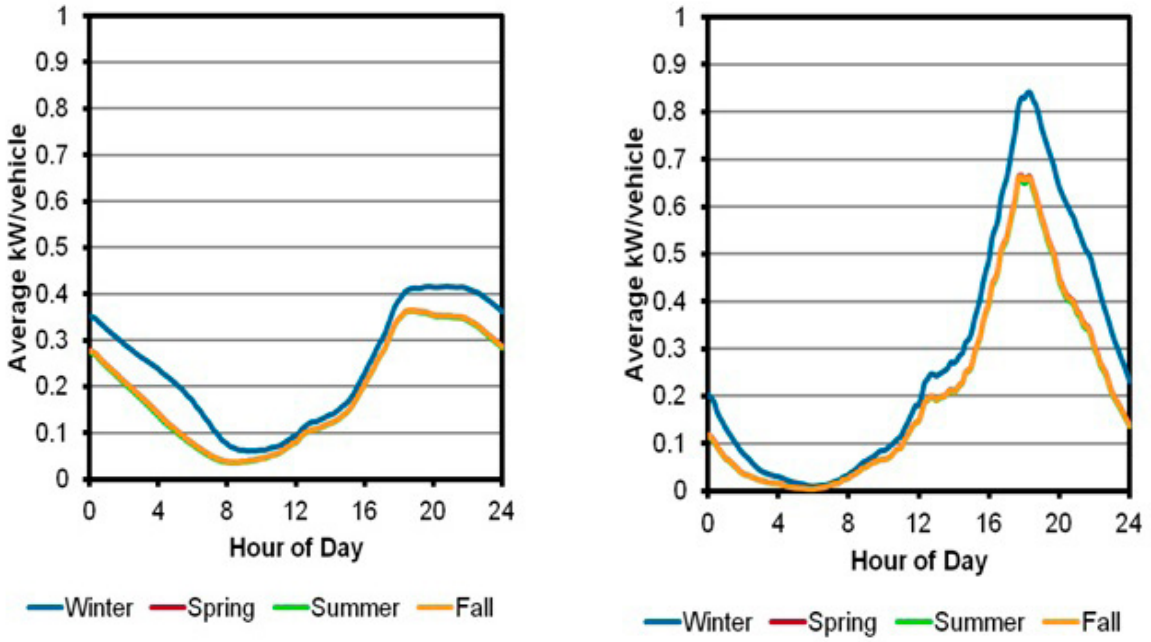


[34] Electric Power Research Institute. *Understanding the Grid Impacts of Plug-In Electric Vehicles (PEV): Phase 1 Study – Distribution Impact Case Studies.* Palo Alto, CA: 2012. 1024101
[35] Electric Power Research Institute. *Transportation Statistics Analysis for Electric Transportation.* Palo Alto, CA: 2011. 1021848

Because of this distribution, if vehicles simply begin charging as soon as they arrive home, the additional load is actually quite small – a fraction of the actual charge power. These results vary slightly by season, as vehicle energy consumption changes throughout the year[36].

The following figure shows the results (average kW load per vehicle) of uncontrolled charging at 1.44 kW (Level 1) and 6.6 kW (Level 2) for weekday driving.

Figure 18: Average Power Demand per Vehicle[37]. Left: Level 1, 1.44 kW; Right: Level 2, 6.6 kW

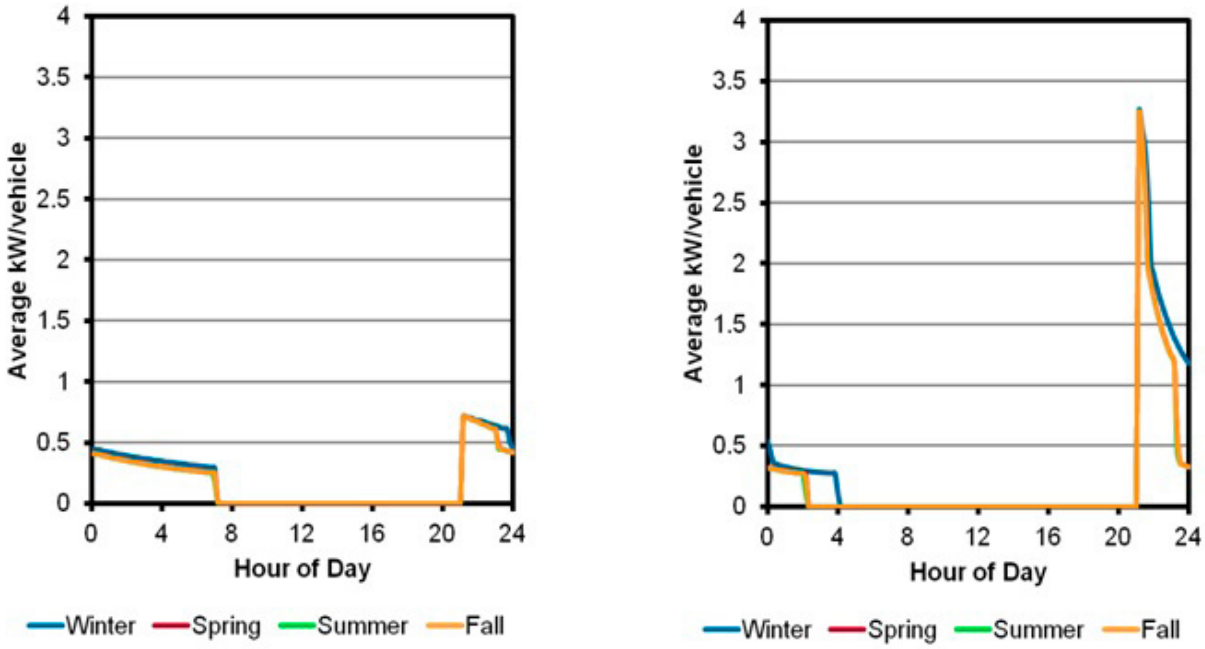


The results presented here are the average power demand per vehicle so it is representative of the entire energy consumption averaged over the entire population of vehicles. These values are quite manageable from a utility perspective. The higher charge power has charging ending early in the morning, while if a lower charge power is used, some vehicles may still be charging (specifically all-electric vehicles which drive long distances) in the early morning.

However, if a TOU rate is applied, and vehicles are encouraged to delay charging, there is actually a second peak that occurs, and it has nearly all vehicles beginning charging at this time. The next figures show the same two charge powers, for weekdays, on a TOU rate.

[36] This occurs in conventional vehicles as well; consumption changes seasonally.
[37] Electric Power Research Institute. *Transportation Statistics Analysis for Electric Transportation.* Palo Alto, CA: 2011. 1021848

Figure 19: Average Power Demand per Vehicle on a TOU Rate[38].



TOU rates produce a much higher peak than uncontrolled charging. TOU rates also encourage consumers to charge at a higher power because they have a shorter amount of time to charge. For the lower power case, almost all vehicles are still charging by the end of the off-peak period, whereas most vehicles have finished charging by the end of the off-peak period at a higher charge level. Consumers have control over the charge power in the sense that they are able to choose whether or not to install a higher capacity circuit. The vehicle may limit the input power based on specifications (for instance, the 2012 Nissan Leaf was only able to charge at approximately 3.3 kW but the 2013 Nissan Leaf is able to charge closer to 6.6 kW).

This method of charging can present a problem at the transformer level which could have a negative impact on the utility because it condenses the demand to a shorter period at a higher power. Charging at a higher power is actually like adding another home to a transformer in an area. If a lower charge power is used, vehicles arrive home from daily driving and can still charge before departing the next day. Additionally, if there are multiple EVs on one transformer it can add 'clustering' effects and require upgrades that otherwise may not need to happen.

If EV owners are allowed to charge at a lower power upon arrival, the average grid impact is lower than the total charge power with a time-of-use rate.

Ohio Utility EV Preparation Efforts

Ohio is served by a wide array of utility providers, and strategies for smart grid integration and electric vehicles will require significant preparation. The primary utility providers for the Cleveland MSA are the Cleveland Electric Illuminating Company, Ohio Edison, and the Lorain-Medina Rural Electric Cooperative. The Columbus MSA is served by more providers with less distinct boundaries, including Columbus Southern Power, Ohio Power, Licking Rural Electrification, South Central Power Company, Union Rural Electric Cooperative.

[38] In this scenario, the peak period is from 7 AM until 9 PM.

In Ohio, electric power is provided by seven investor owned utilities and 25 rural electric associations. Of these entities, the overwhelming majority of Ohio's electric power is generated by four major utility companies: American Electric Power, FirstEnergy, Duke Energy, and Dayton Power and Light. Combined, these four utilities cover every major metropolitan area in the state, including the cities of Toledo, Cleveland, Akron, Canton, Columbus, Dayton and Cincinnati. The following sections detail the steps taken by each of the four major utilities to date regarding:

- Rate structures or provisions and billing protocols for the charging of plug-in electric vehicles
- Analysis of potential impacts to the grid
- Plans to minimize the effects of charging on peak loads
- Plans for making widespread utility and grid upgrades

American Electric Power (AEP)

AEP Ohio has worked internally and collaboratively with various Ohio stakeholders to create policies and plans for accommodating the deployment of plug-in electric vehicles and charging infrastructure. Its major activities, as of mid-2012, are described below.

- Provisions & Billing Protocols for EV Charging
  AEP Ohio offers several rate options EV drivers. Any AEP Ohio customer can utilize an existing residential time of use rate to obtain lower pricing on off-peak electricity usage. The rate is 8.93 cents on peak (7 am – 9 pm) and 1.17 cents off-peak (9 pm – 7 am + weekends/ holidays), excluding riders. Additionally, customers participating in the smart grid demonstration project located in the northeast part of central Ohio can take advantage of several experimental rate options to lower the cost of charging their vehicle. Those rate options include two tier, three tier plus critical peak pricing, and real time pricing. More information on those rates can be found on AEP Ohio's website.
- Analysis of Grid Impact
  AEP has assembled a team of roughly 25 people from across the company, both from its corporate office and from various regional operating companies, to prepare its business and electrical system for EV adoption. In Ohio, AEP has been working collaboratively with groups such as Clean Fuels Ohio, Ohio DOT, Ohio State University, the Electric Power Research Institute, and the National Electric Contractors Association to better understand the usages and impact of EV charging. As part of a smart grid demonstration project in Columbus, partially funded by the DOE, AEP plans to deploy 11 EVs and 19 Level 2 chargers. Eleven chargers will be located in employee participant homes, while the others will be installed at four AEP workplace locations in Columbus, Gahanna, and Groveport. AEP will also install up to four chargers in two public, retail locations in the northeast quadrant of Columbus. AEP also plans to make Level 1 outlets available at each of the above work locations. AEP will collect driving and charging behavior as well as track installations and document lessons learned to better understand how to prepare for EVs. Through this team effort, preliminary analysis of EV charging impact on the grid has begun to emerge, though a formal grid impact study has not yet been developed.
- Minimizing Peak Loads
  AEP recently launched a customer service and outreach campaign through a website for each operating company that explains EV technology. AEP will also use the new, innovative rates and customer feedback to better understand which programs help reduce grid impact and save customers money. Through this education campaign and research on best practices for reducing impact to the grid, AEP has begun to gather data necessary to understand ways to minimize effects of charging on peak loads.
- Utility & Grid Upgrades Plan
  AEP has begun to plan for utility and grid upgrades through the partnerships gained throughout Ohio, research on provisions and billing protocols and public education and feedback.

Dayton Power and Light (DP&L)

DP&L has an internal team that has been following developments with EVs since 2008 with a multi-dimensional focus on the subjects described below.

- Provisions & Billing Protocols for EV Charging
  DP&L has begun to explore rate structure alternatives for EV charging. DP&L has developed partnerships with the goal of developing provision and protocols for EV charging. Through participation and partnership with SMART@CAR at The Ohio State University, DP&L has begun to research proper protocols and procedures associated with EV charging. In addition, DP&L has conducted a third party study to predict EV market penetration on the DP&L system through 2020.
- Analysis of Grid Impact
  DP&L has conducted a preliminary distribution residential transformer loading study of pad mounted transformers to determine capability to handle the additional loading as a result of EV charging. DP&L studies and research suggest that there will be no appreciable adverse grid impact under any expected EV roll-out scenario for the next decade with the possible exception of some residential transformers and service drops.
- Minimizing Peak Loads
  DP&L conducted an EV charging study of a small number of EVs in service and charged at the owner's residence to determine charging characteristics including time-of-charge and coincidental charging. DP&L is committed to using this data to develop a strategy to minimize the load on the grid during peak hours.
- Utility & Grid Upgrades Plan
  DP&L has purchased an EV and has commitments to purchase others to gain firsthand experience with EVs and their charging. DP&L is committed to using the information gathered from firsthand experience to plan for upgrades for the utilities and grid. DP&L has also begun working with customers and local groups to educate them about EV charging. From this education campaign, DP&L plans to gather feedback and responses to plan for future upgrades to utilities.

Duke Energy

Duke Energy has a variety of current and planned activities related to EV readiness and planning for all five of its jurisdictions. Duke is utilizing its gained knowledge and lessons learned across jurisdictions in the subjects described below.

- Rate structures or provisions and billing protocols
  Duke Energy has several initiatives underway with a strategy of initially

collecting charging station data without influencing customer behavior. Duke is establishing a baseline understanding of when customers charge, where they charge, and how often they charge under its current rate structures. Once customer behavior is understood, Duke will have a more informed view of potential grid impact as EVs become more common in Ohio. Duke has discussed developing and testing customer offers that mitigate potential grid impact while providing the best possible charging experience for EV owners, although the details of such offers have not yet been fully developed. Duke Energy is participating in several pilots:

- Duke Energy in conjunction with GM and the DOE has developed and launched an EV pilot to study the grid impacts of charging as well as charging infrastructure interface with grid technology.
- Duke Energy was approved for a 150 EVSE residential customer in pilot in North Carolina and South Carolina. Duke has completed the installation of all the equipment and are continuing to collect data on these units.
- Duke Energy is participating in Project Plug IN in Indiana where to date 60 residential units have been installed with an additional 26 more by the end of 2012, and 18 commercial units at retail facilities, work place charging and local cities/municipalities (with an additional 18 more by the end of 2012).
- Dodge Ram and Chrysler Mini Van Project – North Carolina: Participant of the DOE and Chrysler "Advancing Transportation through Vehicle Electrification" program to test pilot Dodge Ram EV prototype trucks and Chrysler Mini Van EV prototype vans. Duke has eight Chrysler EV Mini Vans and 10 Dodge Ram EV Trucks, and 16 Chrysler-owned charging stations.
- Duke Energy is completing some initial internal testing on three customer programs: Demand Response, Pre-program charging and time of use rates. These tests are focused on testing the technology to provide enhancement to the products and understand behavioral preferences.
- Duke Energy is participating in two projects to assist EVSE manufacturers in fulfilling the DOE requirements of (1) reducing by 50% the cost of EVSEs and (2) assuring the high penetration of EVs does not degrade power quality and reliability in the distribution power grid.

In all of these pilots the primary purpose is to collect the necessary data to assess distribution impacts on the grid and Duke Energy's ability to manage those impacts. All of this data will be critical in determining the appropriate demand response and demand shifting programs to offer its customers that will effectively mitigate the impact of on peak EV charging while also maintaining a positive charging experience for Duke's EV owning customers.

- Analysis of potential impacts to the grid
  In addition to those pilot projects, Duke Energy has developed a grid impact model that reinforces the conclusion that the company does not anticipate issues with the power grid based on current forecasted EV adoption levels, which are also supported by feedback from early adopter locations. Duke Energy does not see a need for widespread upgrades to the grid in the short term based on current adoption forecasts. Duke Energy's near term strategy is to use the data collected through piloting to effectively manage on-peak charging to mitigate the need to make widespread grid upgrades in the near term.

FirstEnergy (FE)

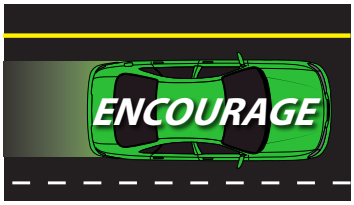
FirstEnergy has been involved in electric transportation R&D through the Electric Power Research Institute (EPRI) since 2005 and has been an active participant in Ohio's Plug-in Electric Vehicle (EV) Stakeholder Task Force since 2010. Through this collaborative, FE has supported various EV readiness initiatives, including public education and outreach with local project partners including The University of Akron (UA), the City of Akron, The Ohio State University (OSU), the Ohio Department of Transportation (ODOT), Clean Fuels Ohio and various automotive companies and tier 1 suppliers. FirstEnergy has also conducted research through EPRI on grid infrastructure, economic development and the environmental aspects of EV technology.

- Provisions and Billing Protocols for EV Charging
  Through R&D partnerships with EPRI, OSU SMART@CAR, the University of Akron, and other organizations, FirstEnergy has been researching EV charging procedures to balance consumer needs and grid compatibility. Through these research studies, the company has collected charging station data to better understand consumer charging patterns under current rate structures and developed EV market penetration scenarios through 2030. FirstEnergy continues to monitor rate options, including those across other states in its territory. Future alternatives for rate structures and billing protocols for EV charging will be evaluated as vehicle deployments reach larger levels.
- Analysis of Grid Impact
  FirstEnergy has been performing EV distribution impact studies through EPRI and OSU SMART@CAR, sharing these analysis insights with the Ohio project partners. In addition, FE is sponsoring a number of technology demonstrations with its collaborative research partners to further understand grid implications and develop solutions for future integration of these vehicles. These tech demos have included installation and evaluation of Level 2 chargers (available for public use) in conjunction with the City of Akron and Clean Fuels Ohio, and vehicle-grid evaluations using MINI E electric vehicles, Chevy Volts and soon, PHEV Vans as part of DOE-EPRI smart charging assessments.
- Minimizing Peak Loads
  Developing "smart charging" technologies, which could manage when and how EVs are charged, will be important to the successful adoption of these vehicles and grid integration in the future. FirstEnergy continues to work with EPRI and local research partners, The University of Akron and OSU SMART@CAR, to evaluate the best approaches and smart charging practices to minimize impacts to the electrical system during peak hours.
- Utility and Grid Upgrades Plan
  FirstEnergy is performing grid infrastructure studies with EPRI and regional and corporate distribution planning personnel to evaluate future loading impacts from projected EV charging, and will develop smart charging options to address these potential impacts. Based on these studies and current adoption rates, FE does not see an immediate need for EV-related grid upgrades beyond the normal load-growth planning process. FE's technology pilots will help to effectively manage on-peak EV charging to optimize requirements for grid upgrades as FE customers use more electric vehicles in the future.

Advancing Electric Vehicles Through Codes & Permits

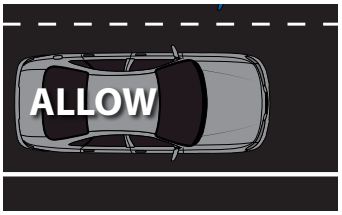
Overview

Ohio municipalities can effectively encourage adoption of electric vehicles through their permitting rules, zoning codes and building codes. This section describes local government regulations, policies and processes that will, at the least, allow electric vehicles and, at best, actively encourage them. These levels of engagement are described as occupying the "slow lane," "middle lane" or "fast lane" of the EV adoption highway. Put simply:



- **Fast Lane** communities actively develop permit processes, codes, policies and programs that accelerate the ownership of electric vehicles and infrastructure development by their residents, businesses and governmental fleets.

- **Middle Lane** communities adjust their processes and codes to make EV ownership easy, and may provide some visible but low-cost incentives that encourage EV ownership.



- **Slow Lane** communities review their permitting processes and codes to ensure that there are no significant barriers to EV ownership, and adjust where needed.

Columbus collects data on whether an electrical permit involves EVSE to track permit volumes and help the City respond as interest increases. Columbus also has a clear permitting process, issuing minor electrical permits where a dedicated circuit is needed and requiring a full permit with inspection only when panels need upgrades.

A supplemental section to this report, *Codes and Policies to Advance Electric Vehicles*, provides model codes and policies that are specific enough to address the needs of municipalities and electric vehicle owners, yet broad enough to be adapted by municipalities according to their own needs and existing processes.

KEY FINDINGS

- Over 40 Ohio municipalities , large and small, already offer at least one public charging station.
- Columbus is off to a strong start in planning for electric vehicles and can serve as a resource for other municipalities.
- Cleveland's EV planning is in the early stages, typical for most jurisdictions nationwide.

RECOMMENDATIONS

Ohio's communities have an opportunity to learn from recent examples and experiences in cities that are further along in the EV preparedness process and adapt these to their particular circumstances and goals. Regardless of size, municipalities can join the statewide EV readiness movement through these specific actions:

1. Evaluating existing codes and procedures to identify, and then address, barriers to EV adoption.

2. Building upon the baseline of allowing EV infrastructure toward facilitating policies and practices that support EV implementation.

3. Becoming a leader in EV planning by actively encouraging policies and practices that support EV implementation.

4. Participating in Clean Fuels Ohio's EV stakeholder group activities and begin local task force.

RESEARCH

Current Conditions and Local Leadership

This analysis is designed to evaluate current practices addressing electric vehicle readiness, with particular focus on the cities of Columbus and Cleveland as well as the I-71 corridor linking them. Important elements of this evaluation are the identification of real and perceived regulatory barriers to installing EVSE infrastructure, and the consideration of how strategic policy changes can overcome these obstacles, streamline the approval process, and establish a strong platform for EV preparedness.

Columbus

The City of Columbus is off to a strong start in planning for electric vehicles. Since January 2011, the City has been a member of Project Get Ready, an initiative of the Rocky Mountain Institute, whose benefits include EV planning and resource-sharing with other cities and access to a network of strategic partners. Since joining Project Get Ready, Columbus has undertaken several initiatives to encourage electric vehicle implementation. Ohio municipalities can look to Columbus as a strong EV readiness model. The City has taken preliminary steps to facilitate permitting and other regulations which will encourage consumer interest, and it is forward-thinking in seeking opportunities to encourage planning and installation of infrastructure. Columbus has potential to become a national leader with further efforts to set the stage for electric vehicle implementation.

- General Sustainability Planning and the Municipal EV Strategy
  Columbus has advanced a variety of sustainability efforts, notably through the Get Green Columbus initiative, which includes transportation recommendations and strategies for incorporating alternative fuel vehicles into the municipal fleet. The ongoing implementation of its Green Fleet Action plan has won Columbus several awards including the Government Green Fleet's award for #1 Green Fleet in North America in 2011 and #3 in 2012. To date, the City's fleet strategies have focused on compressed natural gas, biodiesel, and right-sizing vehicles, with inclusion of electric vehicles on the horizon. The City's Environmental Steward is actively involved with the planning and installation of EVSE, and the City's website provides information for EV owners. Columbus has also purchased two Ford Focus Electric sedans for fleet use and at the time of this report is waiting for delivery.
- Code Guidance
  To prepare for and document anticipated interest and inquiries, the City's electric permit application tracks whether the scope of work includes installation of an EV charging station. The data collection will track EVSE installations and serve as a resource for inventorying chargers within both the public and private realms. The data is available upon request to outside agencies and utility companies (no requests have been made yet). The City has also hosted meetings between electrical inspection staff and AEP to facilitate service needs. The Columbus Department of Building and Zoning Services provides educational outreach to electricians, and it provided information about the permitting process for EVs in a "Winter School" educational session for local electricians in early 2012.
- Institutional Resources and Support
  Columbus benefits from institutional synergies and collaboration through local research and advocacy organizations which are advancing electric vehicle technologies and implementation. Clean Fuels Ohio is based in Columbus and has a substantial network of EV stakeholders. The Ohio State University's Center for Automotive Research (OSUCAR) hosts a program called SMART@CAR (SMART is an acronym for Sustainable Mobility – Advanced Research Team), which focuses on plug-in EVs and charging technologies and is widely considered a preeminent electric mobility research center nationwide.
- Existing Public Charging Stations
  As of February 2013 there are over 30 charging stations in Columbus proper with more in the surrounding area and in the planning stages. Publicly accessible charging stations are located at the Statehouse parking garage, the Electrical Trades Center, and Ohio State University, as well as at retail centers and hotels. Two of the City's public charging stations are within the right-of-way at two pilot sites: (1) downtown in the Gay St. District and (2) in the Short North near Goodale Park, both of which were funded in part by Clean Fuels Ohio.

Cleveland

The City of Cleveland does not specifically promote electric vehicle planning and implementation at this time. Sustainable Cleveland 2019, a 10-year initiative addressing a different topic each year, has designated 2016 as the Celebration Year for Sustainable Mobility, and it is anticipated that alternative fuel vehicles will be addressed within that framework. The Great Lakes Energy Development Task Force, an initiative of Cuyahoga County, is actively planning for EV readiness and implementation, which impacts not only Cleveland but many other municipalities in the MSA.

- General Sustainability Planning and the Municipal EV Strategy
  The Mayor's Office of Sustainability manages sustainability efforts within City government. It is currently evaluating energy efficiency initiatives for Cleveland's vehicle fleet and has assisted other branches of government with navigating the code requirements for installing EV charging stations at various municipal sites. Cleveland Public Power plans to install EVSE at three separate sites around Cleveland in 2013.
- Code Guidance
  The City Department of Building and Housing does not currently provide specific guidance for installing electric vehicle charging stations, and it does not formally track charging station installations through its permit applications. In keeping with requirements for installing major appliances, an electrical permit would be required for

Case Study: The Electrical Trades Center

DATE OF INSTALLATION: March 2012

DESCRIPTION: Five Level 2 charging stations were installed at the Electrical Trades Center for public charging and training purposes. Three GE units, one Eaton unit and one Clipper Creek unit were chosen for the project. All five are pedestal mount and located in parking spaces near the entrance of the building.

LESSONS LEARNED: It is imperative that a load calculation be performed on the existing electrical system to determine if EVSE can be safely added to the system. In this case, the existing system had to be upgraded to support the additional load or demand that would be placed on the infrastructure. The ETC was able to do this by installing a new load center or panelboard.

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Case Study: Akron, Ohio

DATE INSTALLED: November 2012

DESCRIPTION: The City of Akron installed one Level 2 charging station in each of five parking decks within the city. These five EVSEs allow for visitors, residents and downtown workers to recharge their vehicles while at work, shopping or visiting the downtown amenities. Installing the charging stations directly supports the vision and goals of Greenprint for Akron, the City's sustainability plan, first introduced in 1999. Use of electric vehicles and other alternative forms of energy are being reviewed and implemented within the city with primary focus on achieving this goal, and the City fleet has one Chevy Volt.

FUNDING: Funding for the project was provided through a U.S. Department of Energy Clean Cities Program grant through Clean Fuels Ohio and a 50% match was provided by the City of Akron.

The project began in August 2011 and the EVSEs were open for charging in January 2013. The design and installation of the stations were completed using City of Akron personnel. The table below describes the specific costs.

Project Expenses			
Expense Category	Total Project Cost	Local Match	Federal Funding
Equipment	$15,028	$7,514	$7,514
Design and Construction	$33,187	$16,593.50	$16,593.50
Total Direct Expenses	$48,215	$24,107.50	$24,107.50

LESSONS LEARNED: Since the market for electrical cars is still in its infancy the City of Akron is not expecting a large use upfront, but gradually over time these units will be beneficial for the public as the City continues its green initiative.

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installation of EVSE, and evaluation of the permit application would be based on the specific installation/equipment proposed. For zoning purposes, charging equipment would be treated as an accessory use with evaluation on a case-by-case basis.

- Institutional Resources and Support
  In Cleveland, major institutions such as the Cleveland Clinic and Case Western Reserve University are on the forefront of advancing electric vehicle implementation, in keeping with the national trend of higher education and research entities exploring EV infrastructure. Other stakeholders interested in implementing electric vehicle infrastructure include Cleveland 2030 District planning effort, which is focusing on downtown as well as neighborhood planning initiatives. The Northeast Ohio Sustainable Communities Consortium may also be a strategic partner, with its regional coordination of sustainability initiatives, though it is not specifically exploring electric vehicle planning.
- Existing Public Charging Stations
  Over 20 charging stations have been installed in the Cleveland metropolitan area, and more are known to be in the planning process. Almost all of the charging stations are located on the grounds of a university or medical facility and, as is common throughout Ohio, at auto dealerships.

The Interstate 71 Corridor

It appears that specific promotion and support of electric vehicle planning has not yet begun in municipalities or county governments along the I-71 corridor. This interstate corridor could become an important regional facilitator of EV adoption, taking lessons from the Interstate 5 "West Coast Green Highway" initiative in Washington State. The entirety of this Interstate, linking Ohio's three largest cities, can become an important way to ease range anxiety by offering destination charging options strategically placed to serve existing and emerging travel patterns.

Other Local Leaders

In addition to Cleveland and Columbus, several other Ohio cities are advancing policies that address EVs and installing charging stations. Cincinnati offers a convenience incentive that allows free parking to all-electric vehicles at four downtown City-owned parking facilities and at any parking meter within City limits. Launched in 2008, this incentive is administered via a brief application, verification of the vehicle as "all-electric" (excluding both hybrids and plug-in vehicles with an alternative source of power, including Volts), and issuance of a parking sticker designating that the car meets the eligibility requirements. Aside from seeking extension of this policy beyond its three-year pilot period, the City of Cincinnati is not currently pursuing other EV incentives.

Bowling Green and Akron (a Project Get Ready city) are both piloting EVSE installations in City-owned parking facilities. Bowling Green has installed three public charging stations in the downtown shopping district, and Bowling Green State University has installed three additional EVSEs available to the public. The City of Akron has installed five charging stations for public use in parking garages.

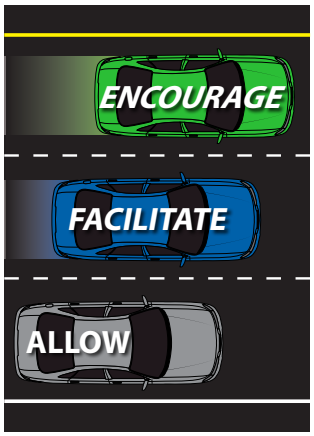
Codes & Permits: Regulatory Tools

Consumer adoption of electric vehicles will be triggered by events and activities largely beyond the control of Ohio municipalities. State and federal financial incentives; the availability, quality, and price of electric vehicles; the price of gasoline; and national imperatives to improve energy independence are, and will continue to be, major influencers on consumer behavior. This does not mean that local governments are powerless to effect or facilitate the inevitable transition away from vehicles powered exclusively by fossil fuel. Municipalities that play an early and active role in focusing discussion and achieving local "buy-in" for a more sustainable transportation system will be prepared to meet the needs of a new generation of vehicle owners who are increasingly drawn to vehicles using more sustainable technologies and which, over the life of the vehicle, are less expensive to operate and maintain.

> Streamlining permit applications and addressing consumer choices through codes and procedures is good public policy generally, and need not be tied exclusively to EV preparedness.

More important, if the recommendations included in this report are implemented, residents will receive additional benefits even if they do not own an electric vehicle. In particular, streamlining permit applications and addressing consumer choices through codes and procedures is good public policy generally, and need not be tied exclusively to EV preparedness. Business owners will benefit from clear permitting processes and code requirements, as they consider the implications of making improvements that accommodate EVs. To complement the policy and procedural strategies, additional opportunities should be explored to address the needs of Early Adopters and the Early Majority, reduce range anxiety for all potential EV owners, and develop approaches for encouraging or incentivizing local action. Some communities, such as Cleveland Heights, have conducted code reviews to ensure other sustainability efforts do not face barriers, such as installations of wind and solar power. It is wise to add EV considerations to such projects as well.

There are three specific approaches that municipalities can take to establish policies and practices that promote EV readiness. The best practices included in this analysis are organized by the following approaches:



1. Slow Lane: Evaluating existing codes/procedures to identify barriers to EV adoption, thereby **allowing** policies and practices supporting EV implementation.

2. Middle Lane: Building upon the baseline of allowing EV infrastructure and **facilitating** policies and practices supporting EV implementation.

3. Fast Lane: Taking a leading role in EV planning by **actively encouraging** policies and practices supporting EV implementation.

The best practices discussed in this section are considered appropriate precedents to inform code and policy recommendations that can be tailored to individual Ohio municipalities of varying sizes.

Permitting and Inspection Processes

Particularly in the early phases of infrastructure roll-out, electric vehicle owners will require access to charging equipment at home. Installation of EV charging equipment should be particularly straightforward for EV owners with access to off-street parking, which comprise the majority of residents in the study area, but many challenges exist and must be addressed. For example, permitting and installation processes are currently being addressed on a case-by-case basis, creating the potential for inconsistent approaches to permitting and inspection. Older houses may require wiring upgrades in order to accommodate charging equipment, adding to the complexity of the permitting process and upfront costs. The more significant challenges will arise from multi-family residential properties and other settings involving shared parking facilities.

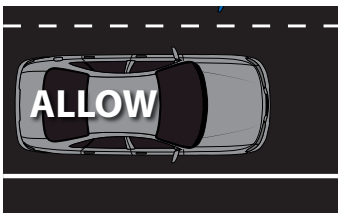
Although Level 2 equipment is anticipated to be the near-term standard for non-residential charging needs, Level 1 charging will satisfy home charging needs for many EV owners and should be considered a viable option for home charging. Level 1 charging does not require installation of any special equipment and is extremely effective for overnight charging. However, many new EV owners, particularly those with all-electric vehicles, may desire Level 2 charging equipment to enhance the overall technology experience. Municipalities and energy companies should anticipate installation of the more energy-intensive equipment as the potential preference for Early Adopters.

The highest priority policy opportunity in the community readiness process will be a clear and straightforward municipal permitting process for home chargers, given the degree to which EV owners will rely on charging equipment at home. An electrical permit is the first and often only step that a new EV owner will need to take in coordination with their municipality. Due to the importance of reliable charging ability at home, non-residential permitting will likely be a secondary priority.

Permit Approval Timeframe

For cities currently considered EV planning leaders, particularly Portland, Raleigh, Houston, and various cities in California, the permit approval process for residential chargers is typically within 48 hours once any necessary electrical upgrades have been completed. This timeframe is an appropriate goal for Ohio municipalities to strive for as part of an overall effort to facilitate EV adoption. Electric vehicle purchasers will expect a clear and simple process to charge their new cars at home; however, an expeditious process understandably must be balanced with the assurance of a safe installation that will not stress the electrical capacity of the home.

The following are examples of Slow Lane permit and inspection processes that allow implementation:

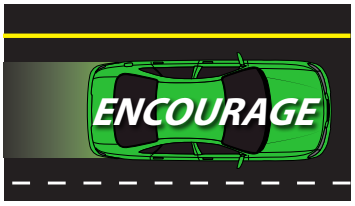


- Columbus, OH and Sonoma County, CA both issue minor electrical permits where a dedicated circuit is needed, and require a full permit/inspection only when panels need upgrades.
- In Normal, IL, there is no special procedure for processing permits associated with EV charging equipment; based on the typical volume of electrical permit applications received, the turn-around tends to be within a day or two for all electrical permits, regardless of type.

The following are examples of Middle Lane permit and inspection processes that facilitate implementation:

- Los Angeles, where permit volumes and turn-around times are a concern, the City established an electric vehicle division and identified specialists within the inspection department to ensure quick permit decisions and to serve as a resource as the technology expands.
- Columbus collects data on whether an electrical permit involves EVSE to track permit volumes and help the department prepare as interest increases. To increase effectiveness, this process requires training staff and outreach to electricians to ensure that the data provided are accurate. Reporting approved permits or otherwise collaborating with utility providers may help coordinate service needs.

The following are examples of Fast Lane permit and inspection processes that actively encourage implementation:



- Raleigh, NC has eliminated plan review by training electrical field inspectors on the new technology and allowing them to grant permits on-the-spot.
- Licensed, certified electricians in San Francisco can have permits issued instantly online or over the counter with an inspection within 48 hours of request.
- For electrical contractors in good standing, Oregon requires only a small sample of charging stations to be inspected.

Public Information

Informed staff that are knowledgeable about the technology and can appropriately field inquiries is critical, as is public outreach to prospective EV owners. Education and outreach will be particularly important for those responding to questions from the public as well as staff in other departments who may handle general inquiries. Raleigh, NC and San Francisco, CA provide a clear process required for the EV permitting process, including anticipated timeframes, and make the information easy to find online. Raleigh also posted videos to YouTube including background information to assist with the permitting and installation processes for residential and non-residential EVSE charging equipment.

Zoning and Related Ordinances/Codes

Existing codes do not typically prohibit the installation of EV charging stations or equipment, but clarification could ease implementation and avoid confusion. Locally-appropriate revisions to zoning codes and related regulations may include design standards for charging stations, regulatory signage, and attention to accessibility standards.

Cincinnati offers free parking to qualified electric vehicles at City-owned parking facilities and street parking.

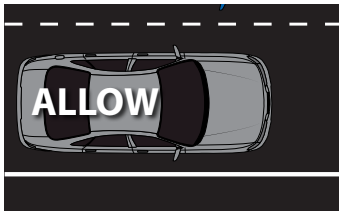
On-street signage and parking enforcement, which are not addressed within zoning codes, also require the designation of specific practices and design through right-of-way standards and/or additional provisions that address right-of-way features, such as subdivision codes.

Development-specific covenants, typical of home owners associations and condominium boards, may pose additional obstacles to EV implementation and would need to be evaluated on a case-by-case basis by the governing authority. Complications to EVSE installations could arise in the following scenarios:

- An EV owner may prefer to park in a driveway or side yard rather than in an adjacent garage; in some jurisdictions, zoning codes may not permit parking in these locations.
- Locations for EV owners to charge where off-street parking is unavailable.
- Multi-family units with shared parking facilities.
- Planning for ADA access, particularly when installing EVSE into existing parking facilities.
- Determining how parking ratios are affected when an existing non-residential use retrofits parking facilities to include EV charging stations.
- Specifying what land uses are appropriate for siting different levels and types of charging equipment.
- Establishing consistent signage for identification and directional purposes.
- Enforcing regulatory signage for charging in commercial or public settings.
- Installing EVSE within public right-of-way which may be limited by the location of existing infrastructure and a public perception of a "wasted space" if it is not in constant use.

Best Practices

The following is an example of a Slow Lane policy that **allows** implementation:

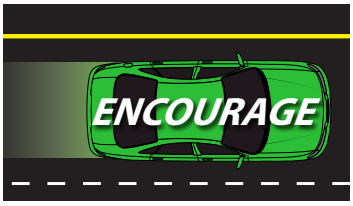


- The State of Washington requires all local governments to allow electric vehicle charging stations and/or battery charging stations in specified zoning categories.

The following are examples of Middle Lane policies that **facilitate** implementation:

- The Puget Sound Regional Council has created standard terminology and definitions to encourage consistent application within policies adopted regionally and statewide, and it has been recommended for adoption statewide. The Council also provides guidance to assist local governments with zoning and related policy issues.
- Oregon and Washington have approved consistent regulatory signage applicable statewide, and it is under consideration in Michigan.
- California has specified standards for accessible parking spaces, and its interim guidelines have been adopted throughout the U.S. Additionally, Clean Fuels Ohio and Virginia Clean Cities collaborated to produce "EV Charging for Persons with Disabilities," published by Sustainable Transportation Strategies.

The following is an example of a Fast Lane policy that **actively encourages** implementation:



- The State of Washington has prioritized EV policy planning, as well as infrastructure improvements, within municipalities with populations over 20,000 and/or located along the key highway corridor of Interstate 5 (the West Coast Green Highway).

Summary

Planning and regulatory tools will be useful to guide policies that further the goals of Ohio municipalities. Model zoning and other development regulations should be easily tailored to the needs of a particular community, while encouraging consistency among jurisdictions for clarity and ease of interpretation statewide. Regulations affecting private development sites, through zoning codes and private covenants, as well as standards addressing the public right-of-way, should be considered for evaluation.

Building and Electrical Codes

Building and related construction codes are regulated by the State of Ohio; larger cities may have supplementary building codes, but many small municipalities and unincorporated areas in Ohio rely on the state codes without amendment. Currently, there are no provisions within the Ohio Building Code that specifically address electric vehicle charging stations; however, some state standards refer directly to national provisions, such as the National Electric Code, which does address EVSE.

Cities with their own codes addressing new construction and reconstruction/renovation, such as Cleveland and Columbus, can augment State building codes by adding their own provisions to facilitate the installation of EVSE. Jurisdictions leading in EV readiness feature

First Responder Safety Training

Under the Ohio Revised Code Section 4765.55, the executive director of the state board of emergency medical services, with the advice and counsel of the firefighter and fire safety inspector training committee of the state board of emergency medical services, is responsible for establishing, maintaining and amending the requirements for all fire service training programs in Ohio. Currently, there are no requirements that first responder receive any safety training in advanced electric drive vehicles in Ohio.

First Responder Safety Training (continued)

However, there are some excellent opportunities for first responder safety trainings for electric vehicles available to interested first responders. In July 2012, the National Fire Protection Association (NFPA) unveiled its online Electric Vehicle Safety Training for firefighters and first responders. NFPA's Electric Vehicle Safety Training project is a nationwide program designed to help firefighters and other first responders prepare for the growing number of electric vehicles on the road in the United States. (The NFPA project, funded by a $4.4 million grant from the U.S. Department of Energy, provides first responders with information they need to most effectively deal with potential emergency situations involving electric vehicles.)

The online version of the NFPA classroom sessions allows first responders from all over the country to participate in this valuable training regardless of their location. The self-paced online training program provides first responders with the knowledge they need to safely handle emergency situations involving EVs, hybrids, PHEVs and charging stations. The online curriculum includes information about the newest technology and safety systems found in the growing number of hybrid and electric vehicles on the road.

This course is recommended for anyone who may respond to incidents involving electric or hybrid vehicles, including fire service and law enforcement, emergency medical service technicians, and tow and salvage personnel. Continuing Education Credits are available for many first responders upon completion of all five modules verification with professional board before attendance.

In December 2012, National Alternative Fuels Training Consortium (NAFTC) at WVU was awarded a nearly $1 million to spearhead first responder training by the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA). Among other things, the grant will provide 8,500 scholarships to firefighters in remote locations across the so they can take the Advanced Electric Drive First Responder Safety Training online course. The project also includes a reconfiguring of the NAFTC's Quick Reference Guide for access by computers on fire apparatus and emergency equipment vehicles. The QRG tool will provide emergency personnel with information about alternative fuel and advanced technology vehicles, including EVS, hybrids and PHEVs, at the accident scene. The QRG tool is currently available as a free IPhone/Android app or as a hard copy.

either voluntary or mandatory measures for incorporating EVSE into new construction or renovation projects. For example, the California Green Building Standards Code (CALGreen) includes voluntary measures recommending EV infrastructure readiness for non-residential development, and the Green Homes Program in Vancouver, British Columbia, mandates EVSE infrastructure for new single- and two-family homes.

The National Electrical Code (NEC), administered by the National Fire Protection Association (NFPA), is an advisory resource commonly adopted by states and municipalities to ensure safe and standardized electrical installations. State and local jurisdictions may adopt the NEC with or without amendments. Although the NEC is updated every three years, the current version in general use in Ohio is 2008. NEC Article 625, Electrical Vehicle Charging System, provides standards for EVSE installation in both the 2008 and 2011 versions. However, the 2011 version includes updates reflecting technological advancements and safety improvements for EV battery charging. In addition to adopting the most recent version of the NEC, municipalities can further prepare for implementation of the technology with fire and emergency responder training to address EV and charging station safety; the NFPA has developed programs and resources that are available for safety training purposes.

Best Practices

The following are examples of Middle Lane building code provisions that facilitate implementation:

- Michigan is evaluating and updating state codes to modify the National Electric Code, allowing rapidly evolving technologies between the three-year updates.
- The California Building Code recommends wiring or capacity with appropriate conduit for dedicated EV parking spaces[39].
- Vancouver, British Columbia requires all new single- and two-family homes to include a cable raceway running from the electric panel to the garage[40]. Sovereign Homes, a developer in the Columbus area, has implemented this voluntarily.

The following are examples of Fast Lane building code provisions that **actively encourage** implementation:

- Vancouver also requires 20% of parking spaces serving multi-family residences to include a receptacle to accommodate electric vehicle charging equipment.
- Both Los Angeles and San Francisco have adopted building codes requiring all new buildings and parking facilities to be wired for EV charging infrastructure, providing capacity for one charging station for every 1-50 spaces, two charging stations for 51-200, and four for larger parking areas (incorporating voluntary guidelines of CALGreen within City code).

Summary

Ohio municipalities look to the State of Ohio for guidance on adopting certain national codes intended to provide enhanced EVSE readiness and safety protocols. Beyond adoption of the most up-to-date national standards, the State may consider evaluating existing codes or

[39] State of California. *California Green Building Standards Code (CALGreen),* 2010.
[40] Electric Transportation Engineering Corporation. *Electric Vehicle Charging Infrastructure Deployment Guidelines for British Columbia,* July 2009.

establishing voluntary policy steps to serve as a resource for communities wishing to further EV planning. Municipalities can consider voluntary or mandatory steps within their own code frameworks to enhance EV infrastructure planning.

Complementary Strategies

Several strategies which complement the policy and procedural aspects of EV readiness are discussed below; most of these strategies are already being pursued by Clean Fuels Ohio.

Strategic Plans

A rapidly growing number of municipalities, regions, and states have created or are in the process of developing strategic plans to evaluate existing conditions and guide infrastructure implementation. Clean Fuels Ohio's Drive Electric Ohio effort is intended to serve as a strategic plan for the State, and it will provide a resource to individual municipalities and regions desiring to develop more specific strategic plans.

Task Forces

Advisory task forces involving utility providers, electrical contractors and inspectors, auto manufacturers and dealerships, local governments, businesses, and nonprofits are helping guide EV readiness planning in several states, including Connecticut and Michigan, as well as in municipalities including Atlanta. Similarly, Clean Fuels Ohio manages an active and diverse task force interested in advancing statewide electric vehicle infrastructure planning from a variety of angles.

Private-Sector Partnerships with OEMs

Several municipalities have developed partnerships with auto manufacturers to advance strategies for facilitating the installation process and locating sites for charging stations. Nissan has formed partnerships with a number of cities, including Raleigh and Seattle, for testing and infrastructure planning support. Houston and Austin are partnering with Ford and local energy providers for readiness planning, as well as outreach and education. Mitsubishi, which has a manufacturing facility in Normal, IL, is collaborating with the municipality in an effort called EVTown. Normal has incorporated EVs into its fleet, installed approximately 50 charging stations and offered grants for businesses and institutions to install additional chargers. The number of chargers installed in Normal is significant given the municipal population of 52,500, and makes the municipality a national leader for providing public charging stations.

Outreach and Education

The most successful readiness plans are typically complemented by strong outreach and education initiatives geared to the consumer, dealerships, and electrical contractors and inspectors. In particular, Raleigh has implemented exceptionally creative outreach strategies, through the public information tools developed to facilitate the permitting process as well as by working with local partners to develop training and educational programs. Similar courses have been developed in Ohio at the Electrical Trades Center in Columbus and IBEW in Cincinnati to address installation requirements and provide training on installing electric vehicle charging stations. Further, Raleigh has plans to provide contact information of contractors who complete this training to auto dealerships, to develop local referral lists for consumers.

Please see Section 6 of this report, *Ohio's EV Marketing Plan,* for a detailed discussion about promoting electric vehicles in Ohio.

The Electric Vehicle Infrastructure Training Program (EVITP) provides training and certification for people installing electric vehicle supply equipment (EVSE). As a voluntary collaboration of electrical industry organizations, EVITP supports developing electric vehicle (EV) charging infrastructure for residential and commercial markets.

The US Department of Energy's Clean Cities program works with EVITP to address technical requirements, safety imperatives, and training needs for electric vehicle industry partners and stakeholders. The Electric Vehicle Infrastructure Training Program offers training around the United States at community colleges and electrical training centers. Training is open to licensed electricians in compliance with requirements of state or municipal jurisdictions. Training on local requirements supplements core training when appropriate. EVITP collaborates with industry organizations to develop curriculum to train and certify electricians. This training teaches industry best practices in electric vehicle infrastructure installation, commissioning, and maintenance.

For more information, visit EVITP at www.evitp.org/.

Case Study: Columbus, Ohio

"Electric vehicles result in less pollution and more job potential for our residents," Mayor Michael B. Coleman said. "With these initial charging stations, we can help support the market and our residents, making the choice to switch to an electric vehicle that much easier."

DATE INSTALLED: March 2012

DESCRIPTION: The City of Columbus is committed to becoming the greenest, most sustainable city in the nation. Use of electric vehicles and other alternative forms of energy are being reviewed and implemented within the city with primary focus on achieving this goal. Mayor Michael B. Coleman also has a vision for Columbus to serve as the center of economic development opportunities in the supply chain for energy storage, EV, EVSE and smart grid technologies. In late 2010, Columbus was designated as the Ohio Energy Manufacturing Solutions Hub whose objective is to focus on energy manufacturing solutions and technologies related to energy storage. Columbus is also home to the award winning Ohio State University's Center for Automotive Research, whose focus is on advanced automotive research and development.

These two Level 2 EVSEs reduce range anxiety and allow for visitors, residents and downtown workers to recharge their vehicles while at work, shopping or visiting Goodale Park and the Beacon Building. Users pay the regular parking meter rate of $0.75 an hour for up to six hours.

FUNDING: Funding for the project was provided through a U.S. Department of Energy Clean Cities Program grant through Clean Fuels Ohio and a 50% match was provided by the City of Columbus.

Project Expenses			
Expense Category	Total Project Cost	Partner Contribution (Your Match)	Federal Funding Requested
Equipment (2 EVSE Units by Eaton)	$8,179.80	$4,089.90	$4,089.90
Design	$11,827.24	$5,913.62	$5,913.62
Construction	$22,898.64	$11,449.32	$11,449.32
Total Direct Expenses	$42,905.68	$21,452.84	$21,452.84

LESSONS LEARNED: The City found it is most cost effective to tie into an existing meter (Gay St.), but there are drawbacks with that approach if the intent is to know exactly how many kWh have been used. The usage at both stations is about the same, yet the electricity costs for the Goodale site include a $71.00 monthly service charge to monitor the kWh that is not charged at the Gay Street site because it is tied into the adjacent building's meter.

For future sites, the City would prefer an EV charging station that provides detailed data about each unit, including electricity usage, in operation, via web-based software. In addition, EV units could be added to this system as the demand grows.

Also important is to plan for both electrical and street occupancy permitting and inspection by the appropriate local authorities as well as including a line item in the project budget for these fees. Just because it is a local government project, it doesn't mean that fees associated with permits and inspections will be waived. Plan ahead and discuss the project early on with the inspection team to avoid delays and to prevent hold-ups in the completion schedule.

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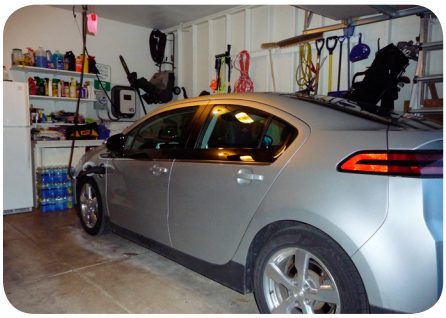
Statewide Electric Vehicle Policy Considerations



Overview

If Ohio wants to become a leader in the nation's move toward new technology vehicles, it will need to consider how it can incentivize EV ownership to accelerate the rate of purchase. Ohio is alone among its five neighboring states in not providing grants or incentives for the EV sector, either for EV owners, auto manufacturers, EVSE manufacturers, research and development, planning, or related job training. Ohio's utilities also are not providing any EV incentives, even when subsidiaries of the same company in adjoining states are providing such incentives. The current EV-focused research and incentive programs in Ohio are funded by universities and non-profits through grants from federal agencies.

If Ohio relies only on its higher income households and private fleets to spur the market, then Ohio will lose out to states that are more aggressive in their self-funding, such as Michigan, and states that have more high income residents, such as the East and West Coast states. These states already have and will continue to maintain the attention of direct job-creating entities including the manufacturing sector (cars, charging stations, and batteries), research money that could be directed to universities and institutions, and the indirect job creation opportunities of installing and servicing charging stations and electric vehicles.

KEY FINDINGS

- The transition to electric vehicles will impact sales tax revenues – which will increase – and fuel tax revenues – which will decrease. The majority of the loss of fuel tax revenue in Ohio will be driven by the volume of increasingly fuel efficient conventional vehicles already hitting the market, not by electric vehicles.
- Ohio offers no incentives for EV ownership, research or manufacturing. Michigan – the state and its utilities – leads the region in providing incentives for EV development, offering 10 different programs.
- During the course of this study, the Public Utilities Commission of Ohio (PUCO) released a statement confirming its position that the sale or provision of electricity through an electric vehicle charging station is not a regulated action under its purview, specifically:

  "Electric vehicle charging station owners are selling access to electricity, which is a service to consumers, not a commodity. As such, the Public Utilities Commission lacks jurisdiction over charging station owners or hosts because such services are not construed within the definitions of an electric light company, a competitive retail electricity supplier, or an electric distribution utility under section 4905.03 of the Ohio Revised Code. Accordingly, the Commission would not have the authority to regulate how a charging station owner recovers costs for providing charging as a service, and an owner or host will be allowed flexibility in characterizing the nature of such a service and pricing model. For example, owners can treat charging as a customer amenity or characterize it as a cost for a parking space, assess a monthly subscription cost, charge a flat rate and even charge per kWh used, as justification for recovering costs."

RECOMMENDATIONS

1. Encourage the state's utilities to offer incentives that promote EV ownership, such as introductory offers for home charging stations (i.e., short-term reduced rates, a set number of rebates); especially encourage those which offer EV incentives in their service areas outside of Ohio.

2. Offer incentives at the state level aimed at each critical group: EV consumers, research institutions, and manufacturers. The incentives could be in the form of tax credits, rebates, grants, fee reductions, and other creative funding strategies.

3. Conduct a statewide EV economic impact study to confirm the direct link between electric vehicles and job creation. Oregon recently completed such a study concluding that the state's "electric vehicle cluster has created more than 1,500 jobs and fired $266.5 million in economic activity."[41]

[41] Williams, C. "Electric vehicle industry drives $266.5M economic impact in Oregon," Sustainable Business Oregon, (02/05/2013)

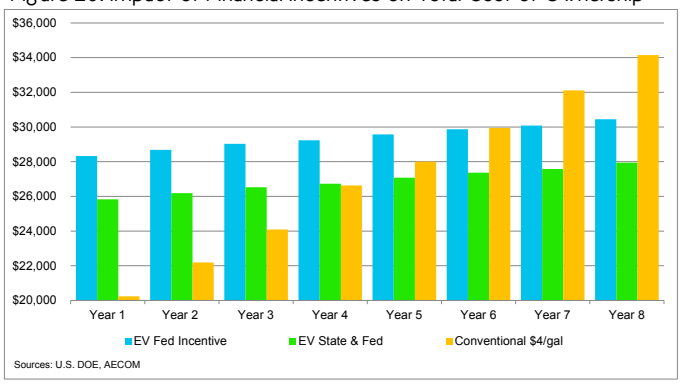
Funding for EV Infrastructure[42]

The question of who exactly should fund the infrastructure is largely unanswered. Private industry (24%), utilities (20%) and consumers (16%) were the top three identified groups government officials believe should be tapped to pay the bill for EV stations. While 11% believe the federal government and 8% believe the state government should fund the infrastructure, only 5% believe local governments should be stuck with the bill. Seventy-five percent of officials believe the utilities should play an active role in advancing EV infrastructure in the state.

Research

Section 1, *The Case for EV Ownership*, established that the total cost to own an electric vehicle is nearly equal to a high-performing gasoline hybrid at current gas prices, and is less expensive to own than a current gasoline-only vehicle. That calculation accounted for the federal tax credit, which is the only financial incentive available to Ohio consumers at this time. The figure below illustrates that if Ohio offered an additional financial incentive, such as a cash rebate or a tax credit, the EV owner's return on investment would be even better, and could lead to an accelerated pace of adoption.

Figure 20: Impact of Financial Incentives on Total Cost of Ownership



As with the earlier calculations, this one assumes that gas prices increase at a rate higher than that of electricity, and accounts for the increased maintenance cost of conventional vehicles, in this case over an ownership duration of eight years.

The analysis indicates that an EV will need to have an MSRP of less than $28,000 to compete with a similarly sized conventional vehicle at an MSRP of $17,000. Ohio can reach this price point if it offers its own incentive in addition to the federal tax credit. As with the structure of the federal incentive, Ohio's could also be structured to phase out over time, as EV purchase prices fall due to technological advances.

Incentivizing EV Ownership

Incentives have historically been a necessary component of the introduction of new technology, particularly as new technology usually requires consumers, whether individuals or businesses, to accept some measure of risk and pay some incremental price premium especially in the early stages of adoption. Meaningful incentives are and will continue to be critical elements of an effective EV preparedness program. Across the nation, federal and state incentive programs, combined with targeted private sector incentives, are easing the way for individuals and business innovators to move toward new energy vehicles.

Incentives should be consistent with the overall public policy benefits arising from increased new energy vehicle adoption – i.e., lower GHG emissions and improved mobility and land use. A combination of incentives such as tax credits, equipment rebates and "convenience" incentives (preferred parking, reduced registration fees), is likely to be the best approach to tip the decision scales in favor of choosing an electric vehicle. The following segment highlights programs that are available through the Federal Government and the State of Ohio, and compares the activities occurring in the surrounding states.

Federal Incentives

For Owners

- Qualified Plug-In Electric Drive Motor Vehicle Tax Credit – This tax credit applies to purchase of new plug-in electric drive motor vehicles. Credit ranges from $2,500-$7,500, based upon battery capacity and vehicle weight rating. Longer range vehicles such as the LEAF, Volt, and Focus BEV qualify for $7,500 in federal incentives and lower range vehicles such as the Ford C-Max Energi qualifies for $3,750. The Prius Plug-in qualifies for $2,500. The credit will phase out beginning in the fiscal quarter when the manufacturer sells a minimum of 200,000 qualified vehicles in the United States.

For Research and Development

- Advanced Energy Research Project Grants – Established by the DOE, the Advanced Research Project Agency – Energy (ARPA-E) is tasked with funding projects that "develop transformational technologies" that reduce energy imports, greenhouse gas emissions, or improve energy efficiency. Projects can include vehicle technologies and energy storage.
- Improved Energy Technology Loans – Through the DOE, the Loan Guarantee Program funds projects focused on reduction of air pollution and greenhouse gases, as well as emerging commercial technologies such as biofuels and alternative vehicles. The funds must be used for project implementation, not for R&D. These loans can fund up to 100% for eligible projects.

For Manufacturing

- Advanced Technology Vehicle (ATV) Manufacturing Incentives – The DOE's Advanced Technology Vehicles Manufacturing Loan Program allows direct loans to private industry for up to 30% of costs

[42] Ohio Survey of Local Governments, 11/09/12, Governing Dynamic

associated with re-equipping, expanding, or establishing manufacturing facilities in the US focused on production of either the ATV themselves or components for ATVs. Hybrid electric and fully electric vehicles meet this standard for ATV.

Ohio Incentives

There are currently no grants, tax credits, or loan incentives being provided by the State of Ohio or its utilities for EV charging stations or for EV purchases. This is a matter of some significance, given that many of Ohio's neighboring states are using such incentives to welcome consumers and businesses who are interested in electric vehicles.

The Ohio Development Services Agency is developing the Alternative Fuel Transportation Program. This is a state program that improves air quality through financial assistance to businesses, nonprofit organizations, school districts, or local governments for the purchase and installation of alternative fuel refueling, blending, or distribution facilities and terminals and fleet vehicle conversion. Alternative Fuels will be defined by the Ohio Revised Code.

Neighboring State Incentives[43]

Each of Ohio's neighboring states offer at least one incentive to promote electric vehicles, either from the state or through its utilities.

Indiana

For Owners

- Duke Energy provides residential and commercial customers with Level 2 charging infrastructure, up to $1,500 of installation costs, and services the equipment for two years.
- The Indianapolis Power & Light Company provides Level 2 EV charging stations and metering equipment at no cost to the first 150 customers seeking special plug-in EV charging rates. This program covers the cost of EV charging station installation, and participants can use public EV charging stations for a flat fee of $2.50/session.

For Research & Development

- The Indiana 21st Century Research and Technology Fund provides grants and loans for projects that promote economic development in high technology industries, including alternative fuel technologies and vehicle production.

For Manufacturing

- Tax credits are awarded by the Indiana Economic Development Corporation for manufacturing and assembly of light-duty alternative fuel vehicles. Funds can be used to cover up to 15% of qualified investments.

Kentucky Incentives

For Owners

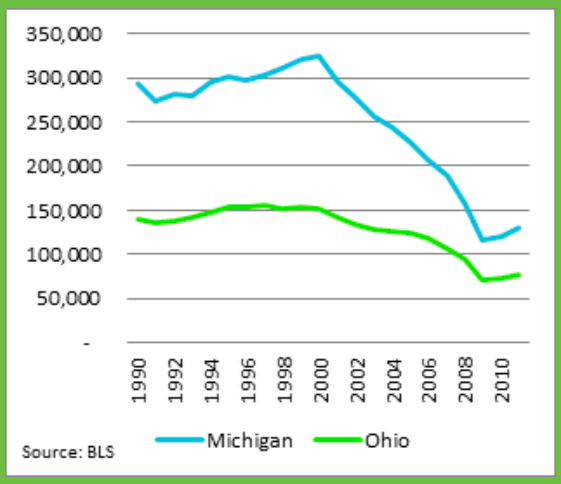
- The Kentucky Utilities Company provides grant funding for procurement of EVs for fleets of government and quasi-government entities. The grants will cover the incremental cost of those vehicles, as well as a DC fast charging station for selected applicants. The total grant amount is $250,000 with $3,500 covered per DC fast charging station.
- Louisville Gas & Electric is running a pilot project for time-of-use electricity rates. The program is for residential customers with an EV, plug-in hybrid, or natural gas vehicle.

Motor Vehicles & Parts Manufacturing Employment

The auto manufacturing industry – including parts suppliers – has a strong history in both Ohio and Michigan. Employment in the auto industry plummeted during the recession, but both states have experienced an increase in jobs in this sector since 2009. However, auto manufacturing jobs in Michigan have increased by 6% compared to 3% in Ohio. If Ohio began to offer competitive incentives throughout the EV auto manufacturing supply chain – for research and development, and manufacturing the vehicles, batteries and charging stations – perhaps the state could capture the attention of national and foreign auto makers.

The chart below shows the combined impact of the motor vehicles and parts manufacturing industry in both states.

Figure 21: Michigan and Ohio Auto Industry Employment[44]



Michigan

For Owners

- Qualified alternative fuel vehicles can be exempted from personal property taxes if the vehicle is new to Michigan, meets federal safety standards, local emissions standards, and has not been previously taxed.
- Alternative fuel vehicles are exempt from Michigan emissions inspection requirements.
- Coulomb Technologies offers EV charging stations at no cost to EV owners for home charging stations in specified areas in southern Michigan.
- Residential EV owners who install a Level 2 EV charging station on a separate meter are eligible for rebates of $2,500 from Indiana Michigan Power, though customers must also sign up for its EV time-of-use rate.
- Consumers Energy offers rebates of $2,500 for purchase, installation and wiring for Level 2 EV charging stations.
- DTE Energy offers a reduced electricity rate or a flat rate option to qualified residential customers for charging all-electric and plug-in hybrid electric vehicles during off-peak hours.

[43] "State Laws and Incentives" Alternative Energy Data Center, US Department of Energy. Dec 2012.
[44] United States Bureau of Labor Statistics. Industry: Motor Vehicle Manufacturing, Series ID SMU39000003133610001, 05 Feb 2013.

- For the first 2,500 customers to purchase EVs, DTE Energy will provide a $2,500 rebate for the purchase and installation of EV charging stations that have a separate meter. Customers must also enroll in the DTE plug-in EV rate.

For Research & Development

- R&D projects pursued by Michigan taxpayers can qualify for the Michigan Business Tax credit equal to 3.8% of wages, salaries, fees, bonuses, commissions, and other payments in a taxable year, not to exceed $2 million/year.

For Manufacturing

- The state's Advanced Vehicle Battery Manufacturer Tax Credits is available through 2015; manufacturers of battery packs in Michigan can receive tax credits that are based on the kilowatt hours of the battery capacity. The battery must also be installed in a plug-in vehicle that qualifies for the federal tax credit.
- Alternative Fuel and Vehicle Research, Development, and Manufacturing Tax Credits – "Qualified taxpayers may claim a non-refundable credit for tax liability attributable to research, development, or manufacturing of qualified alternative fuel vehicles (AFVs)." Businesses within an Alternative Energy Zone may claim credit for qualified payroll amounts. Eligible taxpayers and businesses are certified by the Michigan NextEnergy Authority.
- Alternative Fuel Development Property Tax Exemption – This is a tax exemption for industrial properties involved in high-technology including electric and hybrid electric vehicle manufacturers. The exemption is certified through the Michigan State Tax Commission.

Pennsylvania

For Owners

- PECO (the utility) offers a $50 rebate provided to residential customers purchasing an EV

West Virginia

For Owners

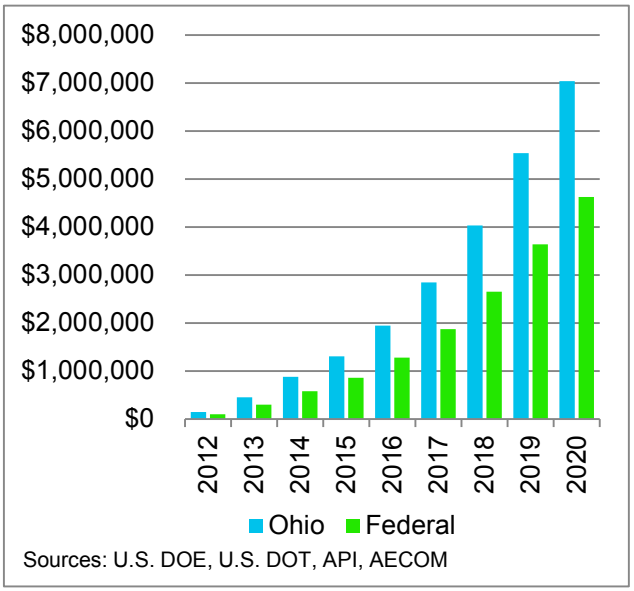
- The Alternative Fuel Vehicle (AFV) Tax Credit is an income tax credit available to eligible taxpayers who convert a vehicle to operate exclusively on an alternative fuel or purchase a new original equipment manufacturer dedicated or bi-fuel AFV. The value of the tax credit is up to $7,500 for vehicles with a gross vehicle weight rating (GVWR) up to 26,000 pounds (lbs.) and up to $25,000 for vehicles with a GVWR greater than or equal to 26,000 lbs.
- The Alternative Fueling Infrastructure Tax Credit is an income tax credit for purchasing and installing alternative fueling infrastructure of up to 50% of total costs. EV charging stations are eligible but only for residential use, while infrastructure for natural gas, propane, hydrogen, and coal-derived liquid fuels are eligible for private and publicly-accessible fueling station installations.

Revenue Considerations

In addition to policies and programs that will incentivize EV ownership, Ohio should also consider the revenue implications on traditional sources of transportation funding, namely the gas tax.

By definition, EVs pay no gas tax because they do not use gasoline and plug-in hybrids will use very little. Study data estimates that Ohio's fuel tax revenues will decrease by $7 million from 2013-2020, but the majority of that loss is due to the majority of gasoline-only vehicles becoming more efficient, with only a small portion of the loss due to EVs. The state should consider alternatives to generate necessary and appropriate transportation revenue from all vehicles regardless of fuel type. It is important not to penalize early adopters of EV.

Figure 22: Cumulative Fuel Tax Loss due to Increased MPG



Vehicle Miles Traveled Fee

Charging motorists for their actual vehicle miles traveled (VMT) on certain roads and highways establishes a pure user fee approach to raising transportation revenue. The VMT User Fee, which has been tested in several pilot programs, notably in Oregon, would require a reliable means of monitoring the daily miles each driver travels on designated roads and highways, typically through GPS, and then sending each driver a bill that corresponds to this amount. Mileage monitoring could be added to annual vehicle license plate renewals and/or to annual air emissions checks. While privacy concerns have been raised about the tracking mechanisms used for a VMT, the Oregon pilot demonstrated that a VMT system could be developed so as not to capture or maintain origin and destination data, thus protecting personal privacy.

According to a report by the Congressional Budget Office, "A consensus view of many transportation experts and economists is that a system of taxes on vehicle miles traveled should be viewed as the leading alternative to fuel taxes as a source of funding for highways."[45] While experts view this method of highway funding positively there has been little political will to pass this sort of legislation. That may change when decision makers, faced with the need to raise transportation revenue, realize that the gas tax is no longer the robust and reliable revenue source it had been during the 20th Century.

Annual EV Fee

Legislators in a number of states have discussed imposing a tax or fee on electric vehicles to substitute for their lack of fuel tax contributions, and at the time of this report, the Virginia legislature has passed a bill mandating one. The Virginia legislation charges a $100 road use fee for

[45] United States. Congressional Budget Office. *Alternative Approaches to Funding Highways.* 2011

all "highway capable electrified vehicles" which "includes hybrids, plug-in hybrids and electric vehicles, as well as natural gas, propane, and hydrogen-fueled vehicles."[45] As noted earlier, more revenue will be lost to efficiency gains in conventional vehicles than will be lost to electric vehicles. A vehicle type fee would only serve as a punitive measure for the EV owner, and would not generate noticeable revenue for the state.

EV incentives should be carefully calibrated to avoid establishing potentially dangerous precedents that may undermine sound public policy. For example, as vehicles become more energy efficient, the gas tax will diminish as a reliable transportation funding source. It is likely that user fees (tolls, or a fee tied to vehicle miles traveled) will be used to replace the gas tax. As a result, incentives that offer free or discounted tolls may be highly undesirable, as it will be politically difficult to impose user fees once motorists become accustomed to driving in a fee-free environment. In addition, incentives that provide exemptions to use high occupancy lanes, or free or discounted parking, can run counter to the larger effort to reduce GHG emissions by encouraging more vehicle miles traveled and discouraging use of alternative transportation. Incentives must be considered not simply for their short term impacts, but also for their long term impacts, particularly since political leaders may find it difficult to end popular incentive programs when EV adoption is more commonplace.

Case Study: AEP EV Ownership Pilot[47]

DATE INSTALLED: September 2011

DESCRIPTION: As part of its smart grid demonstration project in northeast Columbus, Ohio, AEP Ohio introduced Plug-in Electric Vehicles (PEVs) into a smart grid pilot area. The vehicles are being used in various utility and employee/customer/utility applications to determine the suitability, benefits, and challenges of the technology. Specifically, the vehicles are helping AEP Ohio and the U.S. Department of Energy to better understand the impacts of fleet and employee/customer charging and by utilizing the smart grid and home area network technologies deployed in the area.

In total, AEP deployed 11 vehicles and over 37 charging spots into the demonstration area. The vehicles are driven by employees living in the demonstration area and charging locations are installed at the driver's homes, workplaces, and a few public locations.

FUNDING: The project was funded by AEP and the U.S. Department of Energy.

LESSONS LEARNED: Installation costs can vary significantly among locations. Careful consideration and selection of the charger, installation location, and installer can help keep costs reasonable.

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[46] Loveday, E. "State of Virginia Approves $100 Annual Road-Use Tax for All Electrified Vehicles." Inside EVs (02/25/2013)
[47] Provided by AEP

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Ohio's Electric Vehicle Marketing Plan

Drive Electric Ohio

Overview

The overall strategy for the 2013 Ohio Electric Vehicle Marketing Campaign, Drive Electric Ohio, is to educate consumers about EVs by encouraging them to seek information which will help lead to sampling (test-driving) and supporting the Ohio EV initiative. The Drive Electric Ohio campaign is designed to build awareness of and preference for EVs. By changing perceptions about range anxiety, cost, and reliability with educational messages touting numerous EV benefits, the market development campaign will encourage consumers to take action – get information, learn about EVs, and ultimately, to buy a vehicle.

This information will empower consumers and position EVs positively in their minds, leading to sampling and evaluating how an EV would fit into their lifestyles. The sampling and evaluation will eliminate lingering doubts, leading to anticipation of anything from lower costs and more choices, to government incentives and utility support. The final step is adoption, which will accelerate with increased manufacturer, legislative, business and social support.

KEY FINDINGS

- In Ohio, the top five criteria for purchasing an EV, in rank order, include[48]
    - Vehicle Price
    - Reliability
    - Convenience to charge
    - Cost to charge
    - Fuel costs
- Ohio consumers have a high level of awareness for electric vehicles versus all others forms of alternate fuel technologies, but a low familiarity with all alternative fuel technologies except hybrid.
- Among Early Majority consumers, environmental concerns and reducing dependence on foreign oil are also important.
- Consumer driving behaviors are aligned with EV single charge driving range, however, their range expectations required before they will consider purchase are not.
- Consumers expect an EV to cost $15,000 – $35,000.
- The message – that electric vehicles cost less to drive and maintain, are safe and dependable, increase US energy independence, benefit the environment, and create domestic jobs – tested well overall and even stronger among consumers who fit the criteria for the early majority.

All of this information indicates that education is the key to driving preference for EVs in Ohio.

RECOMMENDATIONS

1. Develop a marketing campaign with the following objectives:

- To build consumer and legislative awareness and preference for plug-in electric vehicles.
- To educate consumers and legislators about the benefits of EVs.
- To build awareness, preference and educate secondary audiences (fleets, city officials/planners, business leaders, policy makers, and the media) about EVs.

2. Implement the marketing campaign with the following strategies:

- Build a brand strategy that shapes and integrates all messages.
- Use mass media to reach consumers throughout the state.
- Utilize social media to expand and shape the conversation around key messages.
- Get consumers to take an action (get information, learn about EVs, buy a vehicle, etc.).
- Empower brand ambassadors to represent geographic areas around the state.

[48] Clean Fuels Ohio, Consumer Research, Alternative Fuel Technologies, Communica, May 2012

Opportunities & Challenges[49]

While local officials are largely divided as to whether or not EV charging stations would provide their community with an economic advantage, they do believe being environmentally-friendly, reducing our dependence on foreign oil and promoting their community's image are all advantages of integrating charging stations.

Cost is by far the most significant perceived obstacle to integrating EV charging stations followed by concerns about public education, installation, public opinion and enforcement. To overcome the cost barrier 44% of governments indicate they will require matching-money grants, 39% would seek public-private partnerships and 33% would like preferred loan programs.

Governments also require technical assistance, however it is public education and outreach that topped the scale with 70% of cities, 82% of counties and 90% of villages desiring public education and outreach efforts. They also believe they will have to be creative to incentivize the private sector to build EV charging stations. Thirty-two percent believe tax breaks or waived fees will be necessary, while others believe shared expenses or reduced parking requirements would have to be considered.

- Use the web as the central resource with sections of information for key target audiences; general public, policy makers, media.
- Educate media and build network of media partners in various cities to help promote/support local events.
- Leverage relationships with universities, city leaders, utility companies.

RESEARCH

Background

Communica worked collaboratively in discussion forums with key stakeholders to shape plan development, provide context, generate ideas and share suggestions before developing the consumer marketing plan. The comprehensive Marketing and Branding Strategy includes the following elements: (a) the identification of target audiences through market research, (b) design of tactical program elements (including developing an advertising and promotional strategy that maximizes limited marketing funds, web and social media campaigns), (c) a media relations plan, (d) a special events plan, (e) a direct marketing plan, (f) partnership and promotional strategies (identification of potential partners and their level of support and involvement, including but not limited to targeted academic and medical institutions), (g) a proposed timeline, and (h) budget for implementation of the Plan.

Specific methodology, sampling and analyses included:

- Quantitative web-based in-depth survey.
- Target audience criteria and consumer respondent profiles:
  - Ohio resident
  - 400 completed responses from metro markets, 100 completed from rural
  - Registered voter
  - Age 25+
  - 67% of the sample with household Income >$50,000
  - Education: 67% of sample has a college degree or higher
- Data was cross tabulated to identify statistically significant differences across demographic criteria.

Marketing Strategy

The overall strategy has been developed to educate consumers about EVs by encouraging them to seek information, which will lead to sampling (test-driving a vehicle) and support for the initiative. The campaign is designed to build awareness and preference for EVs. The goal is to change perceptions about range anxiety, cost and reliability with educational messages touting the benefits. The campaign will encourage consumers to take some action (get information/learn about EVs, buy a vehicle, etc.) This information will empower consumers and position EVs positively in their minds, leading to sampling and evaluating how an EV would fit into their lifestyles. The sampling and evaluation will eliminate lingering doubts, leading to anticipation of anything from lower costs and more choices to government incentives and utility support. The final step is conversion, which will accelerate with increased manufacturer, legislative and business support, as well as the support and encouragement consumers receive in their social circles (what they read and hear).

Tactical Plan

The research conducted by Communica indicated that a majority of respondents (57%) are familiar with EVs, but they are not familiar with the specific technology and initially, are only mildly interested in learning more about them. But when given details about the technology involved, respondents were more likely to consider purchasing one of these vehicles.

Information is a very powerful incentive, and if applied in innovative, persuasive ways, can be a critical component in driving acceptance of and support for EVs in Ohio. Information about a highly technical subject, such as alternative vehicles, must be presented in a way that is easy to understand and streamlined. The most successful approach applies data and arguments that appeal to the issues (identified most important in the research) in making a decision to purchase or not purchase an alternative vehicle.

This EV marketing program will provide Ohio residents with the critical knowledge necessary to support the State's effort, and ultimately to make the decision to buy an EV. The information will be delivered in a way that is entertaining and personal, and in which consumers are co-creators of the experience.

This EV marketing program is indeed a journey for Ohio residents – and CFO will facilitate and support what will be a paradigm shift in thinking about transportation. When people participate in this process, it will trigger a strong emotional value – an endorsement of the campaign. This co-creation will support lasting connections, create successful dialogues and accelerate continuous learning – while encouraging the evolution of ideas.

[49] *Ohio Survey of Local Governments*, 11/09/12, Governing Dynamic

The EV marketing program will be centered on a strong source for information about EVs and support as consumers begin to shift their thinking about EVs. The source for this program is the Drive Electric Ohio website, hosted by Clean Fuels Ohio – a versatile location for

- state news and industry trends.
- practical information on buying an EV and charging it around the state.
- stories about people who own and love EVs.
- continuously updated social conversations.

The Drive Electric Ohio website will be the hub of the EV marketing program. All of the other tactical programs – advertising, ambassadors and communities, media relations, social media and events – will direct consumers to the website for additional information, to participate in events and activities and to join the EV community.

Initiative Website

The Drive Electric Ohio Buzz Hub will be the centerpiece of the informational program, and carry consumer-experience information about all aspects of EVs:

- How they work.
- How they compare to gasoline powered vehicles (cost, performance, etc.).
- Buying and maintaining an EV.
- News about the EV market.
- Benefits, cost calculator, personal experiences, etc.

The Buzz Hub will be the living content resource for the EV marketing program, with a format that is narrower than the Clean Fuels Ohio primary website. The website will be populated with original information that addresses the issues of most concern to consumers, including cost, range, reliability, charging, sustainability and future developments. The campaign will also curate applicable information (including data and documentation from our resources) to make the website truly a one-stop source for learning about and sharing personal experiences with EVs.

The information will be provided in an easy-to-understand format, and the website will offer the opportunity for consumers to ask questions about what they're reading and participate in the conversation about EVs.

The site will contain a range of social embedded sections that display and encourage an emotional experience:

- Our news (here's what's happening with our event program around the state).
- Your stories (your personal experiences at our events).
- Your EV experiences (as consumers learn more about EVs they'll be able to share that information here).
- Along the Road (blogs from Clean Fuels Ohio and consumers learning about EVs).
- Images and Videos (provided by Clean Fuels Ohio and by all our participants).

The website will also feature:

- Aggregated feeds from our channel communications (Twitter, Facebook, etc.) to run on the home page and provide real-time updates of the social conversation.
- Badges and other awards consumers can earn, which they can pass along to friends.
- Items consumers can vote for – relating to content, contests and events.
- Calculators consumers can use to compare vehicle costs, fuel expenses, maintenance charges and other elements of EV ownership.
- Running measures of the number of charging stations around the state.
- Live steaming of events and streaming of consumer-generated video about EVs.

The website will be a changing, dynamic location for updated information, personal experiences and support. It will offer several avenues for two-way communication, and encourage utilization of the voice of the consumer in future communications activities.

Advertising/Media Plan

Communica will develop a creative strategy, designed around key messages determined from the branding workshop. The creative execution will ask consumers to take an action – anything from getting more information, supporting the initiative, to buying a vehicle.

CFO has a large geographic area to cover, so it is important to not spread its resources too thin by trying to spend a little bit on all mediums. The strategy is to narrow our focus and "own" a medium. This tactic will include use of outdoor billboards in the top four markets to reach the public.

Communica will execute the creative strategy, developing 3-4 outdoor billboard designs and 3-4 banner ad designs. In addition, Communica will write radio scripts to promote the promotions and events going on in each city.

- Execute this strategy into an advertising campaign in the form of 3-4 outdoor billboard and banner ad designs.
- Develop media plan using outdoor billboards and online ads to reach masses of people in Columbus, Cleveland/Akron/Canton, Cincinnati and Toledo. These major markets are the areas with the highest population and target household incomes.
- Utilize radio to promote the local events going on in each area.
- Communica recommends the following as a basis for the media buy:
    - Outdoor billboard
    - Online- combination of general and specific sites
- Flight the campaign over many weeks.

Signage at future charging station locations

Communica recommends developing a sign or display, using the charging station icon, to indicate where all future charging stations will be located. This will help to build awareness as people are out driving in their environment, making them realize how they will interact with these stations throughout their daily activities, reducing range anxiety.

PSA Funding Strategy

Non-profit organizations struggle to get the most out of every dollar spent. Recognizing that, many media outlets allow for a reduced rate (discounted column inch rate in print) or special offer (free color for a print ad, bonus outdoor billboard). Another way to maximize value is to leverage all paid media buys with PSAs. There are multiple strategies for PSA plans, and Communica recommends the following:

- The purpose of the PSA plan is to boost the media buy's total reach and frequency.
- When buying the media, Communica will require that 20% of the total dollars spent are PSAs.
- Communica will allow the media outlet the flexibility to put the PSAs anywhere into their schedule (the more flexible, the more likely they will be to participate in the buy).
- Print PSAs are based on the individual publications goals and objectives. Communica will work with editorial boards, community service directors and publishers to get free space when possible.

In addition to PSAs, Communica can leverage relationships with existing stakeholders' media buys to get exposure. For example, if a manufacturer has an outdoor billboard campaign, they could give CFO space on one of their boards for a month, or in the case of a digital billboard buy, they could give the campaign a slot in the rotation. Utility partners can reach their customers through utility "bill stuffers" or other direct mail. Communica will develop a plan around these opportunities and develop the associated creative elements.

Public Relations (Earned Media)

Consensus Building

Identification and nurturing of early adopters of EVs around the state will provide the support and validation necessary to successfully market the concept to Ohioans. Additionally, having these "ambassadors" all over the state offers the local credibility and experience that will resonate with residents. Communica will identify these local experts, enthusiasts and other stakeholders (including those already identified by Clean Fuels Ohio), and begin a grassroots campaign to prepare them for mobilization as the Drive Electric Ohio campaign begins.

Activities will include:

- Identifying all possible ambassadors from among Ohio's universities and colleges, local governments, business leaders (including auto dealers), legislators, researchers, etc.
- Introducing the brand and key messages of the campaign to the groups in personal presentations by Clean Fuels Ohio representatives.
- Engaging the groups through online social communities where we can pose discussion topics and offer information, and where they can communicate with one another.
- Providing an ongoing schedule of events, along with various local or national issues as they would arise, so they can serve as spokespersons or local experts with media (if needed).
- Seeking out their participation across all marketing, public relations and social media vehicles.

Policymakers and Legislators

In addition, CFO will identify and build relationships with other supporters who would mutually benefit from EV growth in Ohio:

- Automakers and suppliers.
- Utility industry participants.
- "Secondary" Ohio-based companies that encompass a sustainability philosophy and could be a good partner to the EV program.
- Government bodies in each key city across the state that would also benefit from increased statewide focus, such as tourism.

Communica and Clean Fuels Ohio will establish contact with these groups (similar to the communication plan established with our ambassadors) to invite their participation in the campaign, and to seek out their involvement in PSAs and other activities.

Influencing Thought Leaders

Communica and CFO will also research, monitor and build relationships with thought leaders with the following data collection in mind:

- Who is writing and speaking about EVs?
- Who are the supporters and who are the detractors (what is their reasoning for their positions, and who is listening to them)?
- Who are considered experts in a particular area of EVs, such as vehicles, costs and maintenance, sustainability, etc.?

In addition, the campaign will identify the thought leaders from among legislators and other political leaders, the media (both Ohio-based and national), bloggers and all other social media channels (where EV-related conversations are taking place). The ambassadors, supporters and thought leaders will provide information, insight and an emotional perspective on EVs.

Statewide Media Relations

Communica and CFO will create a statewide media strategy for identifying the top media and reporters across the state – those who have written about EVs, those who view EV development in Ohio favorably, those who have already worked with Clean Fuels Ohio on stories and programs and those whose readership / viewership reaches our primary audiences. With the details from this research, Communica and CFO will establish a program for regular contacts throughout the campaign and beyond, including:

- A city-by-city media tour to introduce the campaign. The tour will feature Clean Fuels Ohio representatives, as well as local ambassadors (when possible and appropriate).
- Statewide distribution of news releases as any news breaks (new charging stations, supplier-state relationships, grant announcements, etc.).
- Development of an editorial calendar of feature (evergreen) stories that can be used statewide, along with stories that can be developed to address specific issues on a city-by-city or region-by-region basis across the state.
- An online media kit containing background stories, bios and a list of applicable story ideas that can be distributed to media.

- Editorial contacts with weekly and monthly state-focused or regional publications to encourage feature coverage.
- News conferences as warranted (in conjunction with news announcements as well as with the statewide events).
- A full schedule of news releases and interview placements to coordinate with the statewide event (detailed below).
- Subject matter podcasts to key media from industry thought leaders (stored and promoted through the website).
- YouTube videos produced with industry thought leaders will be made available to media as background and feature material.

- Social Media
  Social media will be a prominent element of the communications effort, as a way of pushing out information and beginning to engage fans and followers in two-way conversation as a result. Communica and CFO will create content that will inspire a cycle of sharing, and monitor all channels for sentiment, need and ideation. From this information we can define the emotional triggers prompted by the content, and prepare any necessary responses. This strategy will include the effective use of hashtagging and optimization that will best reach all audiences.

Content Creation

Content will be developed and placed based on the overall messaging of the program and the specific news of the day. Communica and Clean Fuels Ohio will develop a scheduled series of posts that will incorporate the flexibility for updated information, breaking news or to respond to followers. And CFO will also utilize our ambassadors, partners and thought leaders to participate in personal interactions with visitors and fans. Communica and Clean Fuels Ohio will create and post a daily selection of messages that can include:

- News as it's distributed around the state.
- Teasers, updates and real-time news about events around the state.
- Links to stories of national interest.
- Posts about individual EV stories in Ohio, and links to video, photos, etc. and information on the website.
- Educational questions about EVs that consumers can answer.
- Trivia information about EVs in Ohio.
- Information and links from our ambassadors and supporter communities.
- Announcements as new vehicles are introduced, new charging stations are opened (with links to maps).
- Photos and videos of all the events and activities happening around the state.

Social Channels

Communica recommends using a wide range of channels for distributing news and engaging in conversations with the public. And, in order to best reach the specific audiences as they grow, CFO will continue to explore new social channels and develop a process for active listening and response, throughout all channels, to better draw consumers into the conversations.

Day in the Life Program

Communica recommends a "Day in the Life ..." online program that will feature Ohioans (representing a range of demographic and geographic areas) who will document their experiences with their EVs over a specific time period. Owners will create video and written journals of their experiences, and participate in live chats and webcasts (when appropriate), all of which will be shared on all the social channels and live on the Buzz Hub website. Communica and Clean Fuels Ohio will work with media in the communities in which the participants live, developing stories that chronicle their progress and perhaps riding along from time to time. The campaign will also include them in any statewide events occurring in their communities.

Re-engagement

Through this program of listening and responding to social conversations (in addition to content generation), we support any social connections as they are created. The program seeks out more than likes, clicks and impressions. It will:

- Identify receptivity – what followers are open to social connections?
- Place both original and published content to seed social dialogues.
- Engage followers in discussions about EVs by providing information, supporting enthusiasm and dispelling erroneous ideas.
- Utilize influencers to deliver messages and build relationships.
- Define points where content can lead to immediate actions (channeling back to the website).

Search Engine Optimization

Search Engine Optimization (SEO) is critical in helping our messages reach far broader audiences. By utilizing keywords in outward-bound material the campaign will rank higher in searches and assure that the messages are reaching more people. Throughout the marketing campaign we'll incorporate SEO into website development and optimize news releases, social media posts, video, blog posts and online advertising. SEO will also be very important in encouraging backlinks to the Buzz Hub website.

Mobile Communications

Mobile communication is a significant contributor to the effectiveness of the messaging, and a natural element of this very "mobile," statewide program. It will also be a source for a great deal of the data that will be critical in measuring the effectiveness of the overall campaign.

- Events and activities throughout the campaign will be very location-focused, and include special programs, badges, etc., on location apps such as Foursquare, as well as with any apps developed specifically for the campaign.
- The campaign will work with partners, such as automakers and utility companies, to participate in their EV mobile programs, such as apps and text message campaigns, particularly as they would pertain to statewide events.
- Communica recommends that Near Field Communication (NFC) enabled charging stations be utilized throughout the state as a means of pushing messages and information, and for data extraction and re-engagement.

Promotional Events

EV engagement is both an intellectual and emotional decision. In order to create this emotional connection, we will hold a series of events that will kick off in the spring of 2013 and run periodically for several months. These events will draw Ohioans in for a personal experience with EVs, meet the people who know and drive them, and learn more about how EVs can become part of their lives.

Drive Electric Ohio Kick-off Week

Our event program will kick off in the spring of 2013 with a week of events around the state to bring attention to the growth of EV use and the state's current infrastructure. To create awareness for the kick-off we plan to coordinate several activities in the city to deliver these messages. For example, we'll link with city leaders in the top four Ohio cities (when possible) to offer a few blocks of free parking specifically for EVs. The campaign will feature a cover for the meters that indicates the free spaces, and offers a message tied to saving ¬– saving cash, saving on your commute, saving the earth. The covers will draw attention and will make a great visual to generate news coverage and visitor interest.

Piggyback Existing Affinity Events

The EV marketing schedule of events will be designed to be a part of already-scheduled events around the state. Communica and CFO will research all of the statewide affinity events during this period, and identify those that will best meet our criteria: EV use and enthusiasts, existing (or near potential) infrastructure, active vehicle dealerships, etc. We will then work with those organizations to include our event along with their activities. For example, baseball games are a perfect venue for these events, major and minor league baseball games will be taking place in most of the large and mid-size cities around Ohio.

The campaign will present the EV messages in the community spirit of each local event – it will be an added feature of what will already be a fun day. The campaign will promote each of these events well in advance using radio advertising and media contacts, so that the excitement will build around the state. Campaign schedules will be coordinated with other state energy initiatives to avoid conflicts or to take advantage of opportunities to form partnerships for these events, when possible.

For the very first event, a news conference will be held that can be broadcast statewide and live-streamed to the website. Communica will also provide b-roll video of charging stations and other related materials.

Each city's event will be unique, building on the local activities and people that could be involved. For example, we recommend coordinating the event with activities happening throughout the state:

- Professional and minor league sporting events (baseball, football, hockey) – these attractions draw the Clean Fuels Ohio demographic groups.
- Ohio State Fair, major county and local fairs – fairs are especially appropriate for the educational value of an event.
- College football games around the state – offer the opportunity to involve our university partners around the state, and can also feature college mascots (a big draw for students).
- Marathons across the state – offering a festive, outdoor setting, marathons will also attract the Clean Fuels Ohio target audience.

Associated Activities at Events

Communica will work with Clean Fuels Ohio to host Ride and Drive programs in each of our event cities. In connection with the Ride and Drive programs, Communica will

- Have a display area where EVs from the major manufacturers will be available (and potentially which will include incentives, deals and representation from local dealers).
- Involve local car dealerships for cars to include in the Ride and Drive, with potential additional visits to nearby recharging stations (to give visitors a feel for the entire EV experience).
- Visitors participating in the Ride and Drive will be able to answer EV trivia questions (a la the E-tour EV below) and earn an entry into the EV drawing, which will take place later in the year.

Media will be contacted well in advance of these events to provide background information and arrange for personal interviews and other special activities during the event:

- Reporters and other local officials (and legislators) can participate in the Ride and Drive, with TV stations doing live reports and reporters providing real-time blogs or other reports. All reports will be live streamed or posted to the Buzz Hub website.
- If the event is presented in conjunction with Clean Fuels Ohio news, Communica will hold a news conference during the event.
- Local ambassadors will be present during the event and available to talk with visitors, be interviewed by media and participate in some of the activities.

E-Tour EV

Communica proposes developing an E-tour EV that would travel around the city during each event day. The E-tour EV will be a logoed vehicle (provided by an automaker or large dealer for the duration of the program) that will operate as a take-off of the popular "Cash Cab" television program. In this case, the E-tour will take residents on a short trip in the area of the event while they are asked questions about EVs and are videotaped giving their answers. For correct answers they will be entered into a drawing (taking place at the end of 2013) for a large EV related prize (i.e. possible a year lease of an EV, etc.). The E-tour is a great educational "vehicle" for the public, an enjoyable time and another way for consumers to get a personal experience in an EV.

Observation, Measurement and Re-engagement

Observation and measurement is an integral part of the marketing program, as it helps to determine the emotional triggers that most resonate with Ohioans. Communica and CFO will continuously employ these and a range of other programs to track and respond to communications activities, and re-engage participants in deeper conversations.

By observing the conversations taking place among all our social communities, Communica will be able to:

- Determine the awareness and reach of our messages.
- Establish keywords that will help to accelerate adoption of EVs.
- Determine the barriers to adoption.
- Identify trends (based on original and professional content).

- Target participants and messages by lifestyle, sentiment, etc.
- Create a valid picture of participants via contextual views.

As mentioned in the social media discussion, Communica and CFO will utilize search engine optimization (SEO) in all communications activities, to drive recognition and visibility among all audiences. Communica will monitor conversations and comments in all social media channels. Communica will also monitor conversations about EVs and other related topics, and the thought leaders influencing these conversations. The monitoring program will feature a rapid response strategy to answer questions, reply to concerns, correct errors and curate the general feedback of the program.

With the data collected from social communities, traffic and activity on the website, data from mobile communications programs and measurement of traditional media placements and dialogues, Communica and CFO will be able to gauge the impact of the campaign's messages on the tangible goals of the program. It will help CFO to determine where the messages are resonating (by demographic and geographic group), what messages need to be refashioned and where new emphasis should be placed.

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Resources

Research Sources

This study began in the Fall of 2011, and over the past year and a half the electric vehicle world has been rapidly evolving, sometimes on a daily basis, with manufacturer and industry forecasts fluctuating from idealistic to dismal, and new technologies being discussed that will find their way into the EVs of the future. In addition to the studies and articles cited in this report, the Team kept a hand on the pulse of EV innovations and consistently monitored many sources of information. The following list of agencies, think tanks, universities, industry experts, and news organizations were crucial to developing the understanding necessary to write this report.

Government Agencies

Bureau of Labor Statistics
Bureau of Transportation Statistics
City of Palo Alto
EvTown
Executive Office of the President
Federal Highway Administration: National Household Travel Survey
Greater London Authority
Jobs Ohio
National Highway Traffic Safety Administration
U.S. Department of Energy: Energy Efficiency and Renewable Energy
U.S. Energy Information Administration

News Media

Arizona Capitol Times
Associated Press
Automotive News
AutoObserver
Business Week
CBS News
Chicago Tribune
Cleantech News and Analysis
CNNMoney
Crain's
Electric Vehicle Update
Engadget
Inhabitat
LA Times
National Public Radio
New York Times
PluginCars.com
Politico
Sacramento Business Journal
The Atlantic
The Christian Science Monitor
The Cleveland Plain Dealer
The Columbus Dispatch
The Detroit News
The Economist
The Toledo Blade
Wall Street Journal
Washington Post
Wired
Yahoo Autos

Research Institutions

Accenture
American National Standards Institute
Battelle Energy Alliance
Brookings Institution
Center for Automotive Research, multiple states
Clinton Climate Initiative
Community Research Partners
Deloitte
Edison Electric Institute
Electric Drive Transportation Association

Electric Power Research Institute
Electric Transportation Engineering Corporation
Ernst & Young
Gallup
Illinois Electric Vehicle Advisory Council
Massachusetts Institute of Technology
McKinsey Quarterly
Natural Resources Defense Council
Oregon Transportation Research and Education Consortium
Organisation for Economic Co-operation and Development
Pike Research
Policy Matters Ohio
Price Waterhouse Cooper
Rocky Mountain Institute
Solar Journey USA
State Smart Transportation Initiative, University of Wisconsin-Madison
The Boston Consulting Group
The PEW Charitable Trusts
Union of Concerned Scientists
University of Vermont Transportation Research Center
Wards Automotive

Additional Resources

Provided web links were active as of March 15, 2013.

Research and Reports

- EV Everywhere Grand Challenge Blueprint – US Department of Energy 2013 http://www1.eere.energy.gov/vehiclesandfuels/electric_vehicles/pdfs/eveverywhere_blueprint.pdf
- Hybrid and Plug-in Electric Vehicles – US Department of Energy Clean Cities www.afdc.energy.gov/afdc/pdfs/51017.pdf
- Plug-In Electric Vehicle Handbook for Consumers – US Department of Energy Clean Cities www.afdc.energy.gov/afdc/pdfs/51226.pdf
- Plug-In Electric Vehicle Handbook for Electrical Contractors – US Department of Energy Clean Cities www.nrel.gov/docs/fy12osti/51228.pdf
- Plug-In Electric Vehicle Handbook for Fleet Managers – US Department of Energy Clean Cities www.afdc.energy.gov/afdc/pdfs/pev_handbook.pdf
- Plug-In Electric Vehicle Handbook for Public Charging Station Hosts – US Department of Energy Clean Cities www.nrel.gov/docs/fy12osti/51227.pdf
- Plug-In Electric Vehicle Community Readiness Scorecard – US Department of Energy Clean Cities www.afdc.energy.gov/pev-readiness
- Charging While You Work, A guide for expanding electric vehicle infrastructure at the workplace – Minnesota Pollution Control Agency 2012 http://www.energyinnovationcorridor.com/page/wp-content/uploads/2011/01/charging-while-you-work-guide-8.5-11.pdf
- 2013 Vehicle Buyers Guide – US Department of Energy Clean Cities http://www.afdc.energy.gov/uploads/publication/55873.pdf
- PEV Collaborative Community Readiness Toolkit – PEV Collaborative 2012, http://www.pevcollaborative.org/sites/all/themes/pev/files/docs/toolkit_final_website.pdf
- A Guide to EV-Ready Communities – Ready, Set, Charge http://www.baclimate.org/impact/evguidelines.html
- Community Planning Guide for Electric Vehicles – Advanced Energy 2011 www.advancedenergy.org/transportation/resources/Community%20Planning%20Guide.pdf
- Charging Station Installation Handbook for Electrical Contractors and Inspectors – Advanced Energy 2011 www.advancedenergy.org/transportation/evse/Charging%20Station%20Handbook%20Rev2011.pdf
- Prepping for Plug-In Vehicles at Condos, Townhomes and Apartments – San Diego Gas & Electric 2011 www.sdge.com/sites/default/files/documents/Prepping%20for%20EVs%20Condos.pdf?nid=3105
- EV City Casebook –Project Get Ready from Rocky Mountain Institute 2012 www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
- Site Design for Electric Vehicle Charging Stations – Sustainable Transportation Strategies 2012 http://www.sustainabletransportationstrategies.com/wp-content/uploads/2012/09/Site-Design-for-EV-Charging-Stations-1.01.pdf
- EV Charging for Persons with Disabilities – Sustainable Transportation Strategies 2012 http://www.sustainabletransportationstrategies.com/wp-content/uploads/2012/01/EV-Charging-ADA-Version-1.0.pdf
- Siting Electric Vehicle Charging Stations – Sustainable Transportation Strategies 2012 http://www.sustainabletransportationstrategies.com/wp-content/uploads/2012/05 Siting- EV-Charging-Stations-Version-1.0.pdf

Websites:

- Alternative Fuels Data Center(AFDC) – US Department of Energy www.afdc.energy.gov/
- FuelEconomy.gov – US Environmental Protection Agency www.fueleconomy.gov/
- Drive Electric Ohio – Clean Fuels Ohio www.driveelectricohio.org/
- Plug-In America, www.pluginamerica.org/
- Electric Drive Transportation Association (EDTA), www.electricdrive.org/
- PEV Collaborative, www.evcollaborative.org/
- Go Electric Drive, www.goelectricdrive.com/
- Project Get Ready from Rocky Mountain Institute (RMI), www.rmi.org/project_get_ready
- Electric Power Research Institute (EPRI), www.epri.com/Pages/Default.aspx
- Edison Electric Institute (EEI), www.eei.org/Pages/default.aspx
- National Fire Protection Association (NFPA), www.nfpa.org/index.asp?cookie_test=1
- National Alternative Fuels Training Consortium (NAFTC), www.naftc.wvu.edu/
- National Electrical Contractors Association (NECA), www.necanet.org/

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