State of New Mexico Fleet Electrification Report

Department of Transportation and General Services Department

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State of New Mexico's Clean Energy Transition

Executive Order 2019-003 states that New Mexico has set a goal of achieving "statewide reduction in greenhouse gas emissions of at least 45% by 2030 as compared to 2005 levels" (Lujan Grisham, M., 2019). One way for New Mexico to achieve this goal is to reduce the tailpipe greenhouse gas emissions created by the state's automobile fleets. Accomplishing this requires transitioning the state vehicles from combustion engine vehicles to electric vehicles, and New Mexico has elected to begin this process with its light-duty fleets. The goal of this report is to help New Mexico begin the process of transitioning its fleets.

This report includes information regarding charging stations for the electric vehicles, types of electric vehicles, and funding options. Additionally, this report includes a baseline emission calculation for the General Services Department's light-duty fleet and a tool which can be used to calculate GHG emissions on an on-going basis. Finally, this report aims to provide options for the steps New Mexico can take to continue their journey to reducing the tailpipe emissions for their fleets.

Goals

1. Addressing the Governor's Executive Order by addressing GHG emissions in the transportation sector, they will be in line with the Governor's Executive Order to "achieve statewide reduction in greenhouse gas emissions of at least 45% by 2030 as compared to 2005 levels" (Lujan Grisham, M., 2019).

2. Determine the baseline tailpipe greenhouse gas emissions for the General Services Department's light-duty fleet.

3. Build a tool that state departments can use to track their tailpipe greenhouse gas emissions as new cars are introduced to the fleets.

4. Provide an overview, best practices, recommendations, and next steps for the Department of Transportation and General Services Department.

Fleet Electrification

Electric Vehicle Benefits

The U.S. used nearly nine billion barrels of petroleum last year, two-thirds of which went towards transportation. Reliance on petroleum makes the U.S. vulnerable to price spikes and supply disruptions.

In addition to reducing vulnerabilities tied to reliance on petroleum, electric vehicles have many advantages over vehicles powered by fossil fuels, including:

- Lower costs for fuel and vehicle maintenance
- More energy efficient
- Produce no tailpipe emissions
- Quiet to drive (Electric Vehicles & Charging Infrastructure, n.d.)

When considering the benefits of electric vehicles, it is also useful to understand the two categories of vehicle emissions: direct and life cycle.

Direct emissions are emitted through the tailpipe, through evaporation from the fuel system, and during the fueling process. Direct emissions include smog-forming pollutants (such as nitrogen oxides), other pollutants harmful to human health, and greenhouse gases (GHGs), primarily carbon dioxide (Reducing Pollution with Electric Vehicles, n.d.).

- All electric vehicles produce zero direct emissions
- Plug-in hybrid vehicles (PHEVs) produce evaporative emissions from the fuel system as well as tailpipe emissions, however most PHEVs are more efficient than conventional vehicles, and still produce fewer tailpipe emissions even when relying on gasoline.

Life cycle emissions include all emissions related to fuel and vehicle production, processing, distribution, use, and recycling/disposal. These emissions also include a variety of harmful pollutants and GHGs (Reducing Pollution with Electric Vehicles, n.d.).

- Emissions are produced when petroleum is extracted from the ground, refined to gasoline, distributed to stations, and burned in vehicles.
- Electric vehicles typically produce fewer life cycle emissions because most emissions are lower for electricity generation than burning gasoline or diesel.

Generally, electric vehicles produce fewer emissions that contribute to climate change and smog than conventional vehicles (Reducing Pollution with Electric Vehicles, n.d.). Increasing the use of alternative fuels and vehicles will help reduce consumers' fuel costs, minimize pollution and increase the nation's energy security (Alternative Fuel Vehicles, n.d.).

Environmental Benefits

A study performed by the American Lung Association of California found that gasoline vehicles are responsible for $37 billion in health and climate costs each year nationwide. Put differently, every 16-gallons of gasoline (representative of a typical tank) combusted adds $18.42 to public health and climate costs. The study found that if electric vehicles represent 65 percent of all cars on the road in 10 western and eastern states by 2050, those costs would drop by $21 billion (Wollenberg, 2017).

Electric Vehicles also reduce the emissions that contribute to climate change and smog, improving public health and reducing ecological damage. (Reducing Pollution with Electric Vehicles, n.d.)

Economic Benefits

Job creation is a major benefit to consider when considering fleet electrification and the expansion of charging station infrastructure. Electrification of the vehicle fleet would be the primary driver of an estimated 38 percent increase in U.S. electricity demand by 2050, according to a 2018 analysis by the U.S. Department of Energy, 58 which will require major expansion and modernization of the nation's electric grid—another source of job creation (Walter et al., 2020).

To compare the price of electricity to the price of gasoline, the Department of Energy (DOE) has created the eGallon metric. According to the DOE, the "eGallon represents the cost of driving an electric vehicle the same distance a gasoline-powered vehicle could travel on one gallon of gasoline." As of March 2017, the average U.S. price of regular gasoline is $2.32, whereas the average gallon equivalent of electricity is $1.11.

Gasoline Pricing vs Electricity Pricing Table for comparison:

Year	Average Price of Gas/Gallon	Average Price of Electricity/Gallon
2017	$2.32	$1.11
2021	$2.85	$1.16

On average, it costs less than half as much to drive an electric vehicle as it does to drive a gasoline-powered car, and electricity prices are also much more stable than gasoline prices (Wollenberg, 2017). Since electricity is a cheaper power source than fuel, fleet electrification and EV ownership can result in large savings over the life of the vehicle, in the long run it would be more cost effective for the State to invest in fleet electrification now.

From an economic standpoint, the maintenance of electric vehicles is quite low which equates to lower costs being spent on vehicle maintenance and associated costs. While the initial price of a plug-in vehicle may be more expensive than that of a conventional car, the total cost of ownership of a plug-in vehicle—the initial cost, plus the cost of fuel and maintenance over the life of the vehicle—may be substantially less. (Wollenberg, 2017).

Overview

Electric Vehicles

When discussing car engines and mechanics, there are three main categories of cars: combustion engine vehicles, electric vehicles, and hybrid vehicles. At present, New Mexico's light-duty car fleets primarily consist of combustion engine vehicles. These cars can be powered either through the use of gasoline or diesel fuel. The engines for these cars are powered by the gas that is created when the car's fuel is ignited ("Internal Combustion Engine Basics," 2013). Combustion engine vehicles are the most common type of vehicle and create the highest level of GHG emissions ("Reducing Pollution with Electric Vehicles," n.d.).

Alternatively, Electric Vehicles (EV) "derive all or part of their power from electricity supplied by the electric grid" ("Electric Vehicle Basics," n.d.). There are two subcategories of electric vehicles: All-Electric Vehicles (AEVs) and Plug-In Hybrid Electric Vehicles (PHEVs).

All-Electric Vehicles (AEV)

AEVs have a battery powered engine which relies on electricity that is pulled from the main electric grid and energy that is created through braking, also known as regenerative energy. ("Electric Vehicle Basics," n.d.). According to the United States Environmental Protection Agency (EPA) these cars produce no tailpipe GHG emissions. However, typically these cars only have a range of 80-250 miles (although some luxury models can reach a range of 350 miles) and can take anywhere from half an hour to a full day to recharge (KBB Editors, 2021).

Plug-In Hybrid Electric Vehicles (PHEV)

PHEVs have both a battery powered engine and an internal combustion engine. These cars typically run on their battery powered engine until it is depleted and then switch over to the internal combustion engine. This means that PHEVs have a further overall driving range, however, the range for the battery powered engine is much smaller with a typical range of 6 to 40 miles ("Electric Vehicle Basics," n.d.). This means that although the tailpipe GHG emissions for PHEVs are lower than those for combustion engine vehicles, they are higher than GHG emission levels for AEVs.

Hybrid Electric Vehicles (HEV)

HEV's "are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery." ("How Do Hybrid Electric Cars Work?," n.d.). This type of hybrid vehicle has been shown to produce lower tailpipe GHG emissions than PHEVs because they are generally able to travel further using the battery powered engine, but they still create more tailpipe GHG emissions than AEVs (Choi et al., 2020).

Charging Stations

Fleet electrification also needs to incorporate electric vehicle infrastructure, this means understanding the types of charging stations and plugs. There are three types of charging stations: level 1, level 2 and level 3. Recently, the State of New Mexico installed (22) Level 2 charging stations and (8) Level 3 charging stations in Santa Fe. Along with different types of charging stations, there are also different kinds of plugs. Depending on the electric vehicle there will be a distinct charge port, there are three types of plugs (connectors/adaptors):

- CCS (Combined Charging System or SAE Combo)
- CHAdeMo
- Tesla

Every electric vehicle on the road today is compatible with the U.S. standard Level 2 chargers, known in the industry as SAE J1772.

Level 1 Stations (Residential)

These stations are the slowest chargers, and are a lower voltage making them a better fit for residential customers who have time to charge their cars at home and overnight.

Level 1 is equivalent to a regular 110-120 volt (V) wall outlet, it is the same voltage that is used to power household items like a microwave or phone charger.

- Example: It would take about 40 hours to fully charge the battery on a Chevy Bolt from empty at a Level 1 charger, at a rate of about 5 miles of added range per hour of charging (Valderrama et al., 2019).

Level 2 Stations (SAE J1772)

These stations provide a fast enough charge to be recommended for light duty vehicles, they are more commonly found and have a voltage of 220 to 240. These charges provide decent charging speeds at around 10 to 20 miles of range an hour, and typically charge at a rate of about 6 kilowatts (kw).

- Example: It would take about 9 hours to fully charge the battery on a Chevy Bolt from empty at a Level 2 charger (Valderrama et al., 2019).

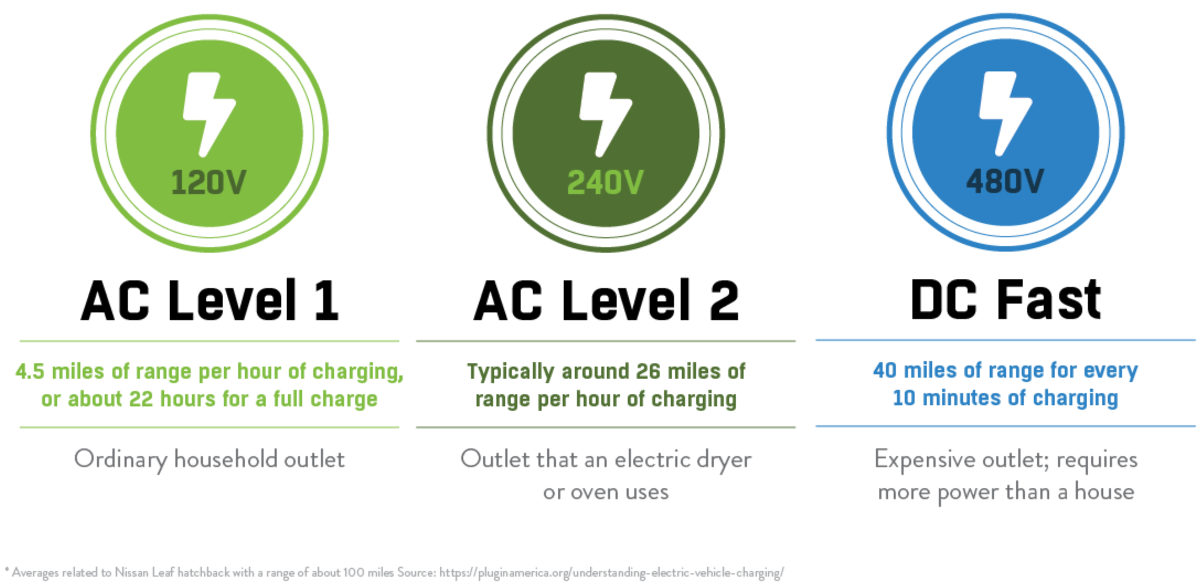
Level 3 Stations (Fast Chargers, DCFC Chargers, or DC Fast Chargers)

These charging stations are referred to as fast chargers because they can charge up to 80 percent of an electric vehicle battery’s total capacity in around 30 minutes. There are two plug standards in the U.S., CHAdeMO and SAE Combo Combined Charging System (CCS). Only two companies, Nissan and Mitsubishi, use CHAdeMO, while all other non-Tesla brands use CCS (Valderrama et al., 2019).

Level 3 charging stations mostly run at 400 V or more, and typically charge at a rate of 50-60 kW. However, it is important to note that not all electric vehicles are designed to handle this kind of charging and this level of charging is the most expensive option.

- Example: It would take about 1 hour and 30 minutes to fully charge the battery on a Chevy Bold from empty.

Fleet electrification must be accompanied by thoughtful and strategic EV infrastructure (EVI) planning. Fleets represent a significant opportunity for states and municipalities to showcase new vehicle technologies and demonstrate the business case for owning and operating these vehicles, as well as the corresponding charging infrastructure.



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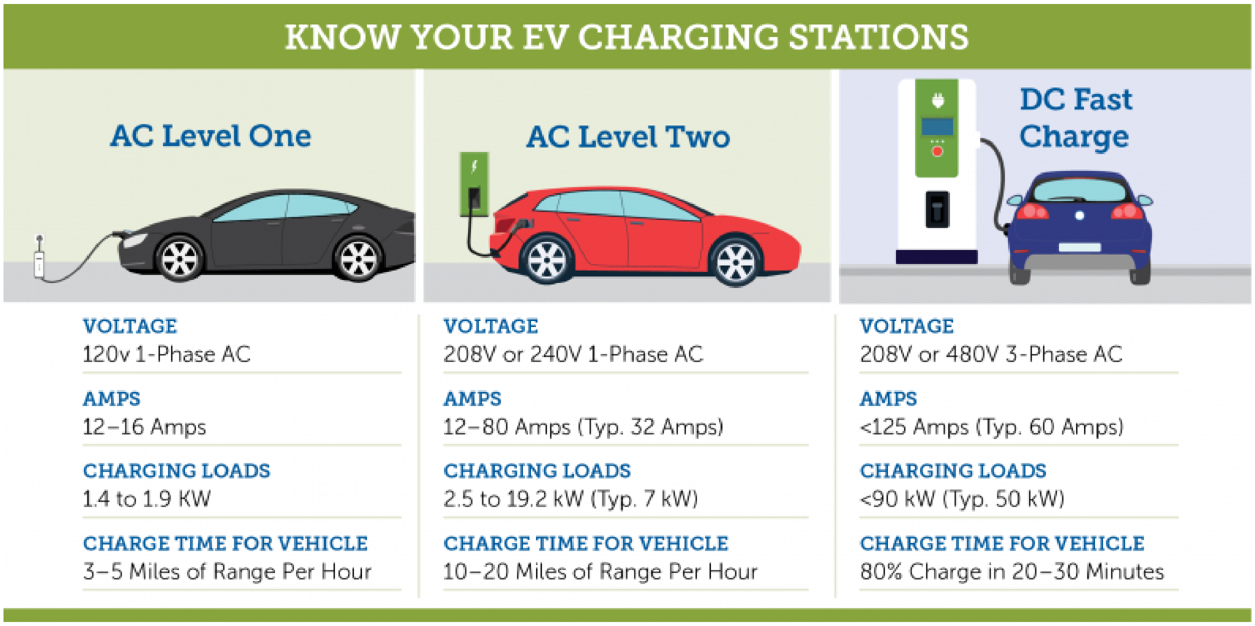

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Electric Vehicle Charging Business Models

- Recommended to confirm offerings with vendors prior to selecting a business model.

	Agency Own and Operate	**Agency Own and Outsource O&M**	**3rd Party Own and Operate**
Overview:	Chargers are owned and operated by the agency.	Chargers are owned by the agency, but O&M is contracted with a third party	Chargers are contracted with third party to own and operate equipment
Pros:	- Often more cost effective to utilize in-house maintenance and accounting (where applicable) staff - Useful in areas where charger utilization is low and/or fleet charging - May only need basic, non-networked chargers	- Implies lower costs for the operator - Less burden on agency staff - Agency does not need to handle payment processing - More predictable O&M costs improve budgeting	- Third party takes on large upfront costs - Third party overseas O&M (where Agency maintenance staff is limited) - Financing and leasing options offered through third party - Agency does not need to handle payment processing

Cons:	- Need for significant investment - Challenging if maintenance staff is not well versed on equipment needs - Challenging if maintenance staff does not have the bandwidth for high traffic charging facilities - Agency will be responsible for collecting payments, if any, which may require accounting staff	- More expensive to contract O&M with third party vs in-house staff - Priorities like charger placement and maintenance could fall out of alignment	- More expensive to contact O&M with third party vs in-house staff - Longer return on investment timelines

Electric Vehicle Greenhouse Gas Emissions Baseline

Baseline GHG Emissions Calculation

GSD Baseline is currently calculated at 9166.8364 metric tons CO2E/year.

Methodology

To determine the overall GHG emission baseline level for each department the following steps were followed:

1. The estimated annual mileage for each car was calculated using the formula:

   (Latest Meter Read Date - Original In Service Date)/365 = Total Years In Service

   Latest Meter Read Mileage/Total Years in Service = Average Annual Mileage

2. A list showing the Year, Make, Model of each car was compiled and loaded to the "Vehicle Breakdown" sheet. ***Important - The Year, Make, Model of each car on this list ties EXACTLY to the Year, Make, Model listing on the Light Duty Vehicles sheet***

3. City MPG and Highway MPG information for each car was pulled from fueleconomy.gov and entered into the "Vehicle Breakdown" sheet.

4. The EPA's formula for converting MPG into GHG emissions was entered into the GHG Emissions column of the "Light Duty Vehicles" tab. The formula is:

   8.89 × 10-3 metric tons CO2/gallon gasoline × 11,484 VMT car/truck average × 1/22.3 miles per gallon car/truck average × 1 CO2, CH4, and N2O/0.989 CO2 = 4.63 metric tons CO2E/vehicle /year

   It can can be found at:

   https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

   For this calculation it was assumed that all vehicles ran at 60% Highway MPG and 40% City MPG.

5. All calculations for vehicles that had already been retired were changed to 0. Additionally, any vehicles with excessive driving patterns (for example 150k miles in 3 months) or which had an Initial In-Service Date which was after the Latest Meter Read Date were changed to 0.

6. Finally, the GHG emission totals for each car were added up and totaled at the bottom of the Light Duty Vehicle sheet.

Using the GHG Emissions Calculator

The goal of creating a spreadsheet to calculate GHG baseline emission levels was to allow departments to continue tracking their GHG emission levels as older combustion engine vehicles are transitioned out of the fleets and newer electric vehicles are transitioned into the fleets.

To recalculate the GHG emission levels once more energy efficient cars are added to the fleets each car should be vehicles Year, Make, Model, and Equipment Description should be added to the "Vehicle Breakdown" tab along with the vehicles City and Highway MPG.

The *exact same* Year, Make, Model, and Equipment Description should then be added to the "Light Duty Vehicles" tab. For initial entries of new cars input the estimated annual mileage for the vehicle, this should be updated with actual mileage once the vehicle has been placed in service. The new GHG emissions level for the vehicles should automatically recalculate.

If a vehicle has been taken out of service hard enter 0 in the GHG emissions column for that vehicle so that it's emissions data is no longer included in the department's total.

Cost Saving Programs, & Additional Financial Resources

Federal Laws, Incentives, and Programs

- Guide to Federal Funding, Financing, and Technical Assistance for Plug-in Electric Vehicles and Charging Stations | Link to Resource
- Low and Zero Emission Public Transportation Research, Demonstration, and Deployment Funding | Link to Resource
    - Financial assistance is available to local, state, and federal government entities; public transportation providers; private and non-profit organizations; and higher education institutions for research, demonstration, and deployment projects involving low or zero emission public transportation vehicles.
- Qualified Plug-In Electric Vehicle (PEV) Tax Credit | Link to Resource
    - A tax credit is available for the purchase of a new qualified PEV that draws propulsion using a traction battery that has at least five kilowatt-hours (kWh) of capacity, uses an external source of energy to recharge the battery, has a gross vehicle weight rating of up to 14,000 pounds, and meets specified emission standards. The minimum credit amount is $2,500, and the credit may be up to $7,500, based on each vehicle's traction battery capacity and the gross vehicle weight rating.
- State Energy Program (SEP) Funding | Link to Resource
    - The SEP provides grants to states to assist in designing, developing, and implementing renewable energy and energy efficiency programs. Each state's energy office receives SEP funding and manages all SEP-funded projects. States may also receive project funding from technology programs in the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) for SEP Special Projects.
- Congestion Mitigation and Air Quality (CMAQ) Improvement Program | Link to Resource
    - The CMAQ Program provides funding to state departments of transportation (DOTs), local governments, and transit agencies for projects and programs that help meet the requirements of the Clean Air Act by reducing mobile source emissions and regional congestion on transportation networks.
- Diesel Emissions Reduction Act (DERA) Program | Link to Resource

    - The U.S. Environmental Protection Agency established the DERA Program to reduce pollution emitted from diesel engines through the implementation of varied control strategies and the involvement of national, state, and local partners. DERA includes programs for existing diesel fleets, regulations for clean diesel engines and fuels, and regional collaborations and partnerships.

Non Profit Partnerships

- Clean Cities Coalition Network | Link to Resource
- Land of Enchantment Clean Cities Coalition | Link to Resource
    - Previously worked with New Mexico Energy, Minerals and Natural Resources Department, Energy Conservation and Management Division to secure a $500,000 award.
    - Opportunity to pursue another project with the non-profit to secure more funding.

Rebates and Incentives

- Chargepoint | Electric Vehicle (EV) Charging Incentives | Link to Resource
- Hybrid and Electric Vehicle Incentives | Map | Link to Resource
- Electric Vehicle Savings Opportunities | Link to Resource

Additional Funding Resources

- VW Settlement | Link to Resource
    - $4.6 million for 43 projects across the State
    - $2.7 million awarded for electric vehicle charging infrastructure projects
- New Mexico Utility | PNM | Link to Resource
    - Although they have higher upfront costs, there is a federal tax credit of up to $7,500 available, depending on the size of the battery. PNM supports the growth of this new business segment in the community by helping to install charging stations, which provides greater range confidence for drivers.

Next Steps recommended for the Dept of Transportation & General Service Dept

Recommendation for Fleet Transition

New Mexico is currently in the process of installing charging stations throughout the state. However, a proposed Executive Order will prohibit all state agencies from purchasing any light-duty vehicles which run solely on gasoline. Therefore, during this transitional period while charging stations are still being installed we recommend purchasing hybrid vehicles (HEV) instead of plug-in electric vehicles in any areas where there are not enough charging stations available to support plug-in vehicles or for any vehicles which will be driven long distances. HEVs will allow government employees to travel further distances without necessitating charging stations while still significantly reducing GHG emission levels. As more charging stations are installed New Mexico can increase the number of all electric vehicles (AEV).

Next Steps for Electric Vehicle Transition

- Investigate the differences between life cycle emission levels for HEVs and AEVs to determine the best models for the state
- Create a decision tree to determine which vehicles are ready to be transitioned out of the fleets.
- Conversion from Gas to Electric
    - Analysis of what NM is paying for Gas and what emissions are VS what is would be for electric
    - General costs for gas
        - Based on gas mileage for the gas cars they have
    - General costs for electric
    - Impacts of continuing to use gas vs converting to electric

Next steps for Charging Stations Infrastructure

New Mexico needs to consider the many infrastructure needs and operational strategies, including where to place chargers, what kind of chargers are needed and who will own the charging system. The State needs to develop a charging strategy to manage electric demand, to do this they will need to design infrastructure and operating protocols that provide for cost effective charging and electric fleet operation. If the EV charging is likely to be expanded in the future, the infrastructure planning should be done accordingly.

Considerations When Adding Electric Vehicles and Charging Stations

- Charging station purchase cost and installation cost
- Electric infrastructure upgrade requirements and costs
- Monthly costs of electricity
- Site specific costs - parking, lighting, signage, permitting, mounting system
    - Understanding the business operating hours and the hours when EV chargers are available to users, informs EV charging profiles.
- Additional network features and costs -- data collection, user communication, billing options
- Preventative and corrective maintenance costs
- Extended warranty coverage costs
- Electric Vehicle Infrastructure Checklist For Government, Community and Business Leaders

Best Practices

- Engage the Utility early so that analysis for the charging stations can be done in advance.
    - Keeping the new EV chargers close to the main building electrical will reduce infrastructure costs.
- Phased approach once the initial evaluation phase is complete:
    - Site visit
    - Planning and Design
    - Infrastructure Evaluation
    - Alternate Location Arrangement
    - Conceptual Design & Cost Estimates

Actions

- Contact charging station companies to get bids on recommended infrastructure and pricing.
    - Chargepoint
    - EVgo
    - Electrify America
- Contact PNM to understand current electric use at facilities, and start planning out the charging station infrastructure | Link to Resource

Case Studies

Overview of the best practices, selection of Type I, II or III chargers, compared to other agencies, help design charging frequency based on fleet use and locations, advice regarding lessons learned from the experience of other states and local governments.

Municipal Fleet Electrification: A Case Study of Winter Park, FL

- Case study examines the factors leading to the City of Winter Park, Florida's purchase of five all-electric fleet vehicles to be used by the City's building inspectors.
- Utilizing the Collaborative's competitive leasing prices on 2020 Nissan LEAFs, the City saved $6,000 over the Florida state contract and has budgeted for five new Level 2 charging stations to be installed on City-owned property.
- Identifying physical locations for EV charging stations is a necessary step to take as cities work to increase EVs in their fleets.
- The responsibility to make the case for the transition of internal combustion engine (ICE)
- vehicles to EVs fell to the building and permitting department to identify the most cost-effective and practical solution, in tune with the City's sustainability action plan.
- After evaluating costs of available models and capabilities with input from the Electrification Coalition, the building services department decided on the 2020 Nissan LEAF as the ideal model.
    - Considering the practical cost savings offered by EVs and recognizing that federal tax credits were still available, the sustainability team identified three additional building inspector vehicles that could be transitioned to Nissan LEAFs in 2020, bringing the total number of ICE SUVs to be transitioned to five.

Municipal Fleet Electrification: A Case Study of Austin, TX

- The Electrification Coalition (EC) is a nonpartisan, non-profit organization that leads implementation of Climate Mayors' transportation electrification initiative, leveraging its broad experience as a municipal partner in accelerating EV adoption on a mass scale.
    - Sourcewell, a public procurement agency, facilitates a competitive solicitation and award process for vehicles and service equipment on behalf of their 50,000+ members across North America.
- The City of Austin began with a very ambitious goal in 2007 to achieve a carbon neutral fleet by 2020.

    - The City plans to have 330 fully electric vehicles registered in the fleet by the end of 2020.
- The City is working to drive down the increased upfront cost of electric vehicles through bulk purchasing.
    - The City conducted an analysis of the fleet and found that by transitioning their light-duty fleet to electric, the City would save $3.5 million dollars over a 10 year period.
- After a detailed fleet analysis, the City is confident this path will save taxpayer money with reduced fuel and maintenance spending and make steady gains towards cleaner air for all residents.

PG & E Take Charge: A Guidebook to Fleet Electrification and Infrastructure

- The backbone of any electric fleet is the charging infrastructure—the physical network that transfers electricity from the grid to the vehicles themselves.
- Vehicle and charging needs will drive site design and electrical requirements - key is to involve the local utility as soon as possible.
- Know your fleet vehicle requirements. Understand your fleet's charging and logistical needs so you can clearly communicate and build everything to support these requirements.
- Plan for the future. Design your layout and electrical infrastructure today to support your fleet's needs of tomorrow, minimizing future construction and connection costs.

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Appendix A - Current Negotiated Vehicle Contracts

Email Attachment A - GSD Calculation Spreadsheet

Email Attachment B - DOT Calculation Spreadsheet