Incentives for the Clean Fuels Industry

An Overview of State and Utility Regulations, Policies, and Incentives in the United States

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Overview

Over the past decade, states across the country have grappled with ways in which to support investment in clean fuel technologies that can reduce their carbon footprint and support vibrant, healthy communities and economies. More and more, states are turning to the clean fuel sector to support their environmental and economic prosperity through the deployment of clean fuel vehicles and the captured investment in related technologies. Clean fuels are fuels that have a lower carbon intensity than the standard for the fuel they replace. Examples of clean fuels include most types of ethanol, biodiesel, natural gas, biogas, electricity, propane, and hydrogen. As the leading producer of cars and trucks in the United States and home to 17 original equipment manufacturer (OEM) headquarters or technology centers, Michigan is well-positioned to lead in this sector (Detroit Regional Chamber n.d.).

Clean Fuels Michigan (CFM), a member-supported, nonprofit organization of 30 local companies and organizations focused on growing a high-tech, clean transportation industry in Michigan, is working to bridge the knowledge gap between policymakers and the clean fuels sector as the field moves swiftly into a reality where electricity and other clean fuels are preferred over traditional fossil fuels. Many other states, including other Midwest states, have made significant investments for the alternative-fuel vehicle (AFV) transformation. To that end, CFM asked Public Sector Consultants (PSC) to develop an inventory of policies and incentives that other states have adopted to incentivize and support the clean fuels industry. CFM and PSC identified the following nine states (and Michigan for comparison) for in-depth studies on specific clean fuel policies or initiatives within each state, as well a baseline summary of the incentives and public policies adopted. These states were chosen as peers to Michigan, as they reflect a similar perspective for the approach to economic development and investment, the geography, and/or the manufacturing sector. The peer states and their respective policy case studies are as follows:

- Colorado: State use of partnerships to plan for a clean energy transition
- Florida: Natural gas fuel fleet vehicle program
- Georgia: Why policy matters
- Michigan: State approach to electric vehicle infrastructure that combines research and investment
- Minnesota: Utility support for public fleet and community ride sharing electric vehicle infrastructure
- New York: EVolve NY Initiative and Drive Clean rebate program
- North Carolina: Utility, public, and private investment in electric vehicle infrastructure
- Ohio: Smart Columbus' comprehensive approach
- Pennsylvania: Public-private partnerships in support of natural gas fuel infrastructure
- Texas: Alternative-fuel vehicle purchase and lease incentive

PSC's research found that Michigan stands out for its limited incentives and pro-alternative–fuel policies. Compared to the other states surveyed, Michigan has a limited number of incentives in place to support AFVs. While Michigan's utilities have recently announced programs to support development of AFV infrastructure, the state does not yet have a standalone program. Michigan has the opportunity to learn from its peers in areas such as promoting AFV adoption and fleet expansion.

Comparison of State Incentitives

The following charts provide an overview of the different state, utility, and regulatory incentives offered by Michigan's ten peer states. More detailed information on each of the incentives is included in the individual case studies.

EXHIBIT 1. Alternative Fuel Incentives of the Surveyed States—State Incentives

	MI	GA	TX	FL	OH	CO	PA	NY	NC	MN
State Incentives										
Vehicle Purchase Incentive			●	Natural gas and propane only	Large truck conversion	●	●	●	●	
Infrastructure Incentive		●	●		●	●	●	●	●	●
Fleet Incentive			●		●	●		●	●	
School Bus Replacement Program	●		●		●	Retrofit only		●		●
Weight Exemptions	●	●	●	●	●	●	●	●	●	●
Emissions Requirement Exemptions	●				●			●	●	
High-occupancy Vehicle Lane Exemption		●		●		●		●	●	
Technology Incentive		●		●		●	●	●	●	
Fuel Tax Exemption			●	●					●	
Sales Tax Exemption						●				

EXHIBIT 2. Alternative Fuel Incentives of the Surveyed States—Utility Incentives

	MI	GA	TX	FL	OH	CO	PA	NY	NC	MN
Utility Incentives										
Vehicle Purchase Incentive				●	Propane		●	●		
Infrastructure Incentive	●	●	●	●	●	●	●	●	●	●
Special Charging Rate	●	●	●					●	●	●

EXHIBIT 3. Alternative Fuel Policies and Regulations of the Surveyed States

	MI	GA	TX	FL	OH	CO	PA	NY	NC	MN
State Laws and Regulations										
State Transportation Plan						●		●	●	●
California Low Emissions Standards						●	●	●		
Vehicle Acquisition Requirements			●	●	●	●	●	●	●	●
Use Requirements			●	●	●		●	●		●
Plug-in Electric Vehicle (PEV) Fee	●	●				●			●	●
Autonomous Vehicle Testing and Operations	●	●	●		●	●	●		●	●
Idle-reduction Requirement			●				●	●		
Excise Tax	●	●	●	●		●	●		●	●
Electric Vehicle Service Equipment (EVSE) Installations and Access Permissions						●				●

Key Findings

States offer dozens of different ways to incentivize the clean fuels industry. For research purposes, PSC separated these options into three categories: state incentives (offered by the State or a state agency), utility incentives (offered by the utility sectors in each state); and state regulations and policies (adopted by the state to support the clean fuels industry).

State Incentives

- **Incentives for AFV infrastructure are common.** Eight of the ten states surveyed provide incentives for the installation of AFV infrastructure, with only Michigan and Florida as the exceptions. These incentives vary in size, form, and fuel type. Most states provide incentives in the form of grants or rebates, while Georgia focuses on tax credits and Florida and Ohio focus on providing financing. The size varies by the type of infrastructure, with home or small businesses fuel infrastructure ranging from $2,500 to $9,000 and larger public fuel infrastructure reaching up to $750,000.

- **The majority of peer states provide an incentive for the purchase of AFVs.** While most of the peer states provide some form of incentive for the installation of AFV infrastructure, only five states—Texas, Colorado, Pennsylvania, New York, and North Carolina—provide incentives for alternative fuels in general. Florida and Ohio limit their incentives to propane and natural gas purchases or conversions exclusively. These incentives also differ in form. Most states provide some form of rebate, with Colorado providing tax credits and North Carolina providing grants. These incentives also vary in terms of the size of the vehicle, with states such as Colorado and New York providing larger incentives for medium- and heavy-duty vehicles.

- **Some states are providing support for AFV public fleet expansion.** Texas, Ohio, and Colorado are providing funding for the expansion of AFV public fleets (not including school buses). These programs focus on the removal and replacement of diesel vehicles with clean diesel or other alternative fuels. Colorado's program is specifically targeted at funding the incremental cost of moving to alternative fuel in areas that have been socially or economically impacted by the mineral fuel extraction and development. Funds come from the state severance tax on energy and mineral production and other mining revenues.

- **Some states, including Michigan, have created standalone programs focused on school bus fleet replacement or conversion.** Minnesota, Michigan, and Ohio have developed programs using funds from a settlement in which German automaker Volkswagen AG agreed to pay $2.9 billion to an environmental mitigation trust for violation of the Clean Air Act (NASEO and NACAA n.d.). These states are using Volkswagen settlement funding to replace older diesel school buses with alternative fuel buses. Colorado has a technical assistance program to retrofit school buses with technologies to reduce emissions and engine idling.

- **Some peer states offer specific benefits for AFV ownership, including high- occupancy vehicle (HOV) lane waivers, emissions waivers, and weight exemptions**. Five of the surveyed states allow AFV owners to use HOV lanes with a single occupant. Georgia and Colorado also allow drivers to use toll roads free of charge, while New York provides drivers with a discount.

Four of the states provide AFV owners with a waiver on emissions inspections. While Michigan does not require vehicle inspections, it has codified that AFVs are exempt from inspections. All of the states surveyed have a weight exemption for vehicles that have installed emissions reduction technologies and/or natural gas technology equal to the difference in weight over standard vehicles.

- **Several peer states support research and development in AFVs.** Six of the surveyed states—Georgia, Florida, Colorado, Pennsylvania, New York, and North Carolina—offer incentives focused on research and development of alternative fuels. Georgia provides a tax credit to businesses focused on alternative fuels based on the number of jobs they create. All of those states except Georgia support projects that promote alternative fuels through research and development.

Utility Incentives

- **Across all the surveyed states, utilities are providing incentives for the development of AFV infrastructure, with a focus on electric vehicles (EVs).** The majority of programs focus on support for EV charging infrastructure. In Michigan, Georgia, Texas, North Carolina, Ohio, Pennsylvania, New York, and North Carolina, utilities are providing rebates for the installation of EV charging stations to consumers, companies, and municipalities. In Florida, Duke Energy has a pilot program where they are installing charging stations free of charge. In New York, the New York Power Authority's (NYPA's) EVolve Initiative has committed $250 million to install public EV infrastructure, including fast-charging stations along transportation corridors. In Minnesota, Xcel Energy is installing public charging stations at 70 community hubs in Minneapolis and Saint Paul. In Pennsylvania, the state is using a public-private partnership to install public natural gas infrastructure. Gas associations in Texas and Ohio are supporting installation of natural gas infrastructure.

- **Many utilities are offering special rates for EV charging.** In Michigan, Georgia, Texas, New York, North Carolina, and Minnesota, utilities are providing time-of-use rates for EV charging, where EV owners who charge their vehicles during off-peak hours receive a discounted rate on power.

- **Utility vehicle purchase incentives exist.** Four of the states surveyed feature utility programs that incentivize the purchase or lease of alternative fuel vehicles. In Florida, Duke Energy customers are eligible for a $3,000 rebate for the purchase of a Nissan Leaf, through a program funded by Nissan. In Ohio, $1,000 is available for propane vehicles and mowers. In Pennsylvania and New York, Duquesne Light Company and Central Hudson Gas and Electric are providing up to $3,500 and $5,000, respectively, for the purchase of a Nissan Leaf.

- **Recent proposals from Consumers Energy and DTE bring Michigan into competition with other states for investment in charging infrastructure.** While not as large as the $250 million proposed program by the NYPA and the $75 million program through Duke Energy in North Carolina, Consumers Energy's $7.5 million and DTE Energy's $13.1 million programs provide Michigan with initial utility investments in EV infrastructure.

State Regulations and Policies

- **Three of the states surveyed have adopted low-emission vehicle standards to date, in line with California.** Three states—New York, Pennsylvania, and Colorado—have established low-emission vehicle standards in line with California's, which are more stringent than those of the federal government. These standards require passenger vehicles sold, leased, imported, delivered, purchased, or acquired in the state to be certified to the California motor vehicle emissions standards. Thirteen states across the U.S. have committed to follow these standards. Of these states, nine have committed to zero-emission vehicle (ZEV) standards, including New York, and have signed a memorandum of understanding to this effect.

- **Four of the surveyed states have developed plans for EV adoption.** Colorado, New York, North Carolina, and Minnesota have all established or are developing state plans for EV adoption. Colorado and Minnesota released their plans in 2018. As part of its commitment to ZEV standards in line with California, New York has committed to developing an action plan, and North Carolina has committed to developing a ZEV plan.

- **State acquisition requirements and goals for EV vehicles are common across the states.** Eight of the ten states surveyed have AFV and fuel acquisition requirements, although these states are taking different approaches. Texas, Ohio, Florida, and Colorado have requirements for the purchase or use of alternative fuels in general, while Pennsylvania, New York, North Carolina, and Minnesota have requirements for EVs. These requirements also differ in structure. Texas, for example, requires 50 percent of select state agency fleets to operate on alternative fuels and requires agencies to use these fuels at least 80 percent of the time the vehicles are driven. Pennsylvania sets a requirement for fleets to have 25 percent plug-in EVs by 2025. Ohio and North Carolina require all new procurements to target alternative fuels and ZEVs, respectively.

- **Half of the states have an EV fee in place.** Five states—Michigan, Georgia, Colorado, North Carolina, and Minnesota—have fees in place for EV ownership, ranging from $30 to $200.

- **Most states have taxes in place on the sale and production of alternative fuels.** Surveyed states have differing rates for how they tax alternative fuels, with some (like Michigan) taxing these fuels at the rate of gasoline. Others provide discounted rates for alternative fuels.

State Case Studies

Colorado

Colorado is approximately half the size of Michigan in terms of population, with 5.4 million residents compared to Michigan's 9.9 million in 2018. Colorado's economy is smaller overall at $368 million gross domestic product (GDP) compared to Michigan's $528 million in 2018, but it has a higher per-capita income (U.S. Census Bureau 2018; U.S. BEA 2019c).

The state of Colorado has many public- and private-sector features that make it unique in the world of energy and auto regulation. Regarding overall energy policy, multiple state government bodies have goals of reducing statewide greenhouse gas emissions, including Colorado's Energy Office and Public Utilities Commission as well as the Departments of Transportation (CDOT), Natural Resources, Public Health and Environment (CDPHE), Agriculture, Local Affairs, and Economic Development and International Trade (CDOT 2015; Jaffe 2019). Additionally, Colorado's Gov. Jared Polis recently signed seven pieces of legislation aimed at promoting renewable energy, energy efficiency, and electric vehicles, and also presented a roadmap for a fossil-fuel-free Colorado electric grid (Kohler 2019). Like Michigan, Colorado has also been the site of ambitious utility renewable energy policy, with Xcel Energy, the state's largest electric utility, releasing the 2017 Colorado Energy Plan, a roadmap to rapidly increase the use of renewable energy and decrease emissions (Bedline 2018).

Colorado's broad AFV efforts include the ALT Fuels Colorado program and AFV tax credits. These programs were motivated by a desire to improve the air quality in Colorado through the use of AFVs, particularly in areas unable to attain federal standards. As such, since ALT Fuels Colorado's inception in 2014, it has been managed by the Regional Air Quality Council (RAQC) and the Colorado Energy Office (CEO). The program also coordinates with the CDOT, the Federal Highway Administration, the Denver Regional Council of Governments, and many more agencies and local authorities to support vehicle purchases and infrastructure. The same air quality concerns, along with a recognition of price barriers, spurred AFV tax credits in the state in 2017 (RAQC 2015).

Colorado has supported a broad transition to alternative-fuel vehicles and infrastructure, and the state has increased its focus on electrification in recent years. In July of 2017, Gov. John Hickenlooper signed Executive Order D 2017-015, which directed the CEO, the RAQC, and the CDPHE to coordinate with other state agencies and develop a statewide EV plan, while aligning with the Volkswagen Environmental Mitigation Trust (Williss 2018). In January 2018, the CEO, CDOT, CDPHE, and RAQC (2018) released the Colorado Electric Vehicle Plan, which outlines a series of goals and strategies to accelerate the adoption of EVs as well as the establishment of EV corridors. The plan estimates that EV adoption in the state could reach 1 million by 2030, and it estimates that this growth could yield a net present value of $7.6 billion in cumulative economic benefits by 2050.

The resulting Electric Vehicle Plan focused on developing charging corridors to facilitate economic development and tourism, while reducing pollution and range anxiety (State of Colorado 2018). Colorado also recognized that its EV charging infrastructure would be insufficient for the state's EV ambitions. Understanding this, Colorado partnered with the National Renewable Energy Laboratory (NREL) to determine the amount of EV charging infrastructure that would be necessary to support growth, and a report was delivered in July of 2017 (Wood and Rames 2017). Colorado also joined the Regional Electric Vehicle West Memorandum of Understanding (REV West MOU) in early 2018 because the effort "reflects bipartisan

efforts around energy in the West" to reduce range anxiety and integrate small communities into the charging network through the development of charging corridors (NASEO 2018).

The following case study examines how Colorado has quickly taken a broad, multifaceted approach to promoting clean fuel vehicles, with an increasing emphasis on EVs.

Case Study: Using Partnerships to Plan for a Clean Energy Transition

The State of Colorado has sought to increase AFV adoption by addressing the two principle barriers affecting residents and fleet decisions to switch to alternative fuels—the cost of AFVs and the lack of fueling infrastructure. While the state has historically supported a broad range of alternative-fuel vehicles, from electric vehicles to dedicated or bifuel natural gas, propane, and hydrogen vehicles, the state is increasing its focus on EVs and is partnering with the NREL as well as other mountain states to plan for a clean energy transition.

In 2014, Colorado launched the ALT Fuels Colorado program to support alternative fuel vehicle purchases and infrastructure. Until 2020, the RAQC is awarding $15 million in grants for the purchase of natural gas, propane, and electric fleet vehicles, while the Colorado Energy Office is awarding $15 million in grants to incentivize investment in AFV infrastructure in Colorado communities and transportation corridors. Under Colorado's Volkswagen Beneficiary Mitigation Plan, an additional $18 million is being allocated to ALT Fuels Colorado for grants to support the purchase of mid- and heavy-duty alternative-fuel fleet vehicles as well as $6.8 million to support the build out of fast-charging stations (Colorado Energy Office n.d.a.).

In addition to supporting fleet and infrastructure adoption through grants, the state is also supporting the purchase, lease, or conversion of light-, medium-, and heavy-duty AFVs through a tax credit program that provides between $5,000 (light) and $20,000 (heavy) for purchase or conversion from 2017–2019, with the amounts decreasing through 2021 (Colorado Energy Office n.d.a).

In developing its plans for EV corridors, the State is leveraging partnerships with NREL and other states to make its plans a reality. Based in Golden, Colorado, NREL worked with the state to look at different scenarios for EV charging infrastructure based on actual driving data, projected vehicle range, and charging-time estimates, and compared this information for increased EV adoption. NREL was able to develop estimates for the number of charging stations needed to meet increasing demand and potential locations for these stations along key transportation corridors (Wood and Rames 2017).

Colorado is also partnering with other states in building out EV charging corridors. In October 2017, Colorado joined seven other western states in signing the REV West MOU. The memorandum creates a framework for states to collaborate in developing intermountain electric corridors along major interstates (CEO, CDOT, CDPHE, and RAQC 2018).

Overview of Alternative-fuel Policies and Incentives

State Incentives

- **Plug-in Electric Vehicle (PEV) and Alternative-fuel Vehicle Tax Credits:** Qualified EVs, plug-in hybrid electric vehicles (PHEVs), and AFVs titled and registered in Colorado are eligible for a tax credit. AFVs include dedicated or bifuel natural gas, propane, and hydrogen vehicles. Incentives

vary by the size of the vehicle, from light-duty vehicles to light-, medium-, and heavy-duty trucks. Incentives decrease each year until 2021. The credit amount for any qualifying truck is limited to the difference in manufacturer's suggested retail price between the truck and a comparable truck that operates on either gasoline or diesel fuel (State of Colorado n.d.b).

EXHIBIT 4. Colorado PEV and AFV Tax Credits

Category	2017–2019	2020	2021
Light-duty EV or PHEV	$5,000 for purchase or conversion; $2,500 for lease	$4,000 for purchase or conversion; $2,000 for lease	$2,500 for purchase or conversion; $1,500 for lease
Light-duty electric truck	$7,000 for purchase or conversion; $3,500 for lease	$5,500 for purchase or conversion; $2,750 for lease	$3,500 for purchase or conversion; $1,750 for lease
Medium-duty electric truck	$10,000 for purchase or conversion; $5,000 for lease	$8,000 for purchase or conversion; $4,000 for lease	$5,000 for purchase or conversion; $2,500 for lease
Heavy-duty electric truck	$20,000 for purchase or conversion; $10,000 for lease	$16,000 for purchase or conversion; $8,000 for lease	$10,000 for purchase or conversion; $5,000 for lease

- **Fuel Reduction Technology Tax Credit:** Fuel reduction technologies are eligible for a tax credit equal to a percentage of the actual cost paid for the technology (State of Colorado n.d.a).

EXHIBIT 5. Colorado Fuel Reduction Tax Credits

Category	2017–2019	2020	2021
Idle-reduction technologies	25% (up to $6,000)	25% (up to $6,000)	25% (up to $6,000)
Aerodynamic technologies	25% (up to $6,000)	25% (up to $6,000)	25% (up to $6,000)
Clean fuel refrigerated trailer	15% (up to $7,500)	11.75% (up to $7,500)	7.5% (up to $7,500)
Conversion to a clean fuel refrigerated trailer	45% (up to $7,500)	33.75% (up to $7,500)	22.5% (up to $7,500)

- **Alternative-fuel Vehicles and Infrastructure Grant Program:** The CEO, RAQC, and CDOT are working together to provide grants through the ALT Fuels Colorado program for new, publicly accessible compressed natural gas (CNG) fueling, electric vehicle charging, and propane station equipment at funded CNG stations. The grants would also apply to CNG, propane, and electric vehicles. However, the program is undergoing modifications and is currently suspended following Governor Polis' announcement in January 2019 of zero-emission goals (Colorado Energy Office n.d.a).
- **PEV and Electric Vehicle Supply Equipment (EVSE) Grants:** The CEO and RAQC are providing grants through the Charge Ahead Colorado program to support PEV and EVSE adoption by individual drivers and fleets. Both CEO and RAQC grants will fund 80 percent of the cost of EVSE. Charge Ahead Colorado was established in 2009 to reduce emissions and diversify the state's fuel mix (Clean Air Fleets n.d.).

- **Impact Assistance Program for Public Fleets:** The Colorado Department of Local Affairs (DOLA) offers funding for the incremental cost of AFVs for public fleets. The purpose of the program is to assist political subdivisions that are socially and/or economically impacted by the development, processing, or energy conversion of minerals and mineral fuels. Funds come from the state severance tax on energy and mineral production and from a portion of the state's share of royalties paid to the federal government for mining and drilling of minerals and mineral fuels on federal land (DOLA n.d.).
- **AFV Fleet Technical Assistance**: The Refuel Colorado program provides free technical assistance on the benefits of converting to alternative fuels to a variety of stakeholders, including, but not limited to, fleets, communities, fuel providers, dealerships, and advocacy groups (Colorado Energy Office n.d.b).
- **Clean Diesel School Bus Retrofit Program**: Diesel engine experts from the Air Pollution Control Division of the CDPHE work with selected contractors to retrofit school buses with emission-reduction technologies to reduce emissions and engine idling and can result in significant emission reductions and cost savings (CDPHE n.d.b).
- **Advanced Industries Accelerator Program Grants:** The Accelerator Programs promote growth and sustainability in Colorado's advanced industries. Colorado includes energy and natural resources as a priority industry, and grants may be available for the development of biofuels and other energy technology (Colorado Office of Economic Development and International Trade n.d.).
- **Low-emission Vehicle Sales Tax Exemption:** Vehicles, vehicle power sources, or parts used for converting a vehicle power source to reduce emissions are exempt from state sales and use tax (State of Colorado n.d.a).
- **HOV Lane Exemption:** Since 2008, CDOT has allowed hybrid electric vehicles (HEVs) to travel in HOV and high-occupancy toll (HOT) lanes with a single occupant with a permit. The program is limited to 2000 permit holders (CDOT n.d.).
- **Idle-reduction Weight Exemption:** Vehicles equipped with a qualified auxiliary power unit or idle-reduction technology may exceed the state's gross, total axle, or bridge formula vehicle weight limits by up to 550 pounds to compensate for the additional weight of the idle-reduction technology (Code of Colorado Regulations n.d.).
- **Alternative-fuel Weight Exemption**: Gross vehicle weight rating limits for AFVs are 2,000 pounds greater than those for comparable conventional vehicles, as long as the AFVs operate using an alternative fuel or both alternative and conventional fuels when operating on a highway that is not part of the interstate system (State of Colorado n.d.a).
- **Natural Gas Fueling Station Air Quality Permit Exemption**: Natural gas fueling stations are exempt from the requirement to file air pollutant emission notices in Colorado (CDPHE n.d.a).

Utility Incentives

- **CNG School Bus Matching Grants:** Noble Energy is partnering with the RAQC to purchase CNG school buses for qualified Colorado school districts to fund CNG school bus purchases (Noble Energy n.d.).
- **Incentives for EVSE purchase and for EV rental—Gunnison County Electric Association (GCEA)**: The GCEA provides rebates for the purchase of EVSE and allows for the rentals of EVs at no additional cost.
- **EVSE Incentive—Holy Cross Energy (HCE):** HCE offers free or discounted EVSE for residential and commercial customers (HCE n.d.).

Laws and Regulations

- **Low-emission Vehicle Standards:** Through an executive order in response to federal government intentions to roll back emission standards for 2022–2025 vehicles, Colorado established that all model year 2022 and later passenger cars and light- and medium-duty vehicles must meet California motor vehicle emissions and compliance requirements specified in Title 13 of the California Code of Regulations (CDPHE n.d.a).
- **Colorado EV Plan:** The CEO, RAQC, CDPHE, and CDOT partnered to create the Colorado EV Plan, which calls for Colorado to be a leader in the EV market and accelerate the adoption of EVs through a series of actions to support EV infrastructure along Colorado's corridors. The plan will be updated annually (CEO, CDOT, CDPHE, and RAQC 2018).
- **Regional Electric Vehicle West Plan:** Colorado is a signatory to the REV West MOU to create an EV corridor that will make it possible to seamlessly drive an EV across the signatory states' major transportation corridors. Arizona, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming are the other signatory states (Alternative Fuels Data Center n.d.a).
- **Zero-emission Vehicle Transportation Plan:** CDOT, together with a Transportation Electrification Workgroup, is required to develop a ZEV plan for Colorado as well as ZEV standards (Paul 2019).
- **Support for Autonomous Vehicle (AV) Testing**: Colorado state agencies must support the testing and operation of AVs if compliant with state and federal laws (State of Colorado, 2016).
- **State Agency Petroleum Reduction Requirement**: Colorado state agencies and departments must reduce petroleum-based fuel consumption on a per-vehicle basis and across the fleet at an annual rate of 4 percent per vehicle, and at least 20 percent by fiscal year (FY) 2020 compared to a FY 2015 baseline. Certain vehicles are exempt (Hickenlooper 2015).
- **Interagency Fleet Coordination**: State agencies and departments (CEO, CDOT, CDPHE, and Department of Personnel and Administration [DPA]) are required to establish a State Fleet Subcouncil to help develop, implement, and improve programs, plans, and policies that save money, reduce emissions, promote domestic fuel use, and conserve natural resources (Hickenlooper 2015).
- **Fleet Purchase and Pricing Agreement Requirements:** In 2015, Colorado required CDOT to purchase natural gas vehicles (NGVs) where natural gas fueling is available or planned whenever possible. Where NGVs are not viable options, other AFVs, such as PEVs, HEVs, and propane vehicles, must be considered (Hickenlooper 2015).
- **EVSE Multi-unit Dwelling Installations and Access:** Residents cannot be impeded from installing EVSE at multi-unit dwellings, and these communities cannot create restrictions around EVSE (Colorado Revised Statutes, 2017a).
- **Alternative Fuel Tax:** CNG, liquefied natural gas (LNG), and liquefied petroleum gas, are subject to excise tax imposed on a per-gallon basis (Colorado Revised Statutes, 2017b).
- **PEV Fee:** PEV owners must pay an annual fee of $50 in addition to other registration fees (Colorado Revised Statutes, 2017c).
- **State Agency Alternative-fuel Use and Vehicle Acquisition Requirement:** The DPA requires all state-owned diesel vehicles and equipment to be fueled with a fuel blend of 20 percent biodiesel, subject to the availability of the fuel and so long as the price differential is not greater than $0.10 more per gallon as compared to conventional diesel (Hickenlooper 2015).
- **Natural Gas and Hydrogen Fueling Station Regulations:** Colorado has regulations for natural gas and hydrogen fueling stations (State of Colorado n.d.a).

Florida

Florida is approximately twice the size of Michigan in terms of population, with 20.3 million residents compared to Michigan's 9.9 million in 2018. Florida's economy is larger overall at $1.036 billion GDP compared to Michigan's $528 million in 2018 (U.S. Census Bureau 2018; U.S. BEA 2019d). Without a strong auto or energy industry, and with a more conservative state government, CFM was interested in understanding how Florida has become a national leader in promoting the use of AFVs.

One of Florida's important mechanisms for incentivizing AFVs is the Natural Gas Fuel Fleet Vehicle Rebate Program, a rebate program for the purchase or lease of natural gas or propane fleet vehicles, as well as a rebate for the conversion of a conventional gasoline vehicle into a natural gas vehicle. Another important mechanism is a tax exemption for natural gas fuels. Both incentives began in 2013 with the passage of House Bill 579 in the Florida Legislature. While the environmental benefits of AFVs were recognized, economics were the primary motivation behind the incentives, as gasoline prices were relatively high and lawmakers were receiving pressure to deal with increased fuel prices (U.S. EIA September 2018). Proponents of the rebate and tax exemptions praised the "budget savings to governmental entities, the business world, and . . . citizens" that natural gas vehicles could provide, if customers were able to overcome the financial hurdles that prevented adoption of these vehicles (FNGVC 2014). Additionally, Florida residents were very receptive to state incentives promoting natural gas, as they were highly aware of the economic and environmental benefits of the vehicles, as well as the fact that increased use of new natural gas discoveries helps promote energy independence and national security (FNGVC 2013).

Florida's promotion of NGVs shows how multiple tools may be needed for the promotion of even a single type of alternative fuel. As discussed in greater detail in this case study, these diverse incentives have been highly successful at promoting the adoption of natural gas vehicles in Florida.

Case Study: Natural Gas Fuel Fleet Vehicle Rebate Program

In 2013, the Florida legislature established the Natural Gas Fuel Fleet Vehicle Rebate Program. As established through Section 17 of House Bill 579, the purpose of the program was to help reduce transportation costs in the state and encourage freight mobility investments that contribute to Florida's economic growth. The program was funded at $6 million per year for five years based on legislative allocation, and it was targeted to commercial and government applicants, with 60 percent ($3.6 million per year) reserved for commercial applicants and 40 percent ($2.4 million) reserved for government applicants (Florida Department of Agriculture and Consumer Services Office of Energy n.d.).

The rebate could be used for the purchase or lease of a natural gas or propane fleet vehicle up to $25,000 but not more than 50 percent of the incremental costs, where incremental costs refer to the excess costs associated with the purchase or lease of an NGV as compared to an equivalent diesel- or gasoline-powered vehicle. The rebate could also be used for the conversion to a natural gas fleet vehicle. The maximum cost per applicant was $250,000 (Florida Department of Agriculture and Consumer Services Office of Energy n.d.).

In addition to the rebate program, Florida established a tax exemption for natural gas fuel in 2014 (State Library and Archives of Florida, Ch. 2013-198, n.d.). Prior to the exemption, natural gas fuels were subject to sales and use tax, and vehicles were required to invest in annual decals permitting the use of state roads at a cost of up to $380.10 per vehicle. Across the U.S., only Florida, Vermont, Arizona, and Alabama do not impose state taxes on natural gas fuels (OPPAGA 2017).

The rebate and the tax exemption contributed to a significant increase in the use of natural gas as a motor fuel in Florida. From 2012 to 2016, Florida's consumption of natural gas as a motor fuel increased 326 percent, with the state moving from 25th to 15th in the nation for the use of natural gas motor fuel (OPPAGA 2017). According to a survey by OPPAGA of all entities that applied for a vehicle rebate, respondents cited the rebate and tax exemptions as likely factors contributing to the growth of natural gas as a motor fuel in Florida. They also cited cleaner emissions (16 percent) and lower maintenance costs (8 percent). Respondents were optimistic about their future investments, with 46 percent stating that their fleet would increase slightly and only 13 percent predicting a decrease (OPPAGA 2017).

In looking at examples of the adoption of natural gas and propane, the U.S. DOE cited South Florida's Broward County as a success story for their investment in propane buses for their paratransit fleet. By 2016, Broward County had invested in 138 propane buses for their paratransit fleet, which reduced the county's operating budget by $800,000 by 2016 (U.S. DOE n.d.)

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **NGV and Propane Vehicle Rebates:** The Florida Department of Agriculture and Consumer Services offers a rebate for up to 50 percent of the incremental cost to purchase or lease a new original equipment manufacturer natural gas or propane vehicle, or convert a vehicle to run on natural gas or propane, up to $25,000 per vehicle and $250,000 per applicant per fiscal year. Of the funds available for these rebates, 40 percent is reserved for government applicants; the remaining funds are allocated to commercial applicants (State of Florida 2019a).
- **EVSE Financing**: Local governments may offer funding to property owners within their jurisdiction to help finance EVSE installations on their property or enter into a financing agreement for the same purpose (State of Florida 2019b).
- **Excise Tax Exemption for Schools**: Biodiesel fuel manufactured by a public or private secondary school is exempt from the diesel fuel excise tax and the associated registration requirements. To qualify for the exemption, total annual production of biodiesel must be less than 1,000 gallons and may only be used by the school, its employees, or its students (State of Florida 2019c).
- **Renewable Energy and Energy-efficient Technologies (REET) Grant Matching Program**: The REET Grant Matching Program provides matching grants of $50,000 to $400,000 for demonstration, commercialization, research, and development projects relating to renewable energy technologies, bioenergy, and innovative technologies that significantly increase energy efficiency for vehicles (State of Florida 2019d).
- **Idle-vehicle Weight Exemption**: Any motor vehicle equipped with idle-reduction technology may exceed the gross vehicle or internal bridge weight by the amount equal to the certified weight of the idle-reduction technology, up to 550 pounds (State of Florida 2019e).
- **HOV Lane Exemption**: Florida drivers may operate a qualified Inherently Low-emission Vehicle (ILEV) or a HEV in a HOV lane at any time, regardless of the number of passengers, provided that the vehicle is certified and labeled in accordance with federal regulations (State of Florida 2019f).

Utility Incentives

- **All Electric Vehicle Rebate**: Duke Energy customers and employees are eligible for a $3,000 rebate for the purchase of a new 2016 or later Nissan Leaf. The program is being provided by Nissan (Duke Energy n.d.a).
- **PEV Rebate**: Jacksonville Electric Authority (JEA) and Orlando Utilities Commission (OUC) are providing rebates for PEVs.
    - **JEA:** Provides a rebate for the purchase of PEVs. PEVs with a battery less than 15 kilowatt-hours (kWh) in capacity receive $500, and PEVs with larger battery capacity are eligible for $1,000 (JEA n.d.).
    - **OUC**: Provides rebates of $200 to residential customers who purchase or lease an eligible new or preowned PEV. OUC customers are also eligible for a $3,000 rebate for the purchase of a Nissan Leaf (OUC n.d.).
- **EVSE Rebate/Incentives**: multiple Florida utilities provide rebates or incentives for the purchase of charging stations and other EVSE.
    - **OUC**: Offers rebates of $200 per EVSE to commercial and multifamily building customers for the purchase of EVSE.
    - **Gulf Power Company**: Gulf Power offers rebates of $750 to residential customers for the purchase of EVSE (Gulf Power n.d.).
    - **Brickell Energy**: Through the aFLoat Host Agreement, Brickell Energy will cover the cost of hardware, network service plans, management service, and warranties. Eligible hosts include commercial real estate property owners and managers. Hosts must cover the cost of installation. The aFLoat Rental Plan offers public and commercial locations the EVSE hardware, network service plan, management service, and warranties at a reduced fee (Brickell Energy n.d.).
    - **Duke Energy**: Through 2022, Duke Energy's Park and Plug Pilot will be providing EV charging stations free of charge to locations on the condition that the location pays for the energy utilized (Duke Energy n.d.b).

Laws and Regulations

- **Natural Gas and Propane Tax:** Propane, CNG, and LNG are subject to an excise tax at a rate of $0.04 per gasoline gallon equivalent (GGE), plus a $0.01 ninth-cent fuel tax, a $0.01 local option fuel tax, and an additional variable component to be determined by the Florida Department of Revenue each calendar year for the following 12-month period (State of Florida 2019g; State of Florida 2019h; State of Florida 2019i).
- **Authorization for Alternative Fuel Infrastructure Incentives**: Local governments may use income from the infrastructure surtax to provide loans, grants, or rebates to residential or commercial property owners to install EVSE as well as propane and natural gas fueling infrastructure, if a local government ordinance authorizing this use is approved by referendum (State of Florida 2019j; State of Florida 2019k).

- **Alternative Fuel Economic Development**: To stimulate local economic development, landowners may apply to amend the local government's comprehensive plan to expand existing uses of rural agricultural industrial centers to include facilities that prepare biomass materials that can be used for the production of fuel, renewable energy, bioenergy, or alternative fuel (State of Florida 2019l; State of Florida 2019m).
- **Fuel Efficient Vehicle Acquisition and Alternative Fuel Use Requirements**: When procuring new vehicles under a state purchasing plan, all Florida state agency, state university, community college, and local government fleets must select the vehicles with the greatest fuel efficiency available for a given use class when fuel economy data is available (State of Florida 2019n).
- **Biofuel Production**: Municipalities, counties, or school districts producing biodiesel must file a return documenting their biodiesel production activities and pay $0.03 of the $0.04 tax required (State of Florida 2019o).

Georgia

The State of Georgia shares similarities with Michigan in terms of population and economic output. Georgia is home to 10.2 million people, while Michigan has 9.9 million residents. Georgia's annual gross state product is also slightly higher than that of Michigan, $563 billion compared to $508 billion respectively (U.S. Census Bureau 2018; U.S. BEA 2019e). Also like Michigan, Georgia has a large automotive manufacturing and engineering sector with more than 300 automotive-related facilities, including the North American headquarters for Mercedes-Benz, Porsche, and PSA Group (a French multinational manufacturer of automobiles and motorcycles, including Peugeot). There are also numerous innovation hubs and research labs in the state, including Mercedes-Benz's Lab1886 and Panasonic Automotive.

The development of Georgia's policies supporting clean fuels was spurred by the ongoing local air pollution problems in Atlanta, the state's capital and largest city. In 1993, Georgia was the first state coalition to receive U.S. DOE recognition through the Clean Cities Coalition Network, an initiative focused on advancing the use of clean fuels, advanced vehicles, and fuel-saving strategies across the country through a network of fuel providers, community leaders, and other stakeholders (Clean Cities Georgia n.d.). By 1998, metro Atlanta had consistently been in violation of federal air quality standards for ozone for two decades. To improve local air quality and achieve compliance, the federal government encouraged the state to pursue local initiatives to reduce air pollution from transportation. One of the solutions pursued was the creation of policies to drive adoption of electric vehicles. In 1998, Georgia lawmakers passed legislation providing a tax credit of up to $1,500 for the lease or purchase of a low- or no-emission vehicle. By 2001, the legislature had increased that credit to $5,000. For several years, the tax credit was one of the most generous in the nation, only behind Colorado (Coombs 2015.)

This successful tax credit spurred the growth of clean fuel vehicles in the state; however, in 2015, Georgia lawmakers eliminated the tax credit as part of a $1 billion transportation funding package arguing it was too generous and too open ended. The rollback of this tax credit, which for many years was one of the leading examples of state incentives for clean fuel technology, has raised concerns about Georgia's continued commitment to transitioning to a clean transportation sector. As discussed in greater detail in the following case study, Georgia continues to offer some incentives for mid- to heavy-duty fleet conversion and charging stations, however the elimination of the tax credit has resulted in a sharp decline in the purchases of electric vehicles in Georgia.

Case Study: Why Policy Matters

From 1998 until June 2015, Georgia had one of the most generous zero-emission vehicle incentive policies in the country, providing $5,000 in income tax credits for the purchase or lease of ZEVs. While the tax credit had been in place since 1998, it went largely unnoticed until 2012, when Nissan developed a leasing program for electric vehicles that incorporated the $5,000 state tax credit together with federal incentives of up to $7,500 for electric vehicles. In the two years that followed, the number of electric vehicles on Georgia's roads increased dramatically, from 1,743 in 2012 to 16,000 in 2014. By early 2014, Georgia had registered more electric vehicles than any other state, with the exception of California (Blau 2016).

In July 2015, Georgia lawmakers eliminated the tax credit as part of a $1 billion transportation bill. Proponents of the measure argued that the tax credit gave an unfair advantage to ZEVs (such as the fully electric Nissan Leaf) over low-emission cars (such as the hybrid Chevy Volt). In addition to removing the tax credit, Georgia legislators introduced a $200 annual fee for electric vehicle owners to compensate for road maintenance costs typically paid through the state's gasoline tax.

These policy changes resulted in a significant decline in ZEV sales. Throughout 2014 and early 2015, Georgia registered 1,000 new electric vehicles every month. After the tax credit was removed, this figure dropped to less than 100 per month, a 90 percent reduction in adoption (Simmons 2016). In 2014, 10,540 PEVs were sold in Georgia. In 2017, only 1,829 were sold through September (Elassar 2018).

A 2017 report examined the potential economic benefits of reinstating Georgia's EV purchase incentive. The report estimated that a new $2,500 tax credit for electric and plug-in hybrid electric vehicles, combined with a reduction to the $200 annual EV fee, would increase GDP by $100 million, increase resident income by $54 million, and create 951 full-time equivalent jobs. While individual communities, such as Atlanta, have pursued fleet electrification, citing the economic and environmental benefits, political efforts to reinstate an AFV tax credit through legislation have not been successful (Rennicks 2017).

Georgia's experience can serve as an example of how important policies can be in terms of the sales and use of AFVs across a state. Due to a favorable tax credit for the purchase or lease of low- or zero-emissions vehicles, Georgia became a nationwide leader in electric vehicle adoption, but the 2015 repeal of this tax credit ceded its leadership position to other states.

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **Alternative Fuel and Advanced Vehicle Job Creation Tax Credit**: Georgia provides a tax credit to businesses that manufacture alternative-energy products for use in battery, biofuel, and electric vehicle enterprises. The amount of the tax credit is based on the number of eligible new full-time employee jobs created by the business, as well as where the credit is located and the associated unemployment rates and income levels (State of Georgia 2019a).
- **Electric Vehicle Supply Equipment Tax Credit:** Businesses may claim an income tax credit for the purchase or lease of qualified EVSE provided that the EVSE is located in the state and accessible to the public. The tax credit is for 10 percent of the cost of the EVSE, up to $2,500 (State of Georgia, 2019a).
- **Idle-reduction Weight Exemption**: Motor vehicles with ideal reduction technology may exceed the state gross, axle, and tandem weight limits by up to 400 pounds to account for the weight of the technology (State of Georgia 2019b).
- **HOV and HOT Lane Exemption:** AFVs displaying alternative fuel license plates may use HOV and HOT lanes, regardless of the number of passengers, and may qualify for toll-free use of HOT lanes (State of Georgia 2019c; State of Georgia 2019d; State of Georgia 2019e).

Utility Incentives

- **PEV Charging Rate Incentive**: Georgia Power offers a PEV time-of-use electricity rate for residential customers who own a PEV and they do not require a separate meter (Georgia Power n.d.).
- **Charging Infrastructure Rebate:** Georgia Power offers a rebate to residential customers, businesses, and builders who install EVSE. Customers are eligible for a $100, $250, and $500 rebate (Georgia Power n.d.).

Laws and Regulations

- **AV Operation:** In Georgia, a person can operate a fully AV with the automated driving system engaged without a driver being present in the vehicle if the vehicle is in compliance with federal motor vehicle safety standards and is registered as a fully AV (State of Georgia 2019f; State of Georgia 2019g).
- **Ethanol Blending Regulation**: Gasoline suppliers must offer gasoline that is suitable for blending with fuel alcohol, and they may not prevent or inhibit a gasoline distributor from being a blender or from qualifying for tax credits offered to blenders (State of Georgia 2019h).
- **PEV Annual Fee**: PEV owners in Georgia are required to pay an annual license fee of $213.69 for noncommercial PEVs and $320.54 for commercial PEVs (State of Georgia 2019i).
- **Biodiesel Specifications**: Biodiesel produced or sold in the state, including for the purpose of blending with petroleum diesel, must meet fuel standards (State of Georgia 2019j).
- **Alternative Fuel Excise Tax**: Distributors who sell or use motor fuel, including special fuels, are subject to an excise tax of $0.26 per gallon, and motor fuels that are not commonly sold or measured by the gallon and are used in motor vehicles on public highways are taxed according to their gasoline gallon equivalent (State of Georgia 2019k; State of Georgia 2019l).
- **CNG Permit**: Individuals or businesses dispensing CNG for use in vehicles must obtain a permit (State of Georgia 2019m).

Michigan

Case Study: Michigan's Approach to EV Infrastructure Planning Combines Research and Investment

In Michigan, a number of partners are working to expand and improve EV infrastructure in the state, with the Michigan Energy Office (MEO), Michigan State University (MSU), major utilities, and NextEnergy all providing leadership across key areas. By integrating research and analysis into the state's investment decisions, Michigan has the opportunity to increase the impact of its investments in EV infrastructure.

At the state level, the MEO expressed its support for the development of a fast-charging network that could provide more convenient EV travel throughout Michigan by 2030. While Michigan is a leader in EV sales, ranking 11th in the country, charging infrastructure is an issue. The state ranks 17th in fast-changing infrastructure, and perceptions around limiting charging infrastructure can serve as a barrier to increased EV adoption by creating range anxiety (MEO and MSU 2019). To mitigate this and enable continuous travel, the MEO engaged researchers at MSU to help optimize the location of fast-charging stations while minimizing investment cost and user delay. MSU developed recommendations for charging station placement, taking into account different scenarios for battery and charging capacity, as well as the effects winter temperatures can have on battery capacity. Through MSU's research, Michigan is better positioned to expand its charging infrastructure strategically, and Michigan utilities are stepping up with programs to support expansion.

Michigan's two largest utilities, Consumers Energy and DTE, are launching programs to support expansion of EV charging infrastructure. On May 30, 2019, Consumers Energy launched a charging infrastructure program, PowerMIDrive, which will provide $7.5 million over three years in rebates to residential and public charging stations and public fast-charging stations across the Consumers service territory as well as educational outreach to customers and site hosts (Consumers Energy 2019). On June 4, 2019, DTE launched its own charging infrastructure program as well, Charging Forward. The program will provide $13.1 million through 2023 to support residential and fast charging infrastructure, as well as customer education (DTE Energy 2019.)

As the state and utilities look for opportunities to expand EV infrastructure across Michigan, NextEnergy, a nonprofit technology accelerator in Detroit, Michigan, is exploring opportunities to make this infrastructure more efficient. NextEnergy is partnering with Delta Technologies, DTE, General Motors, Virginia Tech, MEO, and the City of Detroit to pilot an extreme fast charger. At 400 kW, this extreme fast charger would be able to charge vehicles faster than current technology allows (Next Energy 2019). With funding from the Department of Energy, Next Energy will site the prototype at their Detroit facility with the goal of potentially improving charging infrastructure across Michigan and, potentially, the world.

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **School Bus Replacement Funding**: The Michigan Department of Environment, Great Lakes, and Energy, formally the Michigan Department of Environmental Quality (MDEQ), is incentivizing the replacement of old diesel school buses with alternative-fuel buses through its Fuel Transformation Program. Schools are eligible to apply for grant funding for all-electric or alternative-fuel conversions, and the program is supported by funds allocated to Michigan via the Volkswagen settlement (MDEQ n.d.).
- **Alternative-fuel Development Property Tax Exemption**: Industrial property that is used for high-technology activities, including those related to advanced vehicle technologies, such as electric, hybrid electric, or alternative-fuel vehicles and their components or the creation or synthesis of biodiesel fuel, are eligible for a property tax exemptions (State of Michigan 2017e; State of Michigan 2017f).
- **Natural Gas Fueling Station Air Quality Permit Exemption:** Owners of qualified natural gas, hydrogen, and propane storage and handling equipment at dispensing facilities do not have to obtain an installation permit from Michigan (MDEQ n.d.).
- **AFV Emissions Inspection Exemption**: Michigan vehicles powered by alternative fuels, including CNG, propane, and electricity, are exempt from emissions inspection requirements (State of Michigan 2017c; State of Michigan 2017d).
- **NGV Weight Exemption**: A vehicle primarily powered by natural gas may exceed the state's axle and weight loading limits by a weight equal to the difference between the weight of the vehicle with the natural gas tank and fueling system and the weight of a comparable vehicle with a diesel tank and fueling system (State of Michigan 2017g).

Utility Incentives

- **PEV Charging Rate:** Four of Michigan's largest utilities offer special charging rates for PEVs: DTE, Consumers Energy, Lansing Board of Water and Light, and Indiana Michigan Power (Alternative Fuels Data Center n.d.b).
- **Charging Infrastructure Rebate** - Two utilities also offer rebates for the purchase or lease of charging infrastructure: Lansing Board of Water and Light and Indiana Michigan Power. Lansing BWL provides up to $1,000 for the purchase and installation of electric vehicle supply equipment, while Indiana Michigan Power provides $2500 rebate for the purchase or lease of electric vehicle supply equipment. (Alternative Fuels Data Center n.d.b).
- **Charging Infrastructure Rebate Proposal—Consumers**: Consumers' proposed charging infrastructure program, PowerMIDrive, launched in May 2019. The program will provide $7.5 million over three years in rebates to residential and public charging stations, and public fast-charging stations across the Consumers service territory as well as education. Residential rebates are up to $500 per charger, public rebates are up to $5,000 per charger, and public fast-charging rebates are up to $70,000 per charger. The program will also support educational outreach for customers, site hosts, and EV drivers (Consumers Energy n.d.).

- **Charging Infrastructure Rebate Proposal—DTE Energy:** DTE's proposed charging infrastructure program, Charging Forward, will provide $13.1 million to support residential and fast-charging infrastructure, as well as customer education. $1.5 million is available for residential rebates for up to $500 per in-home charging station, and $10 million is available for public, workplace, and multi-unit dwelling locations and fast-charging corridor stations, for up to $20,000 per DC fast-charging station and $2,500 per level-two charging station, which are suitable for the home. The remaining $1.6 million is for customer and site host education (DTE Energy 2019).

Laws and Regulations

- **Alternative Fuel Excise Tax:** In Michigan, alternative fuels are taxed at the same rate as motor fuels.
- **Alternative Fuel Dealer and Commercial Use License:** Alternative fuel dealers must pay a license fee of $500, and commercial users (users of vehicles with over three axels or over 26,000 pounds) must pay a license fee of $50. Alternative fuels are defined here as natural gas, propane, hydrogen, and hythane.
- **PEV Fee:** All owners of PEVs and PHEVs are subject to annual fees of $30 to $100 for PEVs and $100 to $200 for PHEVs (State of Michigan 2017h).
- **Biodiesel and Hydrogen Production, Retail, and Storage Requirements**: Biodiesel and hydrogen fuels sold in Michigan must meet state fuel requirements, and the sale of both biodiesel and hydrogen requires a license from the Michigan Department of Agriculture and Rural Development.
- **AV Support**: Michigan Public Act (PA) 332 establishes regulation for the use of AVs in Michigan, allowing for their operation on public roads (State of Michigan 2016).

Minnesota

Minnesota is a state familiar with aggressive clean energy goals. In its electric utility sector, the e21 Initiative is an industry-led push to dramatically change regulation, focused on modernizing how rates are decided and better integrating renewables into the regulatory framework (e21 Initiative n.d.). Beyond utilities, cleaner energy is a priority across Minnesota's state government, from the state Commerce Department to the Legislative Energy Commission (Minnesota Department of Commerce n.d.; State of Minnesota n.d.a). Minnesota is also a leader when it comes to promoting the use of clean fuels across economic sectors, including transportation. From 2011 to 2016, they ranked sixth in the nation for number of clean technology transportation patents per capita (Brookings 2017). In May of 2018, Minnesota joined a coalition of 17 states and Washington, D.C., in suing the U.S. Environmental Protection Agency (U.S. EPA) to preserve greenhouse gas emission standards for vehicles (MnPCA 2018).

As part of this larger push to decarbonize energy use statewide, Minnesota's *Accelerating Vehicle Adoption: A Vision for Minnesota* report documents the advancement of EVs, highlights their benefits, and outlines how Minnesota can and should encourage this transition. The Minnesota Department of Transportation (MnDOT), Minnesota Pollution Control Agency (MnPCA), and Great Plains Institute (GPI) worked together to produce the report (MnDOT, MnPCA, and GPI 2019). The team collaborated on the report as part of the state's ambitious goal to be the leading Midwest state for PEV use, citing new technologies, advanced technology jobs, cleaner air, reduced greenhouse gas emissions, improved public health, increased efficiency, and social justice as motivation. The report primarily focuses on light-duty passenger vehicles because of their availability and because they are the leading source of greenhouse gas emissions from transportation in Minnesota (MnDOT, MnPCA, and GPI 2019). The push for electric vehicles also increases MnDOT transportation revenue and aligns with the Federal Highway Administration's goal of turning the section of Interstate 94 from Moorehead, Minnesota, to Port Huron, Michigan, into a zero-emission corridor (MnDOT n.d.).

Xcel Energy, one of the state's largest electric utilities, is also helping advance the use of electric vehicles in Minnesota through various EV charging pilot programs. This comes as part of Xcel's larger push to electrify the transportation industry, saving customers money and reducing their carbon footprint. The first of these pilot programs was announced in August of 2018, with the utility providing advanced home EV-charging meters to a select number of customers (Walton 2017). Since then, pilot programs have expanded to include public charging in the Twin Cities and various fleet charging locations (Hughlett 2018).

Minnesota's *Accelerating Electric Vehicle Adoption* and Xcel's Public Charging Pilot exemplify how states and their utilities can both use unique and specialized programs to accelerate the use of EVs. The following case study details how each program helps advance the use of electric vehicles by describing how each initiative is funded, where their efforts are targeted, and the logistics of implementing such programs.

Case Study: Utility Support for Public Fleet and Community Ride-sharing EV Infrastructure

Minnesota shows leadership in promoting EVs and infrastructure through both state plans and utility programs. While the state ranks fourth in the Midwest in the number of EVs registered, after Illinois, Michigan, and Wisconsin, Minnesota seeks to become the leader in the Midwest by 2030.

In 2019, MnDOT released *Accelerating Electric Vehicle Adoption: A Vision for Minnesota*, a statewide plan for increasing EV adoption. The vision sets a statewide goal of having 20 percent of light-duty vehicles in the state electric by 2030, and it outlines strategies for meeting this goal: increasing education and marketing of EVs to increase sales and use, expanding EV charging infrastructure, increasing coordination between regional and national initiatives, and prioritizing renewable energy for charging EVs. State government is also seeking to model its goals through its own actions, and the vision sets a goal for the state's own fleets to reach 20 percent electric by 2027 (MnDOT, MnPCA, and GPI 2019).

Minnesota utilities are also looking for opportunities to promote EV adoption, primarily through pilot programs focused on EV infrastructure expansion. Minnesota regulators earlier this year approved nearly $25 million for two EV pilot programs from Xcel Energy. The Fleet EV Service pilot will use $14.4 million over three years to install and maintain EV infrastructure for fleet operators in Minnesota, including the City of Minneapolis and the Minnesota Department of Administration. Xcel estimates that the program will install over 700 charging ports over the three-year period (Xcel Energy 2018).

Xcel's Public Charging pilot will use $9.2 million over three years to install public charging stations along key transportation corridors as well as over 70 community mobility hubs in the Twin Cities. The installations along key transportation corridors will focus on fast-charging EV stations, while the community mobility hubs, identified in partnership with the cities of Minneapolis and Saint Paul, will provide EV charging stations for use of the general public, fleets, and the Saint Paul-based ride-sharing service HOURCAR, which the cities have identified as an anchor tenant for the hubs (Xcel Energy 2018). Through its support for EV ride-sharing infrastructure, the Twin Cities will join Los Angeles and Indianapolis in piloting a different approach to mobility (Jossi 2019).

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **EVSE Grants:** The MnPCA is providing grants for the installation of public fast-charging EVSE along Minnesota highways and interstates in order to create fast-charging station corridors. Funded by the state's Volkswagen settlement, grants are available for 80 percent of the project costs, up to $70,000 per 50kW EVSE. A total of 21 50kW fast-charging stations will be funded, as well as one 150KW fast-charging stations (MnPCA n.d.b).
- **School Bus Replacement Grants:** The MnPCA is also using Volkswagen settlement funds to replace model year 1992–2009 diesel school buses. Replacements must be 2018 model year or newer certified diesel, natural gas, propane, electric-diesel hybrid, or all-electric buses (MnPCA n.d.d).
- **Biofuel Blending Infrastructure Grants**: The Minnesota Department of Agriculture provides grants for up to 35 percent of the installation and purchase price of biofuel blending equipment (Minnesota Department of Agriculture n.d.).

- **Ethanol Fueling Infrastructure Grants**: The Minnesota Department of Agriculture is offering funding assistance to fuel retailers for the installation of equipment to dispense ethanol fuel blends ranging from E15 through E85 (Clean Air Choice n.d.).
- **Idle-reduction Technology Loans**: MnPCA's Small Business Environmental Assistance Program provides low-interest loans up to $50,000 to qualified small businesses to finance environmental projects such as capital equipment upgrades that meet or exceed environmental regulations. This includes idle-reduction technologies (MnPCA n.d.c).
- **Idle-reduction and NGV Weight Exemption**: Vehicles with idle-reduction technology and natural gas vehicles may exceed the state vehicle weight requirements (State of Minnesota n.d.c).

Utility Incentives

- **Public Charging Pilot—Xcel Energy:** Xcel's $9.2 million public charging pilot program will provide fast-charging and public level-two charging stations in Xcel's territory. Much of these funds will go toward the development of a network of 70 community mobility hubs targeted to the neighborhoods in Minneapolis and St. Paul that have the worst health impacts from air pollution. These hubs are also a crucial component in a local car-sharing service's plans to electrify its entire fleet (Jossi 2019).
- **Fleet EV Service Pilot—Xcel Energy:** Xcel's $14.4 million fleet program will be targeted primarily to public fleets, providing EVSE charging infrastructure and giving customers the option to pay for the chargers themselves through a higher monthly fee. The program targets government fleets (Jossi 2019).
- **EV Charging Rate—Xcel Energy:** Xcel offers EV customers the option to charge their EV at night or on weekends at half cost. Similarly, if they charge during the day, it costs approximately twice the cost of power (Xcel Energy n.d.b).
- **Residential PEV Charging Pilot Program—Xcel Energy**: Under Xcel's PEV Charging Pilot Program, 100 residents were eligible to purchase EVSE through monthly charges or through an up-front payment and have them installed by Xcel. Participants receive the discounted EV charging rate discussed above. Enrollment in the program is currently closed (Xcel Energy n.d.a).
- **EVSE Rebate and EV Charging Rate Reduction—Lake Region Electric Cooperative**: Lake Region Electric Cooperative (LREC) offers a rebate of up to $500 for the installation of EVSE. Members enrolled in the ChargeWise program receive a reduced rate for the electricity used to charge PEVs between specified off-peak hours (LREC n.d.).
- **PEV Wind Energy Promotion—Great River Energy**: Great River Energy's Revolt Initiative offers customers the ability to have their vehicle powered by 100 percent wind energy for the life of the vehicle (Great River Energy n.d.).
- **EVSE Rebate and EV Charging Rate Reduction—Dakota Electric Association:** Dakota Electric offers $500 for the installation of EVSE as well as a reduced charging rate during off-peak hours (Dakota Electric Association n.d.).
- **EVSE Rebate and EV Charging Rate Reduction—Connexus Energy:** Connexus Energy offers $500 for the installation of EVSE as well as a reduced-rate EV charging (Connexus Energy n.d.).

Laws and Regulations

- **Electric Vehicle Adoption Plan**: MnDOT released the *Accelerating Electric Vehicle Adoption: A Vision for Minnesota* plan to set a statewide goal of having 20 percent of light-duty vehicles in the state electric by 2030 through increased education, expanded EV charging infrastructure, increased coordination between regional and national initiatives, and increased renewable energy. It also sets a goal for the state's own fleets to reach 20 percent electric by 2027 (MnDOT, MnPCA, and GPI 2019.)
- **EV Fee**: Minnesota EVs are subject to an additional registration fee of $75 (State of Minnesota n.d.b).
- **Alternative Fuel Tax**: Alternative fuels are taxed differently from gasoline in Minnesota. E85 is taxed at the pump at a rate of $0.2025 per gallon, pure biodiesel (B100) is taxed at $0.285 per gallon, propane is taxed at $0.2135 per gallon, LNG is taxed at $0.171 per gallon, and CNG is taxed at the rate of $2.50 per thousand cubic feet. Gasoline is taxed at the rate of $0.285 per gallon (Minnesota Department of Revenue n.d.).
- **Connected Autonomous Vehicles (CAVs) Advisory Council and Support:** In 2018, Minnesota established an advisory council to study, assess, and prepare for the widespread adoption of CAVs (Dayton 2018).
- **Biofuels Replacement Goals**: The Minnesota Department of Commerce Weights and Measures Division promotes the replacement of 25 percent of all gasoline offered for sale by 2020 and 30 percent by 2025 (State of Minnesota n.d.d).
- **EVSE Requirements**: EVSE installed in Minnesota must be able to be used by any make, model, or type of PEV; comply with state safety standards and standards set by the Society of Automotive Engineers; and be capable of bi-directional charging once electrical utilities achieve a cost-effective ability to draw electricity from PEVs connected to the utility grid (State of Minnesota n.d.e).
- **PEV and NGV Procurement Goals**: The State of Minnesota requires state solicitations to include requirements for the use of EVs, PHEVs, neighborhood EVs, and NGVs. In order for this requirement to apply, vehicles must meet the state's performance specifications and have a total life-cycle cost of ownership less than or comparable to that of gasoline-powered vehicles. State agencies are also charged with developing sustainability plans, which should include reference to state agency targets for the purchase on-road vehicles that use alternative fuels, including biodiesel blends of 20 percent (B20) or greater, compressed or LNG, ethanol blends of 70 percent or greater, hydrogen, propane, or electricity (State of Minnesota n.d.f).
- **State Agency Vehicle Procurement and Management Requirement**: When purchasing a motor vehicle, a state agency must select one that is capable of being powered by cleaner fuels, including electricity and natural gas, if the total life-cycle cost of ownership is less than or comparable to that of a gasoline-powered vehicle (State of Minnesota n.d.f).

New York

New York is vitally connected to the transportation industry. While it may not contain many auto manufacturing facilities, many major auto manufacturers' debts are held by New York-based financial institutions (Office of the State Comptroller 2008). New York is approximately twice the size of Michigan in terms of population, at 19.7 million, and its GDP of $1.676 billion is approximately three times as large as Michigan's (U.S. Census Bureau 2018; U.S. BEA 2019f). Beyond population and GDP differences, Michigan remains a much greater automotive innovation hub, particularly for clean tech, filing 31.94 clean tech transportation patents per capita to New York's 2.55 (Brookings 2017). The automotive industry also plays a larger role in Michigan's economy than it does in New York's economy, employing 7 percent of Michigan's workforce and contributing 10 percent of state tax revenue, compared to only 1.9 percent of employment and 2 percent of state tax revenue in New York (Alliance of Automobile Manufacturers 2019a; Alliance of Automobile Manufacturers 2019c). New York does, however, contain one of the largest urbanized populations in the country and as such, offers an opportunity to learn how to promote clean fuels while balancing urban and nonurban needs with complex transportation networks and challenges (U.S. Census Bureau 2012).

New York's aggressive clean fuel policies officially began in 2014 with the launch of Gov. Andrew Cuomo's Reforming the Energy Vision (REV) strategy, although the governor had implemented numerous smaller initiatives prior to this official launch. Motivated by the destruction of Hurricane Sandy in 2012, particularly to the power grid, the REV strategy was designed to improve efficiency, resiliency, and affordability of New York's electric grid, as well as drastically reduce carbon emissions (New York State n.d.). One component of the REV is the promotion of electric vehicles. This occurred through numerous initiatives and programs, the most significant of which were Charge NY and Charge NY 2.0. The Drive Clean Rebate Program is part of the first Charge NY, which began in 2013 with the initial goal of promoting the purchase of 30,000 to 40,000 electric vehicles by the end of 2018. The rebate began in 2017 and continues to this day (NYSERDA n.d.e). EVolve NY is part of Charge NY 2.0, which began in 2018 and aims to promote electric car adoption and reduce range anxiety through the construction of charging stations, helping the state achieve its goal of installing at least 10,000 EV charging stations before 2022 (Office of Governor Cuomo May 2018). Additionally, in 2014 the state adopted the Zero-emission Vehicle Action Plan, in which multiple states aimed to dramatically increase the number of consumer-driven clean vehicles on the road by 2025. This goal served as further motivation for the state to implement EVolve NY and the Drive Clean Rebate Program (Office of Governor Cuomo 2014).

These programs are generally considered successful, with the Drive Clean Rebate awarding more than 5,750 rebates in its first year alone (Office of Governor Cuomo March 2018) and the NYPA siting locations for up to 200 DC fast chargers across the state as part of EVolve NY (NYPA 2018). The state of New York is moving quickly and aggressively in its clean fuel policies, and it is seeing the results in the form of dramatic increases in electric vehicle ownership and consumer interest in program participation.

Case Study: New York's EVolve NY Initiative and Drive Clean Rebate Program

In 2018, the NYPA launched EVolve NY, a $250 million initiative focused on expanding EV infrastructure, increasing EV adoption, and raising awareness about the benefits of EVs with consumers. The NYPA, New York's state public power utility, will partner with the private sector and other key stakeholders through 2025 to attract longer-term private investment and collaborate on programs that will address key infrastructure and potential market gaps to make EVs more user friendly and accessible. It represents one of the largest utility investments in support of EVs to date (NYPA n.d.).

In terms of EV infrastructure, NYPA plans to invest an initial $40 million to install 200 DC fast chargers along major traffic routes across the state as well as metropolitan areas such as Buffalo, Rochester, Syracuse, Yonkers, and Albany by the end of 2019. NYPA will also install a ten-station high-speed charging area at John F. Kennedy airport. NYPA is investing in these charging stations to remove a barrier identified by potential EV customers—a perceived fear over the ability to take long-distance trips. While the majority of EV charging takes place at home or at the workplace, EV charging stations at 30-mile intervals along transportation corridors will enable these trips and help relieve range anxiety (NYPA n.d.).

As NYPA expands investment in EV infrastructure, the state is increasing its support for EV adoption. In 2017, the New York State Energy Research and Development Authority (NYSERDA) launched the Drive Clean Rebate Program, a $70 million initiative that provides residents with a rebate of up to $2,000 for the purchase or lease of a new PHEV or EV from participating new car dealers (NYSERDA n.d.b). The amount of the rebate is based on the all-electric range of the vehicle, with EVs receiving a higher rebate than hybrid vehicles. In 2017, this initiative contributed to a 67 percent increase in electric vehicle sales over 2016. By November 2018, NYSERDA had awarded over $15 million in rebates to over 11,000 customers (Pyper 2018).

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **PEV Rebate Program**: The NYSERDA provides point-of-sale rebates of up to $2,000 for the purchase or lease of a new eligible PEV (NYSERDA n.d.b.).
- **EVSE Rebate**: NYSERDA's Charge Ready NY provides rebates for public and private entities toward the purchase and installation EVSE at public parking facilities, workplaces, and multi-unit dwellings. Rebates are available for $4,000 per port (NYSERDA n.d.c).
- **Heavy-duty Alternative-fuel and Advanced Vehicle Purchase Vouchers**: NYSERDA provides incentives for alternative-fuel trucks, alternative-fuel buses, and diesel emission controls. For public fleets, incentives are for up to 80 percent of the incremental cost or $150,000 per vehicle. For private or nonprofit fleets, incentives are for up to 80 percent of the incremental cost or between $40,000 and $60,000 per vehicle (NYSERDA n.d.e).
- **Clean Truck Replacement Program**: The Port Authority of New York and New Jersey provides funding for up to 50 percent of the cost to replace a heavily emitting truck, up to $25,000 (Port Authority of New York and New Jersey n.d.).
- **Idle-reduction and NGV Weight Exemption**: Any motor vehicle equipped with qualified idle-reduction technology may exceed the state's vehicle weight limits by up to 400 pounds to compensate for the additional weight of the idle-reduction technology. Any NGV may exceed the limits by up to 2,000 pounds (State of New York n.d.).

- **AFV Research and Development Funding**: NYSERDA's Clean Transportation Program provides funding for projects that enhance mobility, improve efficiency, reduce congestion, and diversify transportation methods and fuels through research and development of advanced technologies. NYSERDA offers annual solicitations that support new product development and demonstration as well as research on new transportation policies and strategies (NYSERDA n.d.a).
- **ZEV and Fueling Infrastructure Rebates for Municipalities:** The New York State Department of Environmental Conservation's (DEC) Municipal ZEV Clean Vehicle Rebate Program offers rebates to cities, towns, villages, counties, and New York City boroughs for the purchase or lease of eligible ZEVs and the installation of eligible ZEV fueling infrastructure. For ZEVs, the rebates are $5,000 for vehicles with more than 50-mile ranges and $2,500 for vehicles ten- to 50-mile range. EVSE and hydrogen fueling infrastructure rebates are for up to $250,000 per facility (New York State Department of Environmental Conservation n.d.).
- **EVSE and PEV Incentives:** NYSERDA is offering employers in the greater New York City region an $8,000 rebate per dual-connector EVSE installed. Employees of organizations that receive the rebate are eligible for a $500 rebate toward the purchase or lease of a qualified PEV (NYSERDA n.d.d).
- **EV Inspection Exemptions:** Vehicles powered exclusively by electricity are exempt from state motor vehicle emissions inspections (New York State Department of Motor Vehicles n.d.).
- **HOV Lane Exemption:** Through the Clean Pass Program, PEV and PHEV may use the Long Island Expressway HOV lanes with a single occupant (New York State Department of Transportation 2019).
- **PEV Toll Discount:** Vehicles eligible for the Clean Pass Program, including PEVs and hybrid electric vehicles, receive a discounted toll rate on all port authority off-peak hour crossings (Port Authority of New York and New Jersey n.d.).

Utility Incentives

- **Workplace EVSE Rebate—Public Service Enterprise Group (PSEG) Long Island**: PSEG Long Island offers rebates of 80 percent of the invoice price, up to $4,000 per port, toward the purchase of up to ten workplace EVSE units (PSEG Long Island n.d.).
- **EVSE Rebate—Greater Rochester Clean Cities (GRCC)**: GRCC offers rebates of up to $2,000 toward the purchase and installation of public EVSE, and eligible applicants include municipal government entities, public school districts, universities, and hospitals (GRCC n.d.).
- **EV Rebate—Central Hudson Gas and Electric Corp.**: Central Hudson customers are eligible for a $5,000 rebate for the purchase of a new 2018 Nissan Leaf (Central Hudson n.d.).
- P**EV Time-of-use Rate—Consolidated Edison, Inc.**: Customers pay a reduced price for electricity during off-peak hours (Consolidated Edison Company of New York n.d.).

Laws and Regulations

- **PEV Charging and Infrastructure Support**: EVolve NY has allocated up to $250 million to support PEVs and address charging infrastructure gaps throughout the state, with a focus on interstate DC fast chargers, airport charging hubs, and PEV model communities (New York Power Authority n.d.).
- **ZEV Action Plan:** New York signed an MOU to support the deployment of ZEVs through involvement in the ZEV Task Force. In 2018, the task force published a ZEV action plan identifying priority actions to accomplish the goals of the MOU. The plan focuses on five priority areas: 1) raising consumer awareness and interest in EV technology; 2) building out a reliable and convenient

residential, workplace, and public charging/fueling infrastructure network; 3) continuing and improving access to consumer purchase and nonfinancial incentives; 4) expanding public- and private-sector fleet adoption; and 5) supporting dealership efforts to increase ZEV sales (ZEV Task Force 2018).

- **School Bus Idling Reduction**: School bus drivers or drivers of other vehicles that the school district owns, leases, or contracts must turn off the vehicle engine while loading or unloading passengers on school grounds or near a school (New York State Education Department n.d.).
- **HEV Taxi Cabs**: The New York City Taxi and Limousine Commission must approve one or more HEV models for immediate use as a taxicab by taxicab medallion owners. Approved HEV models must meet all requirements of for-hire vehicles. The commission must also allocate 1,350 clean air taxicab medallions to HEVs (Senate Bill 7331, 2018).
- **ZEV Emission Standards and Low-emission Vehicle Standards**: Any new light-duty passenger car, light-duty truck, or medium-duty passenger vehicle sold, leased, imported, delivered, purchased, or acquired in New York State must be certified to the California motor vehicle emissions standards and compliance requirements specified in Title 13 of the California Code of Regulations (New York State Department of Environmental Conservation n.d.).
- **Vehicle Retrofit Requirements**: State agencies and state and regional public authorities must install the best available retrofit technology to reduce air pollutant emissions on all heavy-duty diesel vehicles that they own, operate, or lease on or before December 31, 2019 (State of New York, January 18, 2018).
- **Heavy-duty Idle-reduction Requirement**: Heavy-duty vehicles with a gross vehicle weight rating greater than 8,500 pounds may not idle for more than five consecutive minutes when the vehicle is not in motion. Exceptions apply (New York State Department of Environmental Conservation n.d.).

North Carolina

North Carolina and Michigan are similar from economic and population standpoints, with North Carolina's 10 million residents and $565 billion GDP fairly similar to Michigan's 9.9 million residents and $528 billion GDP (U.S. Census Bureau 2018; U.S. BEA 2019a). However, the auto industry plays a much smaller role in North Carolina's economy than it does in Michigan (Alliance of Automobile Manufacturers 2019a; Alliance of Automobile Manufacturers 2019d). The state's political layout presents an interesting climate for energy programs. Similar to Michigan, North Carolina has recently emerged with a politically divided state government. While Democrats controlled all three levels of government for the early 2000's, the state rapidly switched to having entirely Republican control by 2013. Since 2017, the state is now divided, with a Democratic governor and two Republican legislatures, similar to Michigan (Ballotpedia n.d.a). North Carolina presents an opportunity to understand how a state with an irregular political landscape can advance the promotion of clean fuel technologies.

An important company in North Carolina energy is Duke Energy, one of the state's largest electricity and natural gas providers, which has announced plans to invest heavily in EV charging infrastructure. These efforts are rooted in concerns of efficiency, emissions, and cost-savings, but also as a reaction to North Carolina's place in the national EV conversation. The state's EV market may be growing, but it is still less than half of the national average, at one EV per 1,000 people. These EVs are serviced by 565 public charging stations, equaling roughly one outlet per seven cars, below the expert-recommended ratio of one outlet per five vehicles (Ouzts 2019). In reaction to this news, the state is beginning to enact policies promoting EVs, and Duke Energy asserts that North Carolina's EV infrastructure "cannot support the current and future pace of EV growth" (Duke Energy March 2019). By investing in EV charging infrastructure, Duke positions itself to be ready as the EV market grows and energy demands shift accordingly.

The Volkswagen Group of America and the State of North Carolina have also begun investing in EV charging infrastructure. For Volkswagen, this is motivated by a court settlement and a want to repair Volkswagen's public image. In early 2017, Volkswagen was found guilty of cheating U.S. exhaust emissions tests. As part of the court settlement, Volkswagen's American subsidiary, Volkswagen Group of America, formed Electrify America, LLC to invest in zero-emission vehicle infrastructure and awareness programs, such as those emerging in North Carolina (Shepardson 2017). North Carolina's interest in EVs stems from an interest in reducing range anxiety and promoting EV adoption. Funding for the state's efforts came from the 2017 Volkswagen settlement. States can only use these funds for projects that reduce emissions of nitrogen oxides, with a maximum of 15 percent spent on EV infrastructure. After a period of public comment, North Carolina's Department of Environmental Quality decided to allocate this maximum towards EV charging infrastructure (Sorg 2018).

North Carolina stands out as a state with a wide variety of parties investing heavily in EV charging infrastructure. The following case study outlines how these groups are funding their projects, where they are choosing to deploy this infrastructure, and the mechanisms by which they are incentivizing their customers. The study also details how well each program is progressing toward its goals.

Case Study: Utility, Public, and Private Investment in Electric Vehicle Infrastructure

Duke Energy recently announced plans for significant investment in electric vehicle infrastructure in North Carolina, adding to planned investments by the state and Electrify America, LLC.

In April, Duke Energy filed a proposal with the North Carolina Utilities Commission (NCUC) to invest $76 million over three years in EV charging infrastructure. If approved by the NCUC, the proposal would support an additional 2,500 charging stations by 2023, and it would represent one of the largest utility investments in the United States to date.

Duke Energy's proposal would provide funding for five different types of EV charging infrastructure. For residential charging, it would provide a $1,000 rebate for level-two home charging stations for up to 800 residential customers. For public charging, Duke Energy plans to install and operate more than 800 public charging stations, including fast-charging stations, across North Carolina. For fleet EV charging, Duke Energy will provide a $2,500 rebate for up to 900 charging stations for commercial and industrial customers establishing fleets of electric vehicles, including cities and universities. For schools, Duke Energy will provide financial support for as many as 85 electric school buses and their supporting charging infrastructure. For public transit, Duke Energy will install and operate more than 100 transit bus charging stations (Duke Energy April 2019).

Duke Energy's proposed investments will build on the planned investments by the State of North Carolina and Volkswagen. North Carolina received $92 million from Volkswagen as part of their settlement, and the state intends to commit 15 percent to EV charging infrastructure. Beyond this allocation, Volkswagen Group of America is also committed to investing $2 billion in ZEV infrastructure across the country through Electrify America. Electrify America has already initiated its first cycle of projects, and it plans to implement the second between July 2019 and December 2012 (NCDEQ n.d.b). North Carolina currently has 600 public EV charging stations at present, and these investments from the state, Electrify America, and Duke Energy will expand North Carolina's network significantly.

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **Clean Fuel Advanced Technology Project (CFAT):** North Carolina's CFAT project provides annual funding, by application, for AFV purchases and conversions, idle-reduction technology, diesel-retrofit funding, and EVSE infrastructure. The primary purpose of the CFAT project is to reduce transportation-related emissions in 24 eligible North Carolina counties.
- **Diesel-emissions Reductions Grants**: North Carolina's Division of Air Quality (DAQ) provides grants for the incremental cost of original-equipment manufacturer AFVs, vehicle conversions, and implementing idle-reduction programs. In 2018, DAQ awarded $667,770 in grants for three projects to reduce air pollution from diesel-powered mobile sources through the 2018 Diesel-emission Reduction Grant program (NCDEQ n.d.a).
- **HOV Lane Exemption**: Qualified PEVs, dedicated natural gas vehicles, and fuel cell electric vehicles may use North Carolina HOV lanes, regardless of the number of occupants (State of North Carolina n.d.a).
- **PEV and Fuel Cell Electric Vehicle (FCEV) Emissions Exemption**: Qualified PEVs and FCEVs are exempt from state emissions inspection requirements (State of North Carolina n.d.a).

- **Alternative-fuel Tax Exemption**: In North Carolina, the retail sale, use, storage, and consumption of alternative fuels is exempt from the state retail sales and use tax (State of North Carolina n.d.h).
- **Biofuel Tax Exemption:** In North Carolina, individuals who produce their own biofuel for use in their own passenger vehicles are exempt from the state motor fuel excise tax (State of North Carolina n.d.i).
- **Alternative-fuel Revolving Fund**: The Alternative-fuel Revolving Fund provides state agencies with funding to offset the incremental costs of purchasing biodiesel fuel, developing alternative-fueling infrastructure, and purchasing AFVs and hybrid electric vehicles. For the purposes of this program, alternative fuels include 100 percent biodiesel, biodiesel blends of at least B20, ethanol blends of at least E85, CNG, propane, and electricity (State of North Carolina n.d.o; State of North Carolina n.d.d; State of North Carolina n.d.n).
- **NGV Weight Exemption**: A vehicle primarily powered by natural gas may exceed the state's gross vehicle weight limits by a weight equal to the difference between the average weight of the vehicle with the natural gas tank and fueling system and the average weight of a comparable vehicle with a diesel tank and fueling system (State of North Carolina n.d.g).

Utility Incentives

- **EVSE Rebate and PEV Charging Rate—Cape Hatteras Electric Cooperative (CHEC)**: CHEC offers a bill credit of $100 to residential customers who install EVSE and a special time-of-use charging rate (CHEC n.d.).
- **EVSE Rebate and PEV Charging Rate—Randolph Electric Membership Corporation (EMC)**: Randolph EMC's Electric Vehicle Utility Program offers rebates for residential customers of $500 towards the purchase of residential EVSE as well as a special time-of-use charging rate (Randolph EMC n.d.).

Laws and Regulations

- **Support for ZEVs:** The North Carolina Department of Transportation (NCDOT), in coordination with the NCDEQ, is required by executive order to develop a ZEV plan to increase the number of ZEVs in the state by at least 80,000 by 2025. The plan will establish ZEV corridors, coordinate and increase the installation of ZEV infrastructure, and identify best practices for increasing ZEV adoption (Cooper 2018).
- **ZEV Requirements**: State-owned vehicle fleets must prioritize ZEVs in the purchase or lease of new vehicles and use ZEVs for agency travel when feasible. The Department of Administration must develop the North Carolina Motor Fleet ZEV Plan (Cooper 2018).
- **AV Regulations and Committee**: The NCDOT created the Fully Autonomous Vehicle Committee to consider matters relevant to AV technology; review state motor vehicle laws; and make recommendations concerning vehicle testing, traffic rules and ordinances, and changes needed to state laws (State of North Carolina n.d.e; State of North Carolina n.d.f).
- **Alternative-fuel Tax**: The state motor fuel tax on LNG is imposed based on the diesel gallon equivalent and the tax on propane and CNG is based on the gasoline gallon equivalent (State of North Carolina n.d.j; State of North Carolina n.d.k).
- **EV Annual Fee:** The owner of an EV that is exclusively powered by electricity must pay a fee of $130 in addition to any other required registration fees at the time of initial registration and annual registration renewal (State of North Carolina, n.d.q).

- **Biodiesel Warranty Requirement**: All new state government diesel vehicles must have a manufacturer's warranty that allows the use of biodiesel blends of 20 percent (State of North n.d.b; State of North Carolina n.d.c; State of North Carolina n.d.d).
- **Biodiesel Requirement for School Buses**: Every school bus that is capable of operating on diesel fuel must be capable of operating using blends of at least 20 percent biodiesel, and at least 2 percent of the total volume of fuel purchased annually by local school districts statewide for use in diesel school buses must be a minimum of B20 (State of North Carolina n.d.l; State of North Carolina n.d.m).
- **Fuel-efficient Vehicle Acquisition Requirements**: When purchasing new state vehicles, the North Carolina Department of Administration must give purchase preference to vehicles with fuel economy ratings that rank among the top 15 percent of comparable vehicles in their class (State of North Carolina n.d.p).
- **AFV Acquisition Goal:** North Carolina established a goal that at least 75 percent of new or replacement state government light-duty cars and trucks be AFVs or low-emission vehicles (State of North Carolina n.d.r).

Ohio

As a state in the Midwest, built in part by the auto and manufacturing industries, Ohio has much in common with Michigan. Both states have been ranked in the top three states for number of automotive manufacturing establishments, and while both have suffered as automotive manufacturers close factories, the auto industry remains a strong factor in their economies (CAR 2015). The auto industry contributed 8 percent to Ohio's state tax revenue, just below Michigan's 10 percent (Alliance of Automobile Manufacturers 2019a; Alliance of Automobile Manufacturers 2019e). From *Fortune Magazine's* US-1,000 or Global-500 lists, 28 major companies have motor vehicle industry establishments in Ohio, including Ford, Honda, GM, and Fiat/Chrysler, and several motor vehicle suppliers are headquartered in the state, including Cooper Tire & Rubber Company and Goodyear (ODSA 2019).

The U.S. Department of Transportation's (U.S. DOT's) Smart City Challenge grant was announced in 2015 as a partnership with Vulcan, Inc. after a February 2015 report revealed that the nation and its cities might not be equipped to deal with a growing population from a transportation perspective. The grant would fund one city with $50 million to implement its proposed transportation vision. Cities were instructed to submit proposals that demonstrated how "advanced data, technologies, and applications can be used to reduce congestion, keep travelers safe, protect the environment, respond to climate change and support the economy" (Emmino 2015). While lessons from the winning city would be applicable to other locations, the competition ideally aimed to inspire innovation in all applying cities. The U.S. DOT was focused on modernizing the national urban transportation vision, integrating connected, shared, and autonomous vehicles to reduce crashes, traffic, and environmental impact, while Vulcan, Inc. was primarily concerned with reducing greenhouse gas emissions (Boyle 2015).

The city of Columbus was interested in the grant for several reasons. Columbus was, and still is, the fastest-growing city in the nation and faced a number of problems, including "an aging population; a growing younger population that is moving to the dense urban areas; mobility challenges in select neighborhoods; and a growing economy and population with related housing, commercial, passenger and freight, and environmental issues" (City of Columbus 2016). The city is also unlike most other cities of its size because it lacks high-capacity transit beyond public busing. The U.S. DOT selected Columbus in part because of the broad community support that the initiative received, with local governments, nonprofits, and companies like Honda pledging $90 million in additional funding to support the city's proposed programs. Columbus was also selected because their proposal was specific in how the grant would address problems and help impoverished communities (Vock 2016).

Since winning the grant, the city has made steady progress on several mobility initiatives, including the construction of EV infrastructure, promotion of EV adoption among consumers and fleets, and even the introduction of autonomous vehicle technology into public transportation. The following case study will outline in greater detail the robust and diverse approaches of the Smart Columbus approach to effectively transform the city's transportation sector.

Case Study: Smart Columbus Comprehensive Approach

In 2016, Columbus won the U.S. DOT first-ever Smart City Challenge, receiving $40 million in federal grant funding to pilot new approaches to mobility. Together with $10 million from the Paul G. Allen Family Foundation, as well as over $90 million in commitments from the private sector and local government, Columbus established Smart Columbus, a regionwide Smart City initiative co-led by the City of Columbus and the Columbus Partnership whose mission is to accelerate human progress through open mobility (Smart Columbus 2018a). Smart Columbus developed a playbook that outlines their plans and programs, and they have made adoption of clean fuel technology, in particular vehicle electrification, a key focus.

Smart Columbus is proposing a comprehensive approach to clean fuel adoption, targeting public and commercial EV fleet adoption, EV consumer adoption, EV charging infrastructure, decarbonization of the electric grid, and piloting connected autonomous electric vehicles (CEAV) in the city (Smart Columbus 2018b).

- EV fleet adoption: Smart Columbus has set a goal of adding 300 public and 400 private electric vehicles by 2020, and it developed an innovative universal-term contract that allows the city and surrounding communities to procure electric vehicles at a lower cost.
- EV consumer adoption: Smart Columbus is targeting a 500 percent increase in consumer EV adoption across the region, and it established the Ignite Action Fund to provide matching funds to local employer partners so that they can create EV rebate programs for their employees.
- EV charging infrastructure: Smart Columbus's goal is to increase the number of charging stations in the region by nearly 1,000 ports by 2020, and it is working with workplaces, utilities, owners of multi-unit dwellings, the City of Columbus, and residents to inform, plan, and incentivize adoption through rebate programs.
- Decarbonization: Smart Columbus is working with American Electric Power (AEP) and the City of Columbus to modernize the electric grid by bringing online utility-scale renewables, improving efficiencies, and deploying smart meters.
- CEAV pilot: Smart Columbus launched a self-driving EV shuttle service in December 2018, Smart Circuit, to provide residents and visitors with a hands-on educational experience with self-driving technology and inform future deployments of self-driving technology in the city, Ohio, and the rest of the country.

In addition to these programs and pilot projects, Smart Columbus is capturing and sharing the results of their efforts online to include both successes and challenges. Their goal is to serve as a demonstration for other cities interested in becoming a smart city.

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **Medium- and Heavy-duty Emissions Reduction Grants:** The Ohio EPA provided matching grants of $50,000 to $2 million for the replacement or repower of medium- and heavy-duty diesel fleets with clean diesel or alternative fuels (natural gas, propane, hybrid electric, or all-electric vehicles) and equipment. $15 million was available, and projects required at least a 25 percent match of funds, with larger matches required for some project categories. The next series of grants will begin

in June 2019, and the terms are expected to be similar. The program is funded out of Ohio's share of the Volkswagen Environmental Mitigation Trust (Ohio EPA n.d.).

- **Alternative-fueling Infrastructure Incentive:** The Ohio Development Services Agency (DSA) administers the Alternative-fuel Transportation Program, which provides financial assistance to businesses, nonprofit organizations, school districts, and local governments for the purchase and installation of alternative fueling, blending, and distribution facilities or terminals. Low-interest loans are available through the program, and loan amounts vary depending on the project and can be from $250,000 up to $750,000 for up to 75 percent of total eligible project costs (Ohio DSA n.d.).
- **AFV Conversion Grant Program:** The Ohio EPA is administering a one-time $5 million grant program to replace or convert large diesel or gasoline trucks to CNG, LNG, or propane. Maximum grant awards will be 50 percent of the fuel components of the new vehicle or 50 percent of the cost of the conversion parts, up to $25,000. Total grants to any recipient may not exceed $400,000 (Ohio EPA n.d.).
- **AFV Emissions Inspection Exemption:** Vehicles powered exclusively by electricity, propane, or natural gas are exempt from state motor vehicle emissions inspections after receiving a one-time verification inspection (State of Ohio n.d.c).
- **NGV Weight Exemption:** In Ohio, NGVs can exceed state weight restrictions by not more than 2,000 pounds (State of Ohio n.d.j).

Utility Incentives

- **Propane Vehicle and Mower Rebate:** The Ohio Propane Gas Association (OPGA) provides rebates of $1,000 to customers for the purchase of new U.S. EPA-approved propane vehicles or mowers (OPGA n.d.).
- **EVSE Lease Pilot Program—FirstEnergy:** FirstEnergy residential customers can lease an EVSE for a monthly rate of $39.99 for three years. Included in the lease is the installation of the EVSE and a repair or replacement guarantee for the life of the agreement (FirstEnergy n.d.).
- **Commercial EVSE Incentive Program—AEP Ohio:** AEP Ohio offers financial incentives for the hardware, network services, and installation of EVSE for DC fast-charging stations, with incentives up to $100,000 available to local governments for DC fast chargers, up to $30,000 available for workplace chargers, and up to $45,000 available to multifamily complexes (AEP n.d.).

Laws and Regulations

- **AV Testing and Operation Requirements:** The Office of the Governor in Ohio created a pilot program to promote the safe testing of AVs in select municipalities across Ohio. The program is part of DriveOhio, Ohio's center for smart mobility. All AVs tested in Ohio must have a designated operator responsible for the safe operation of the vehicle while in use and in compliance with all traffic laws and regulations, among other requirements (DriveOhio n.d.).
- **Alternative-fuel Signage:** The Ohio Turnpike Commission allows businesses to place their logos on directional signs within the right-of-way of state turnpikes. An alternative fuel retailer may include a marking or symbol within their logo indicating that it sells one or more types of alternative fuel (State of Ohio n.d.a; State of Ohio n.d.b).

- **AFV Acquisition and Fuel-use Requirements**: All newly acquired state agency vehicles, with exception of law enforcement, must be capable of using an alternative fuel and must use the relevant alternative fuel if it is reasonably priced and available. Alternative fuel is defined as E85, fuel blends containing at least 20 percent biodiesel, natural gas, propane, hydrogen, electricity, or any other fuel that the U.S. DOE has determined is substantially not petroleum. State agencies must also meet the annual average fuel economy requirement set by the Ohio DSA on all passenger automobiles purchased. The Office of the Ohio Treasurer established a biodiesel revolving fund in which funds appropriated by the Ohio General Assembly can be used to pay for the incremental cost of biodiesel used in state-owned or leased diesel vehicles. (State of Ohio n.d.b, State of Ohio n.d.c, State of Ohio n.d.d), State of Ohio n.d.e, State of Ohio n.d.f, State of Ohio n.d.g).
- **LNG Measurement:** For the sake of policy, one gallon of LNG is the equivalent of one gallon of motor fuel (State of Ohio n.d.h, State of Ohio n.d.i).

Pennsylvania

Pennsylvania is one of the most significant states in understanding energy. This is in part due to the abundant natural resources present in the state, including the Marcellus Shale, the nation's largest gas field. As such, it ranks as one of the nation's top producers of natural gas. The state has also been one of the leading producers of coal for nearly 200 years (Ladislaw and Hyland 2018). While the auto industry plays a much smaller role in the state's economy and state tax revenue than it does in a state like Michigan the state has also been a leader in energy policy (Alliance of Automobile Manufacturers 2019a; Alliance of Automobile Manufacturers 2019f). Despite the abundance of fossil fuels, Pennsylvania was one of the first state to advance an alternative energy portfolio standard was also one of only three states in 2015 with grant programs for renewable energy at the state, utility, local, and private program levels (Ladislaw and Hyland 2018; Ballotpedia n.d.b).

One of Pennsylvania's clean fuel efforts began in 2012, when Gov. Tom Corbett signed Act 88 into law. Act 88 permitted public-private partnerships (P3s) for transportation projects, and had numerous supporters, including Pennsylvania Department of Transportation (PennDOT) then-secretary Barry Schoch (PennLive Editorial Board 2012). At the time of signing, over 30 other states already permitted such partnerships (Finizio and Stewart 2013). The law also established the Public-Private Transportation Board (P3 board), which included members from various state offices, as well as nominees from the legislature and governor (Commonwealth of Pennsylvania 2012). Projects approved by the board would allow PennDOT to design unique agreements with private companies to determine delivery, revenue sharing, financing, operation, and maintenance of projects (Finizio and Stewart 2013). Public-private partnerships were not new to the state of Pennsylvania; they had already been discussed as means to help fund state parks and transportation shortages; however, many felt that the standard procurement process had many disadvantages, including slow project delivery, suboptimal risk distribution, and the need for public funding—P3's were seen as the solution to these issues (Currie 2011; Associated Press 2011; PennDOT n.d.b).

On September 29, 2014, the P3 board approved a project seeking a private partner for the development of CNG fueling stations. The stations would be available to various transit agencies across the state, and some would also allow public access (PennDOT 2014). Over the next couple of years, the board received numerous applications, held industry forums, and reviewed potential partners (PennDOT n.d.b). On June 16, 2016, Trillium CNG was selected by the P3 board as the private partner for the CNG Fueling for Transit Agencies Partnership Project (PennDOT 2016).

In April of 2017, less than one year after the contract was approved, Trillium had already opened its first CNG fueling location, and more sites were in development (AJOT 2017). The following case study discusses how Trillium's contract with PennDOT, under P3 legislation, serves as an example of how the private and public sectors can work together to accelerate the use of clean fuels statewide. The case study will also outline contract details, such as timeline, funding mechanisms, and benefits to the state.

Case Study: Pennsylvania's Public-private Partnership in Support of Natural Gas Fuel Infrastructure

Pennsylvania is expanding CNG infrastructure across the state, and they are using a public-private partnership to do it.

In 2016, PennDOT awarded a 20-year, $84.5 million contract to Trillium CNG to design, build, finance, operate, and maintain 29 CNG facilities across the state. Seven of the 29 stations will have public access dispensers to fuel vehicles of all types, including heavy-duty trucks, while the other 22 locations will supply CNG to more than 1,600 CNG buses at transit agencies across the state (PennDOT 2014). CNG is less expensive than conventional gas and diesel fuel, and PennDOT estimates that transit agencies that use CNG could save an estimated $10 million annually (Gilroy 2016.)

The project differs from traditional public infrastructure projects due to its structure. In July 2012, Pennsylvania passed legislation that allows public entities to enter into agreements with a private party (a public-private partnership) to develop transportation facility projects, and PennDOT established an Office of Public-Private Partnerships. While governments typically finance and maintain key infrastructure, they turn to the private sector through a competitive bidding process for the construction and/or the engineering and construction of infrastructure. In this case, PennDOT is contracting with Trillium to design and build but also finance, operate, and maintain CNG stations for the next 20 years.

PennDOT sites a number of benefits to this approach. According to PennDOT estimates, the P3 agreement will result in cost savings of more than $46 million by allowing PennDOT to install the fueling stations faster than if traditional procurement mechanisms were used (PennDOT 2016). Trillium is also financing the project, providing $25 million up front that the state will pay back over the next five years. Under the contract, PennDOT will also receive a 15 percent royalty, excluding taxes, for each gallon of fuel sold to the public. PennDOT officials also site the potential long-term benefits to the state, which is believed to have a 100-year supply of natural gas (Murphy 2016).

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **Medium- and Heavy-duty Vehicle Rebates:** The Pennsylvania Department of Environmental Protection (DEP) is offering $30 million in rebates over five years for the replacement or repowering of local freight trucks and port drayage trucks and school and shuttle buses. Qualified trucks (classes four to seven, with model years from 1992–2009) and buses (model years 2009 and older) are eligible for rebates for replacement or repowering with new diesel, electric, or AFV or technologies. Rebates are for up to 100 percent of total project cost, with municipalities being eligible for 100 percent rebates and other government and nonprofit entities eligible for lower amounts. The rebate program is funded by Pennsylvania's portion of the Volkswagen settlement (DEP n.d.a).
- **Heavy-duty Truck and Transit Bus Grants**: DEP is also providing $16 million in competitive grants over five years for the replacement or repowering of heavy trucks and transit buses (DEP n.d.a).
- **EVSE Rebates**: DEP offers rebates for the acquisition, installation, operation, and maintenance of EVSE, with the rebates differing by access and public or private ownership. Approximately $7.7 million is being allocated over a five-year period to fund a rebate program for the installation of EVSE (DEP n.d.a).

EXHIBIT 6. EVSE Rebates—Pennsylvania

Project Type	Maximum Reimbursement: Government-owned Property	Maximum Reimbursement: Nongovernment-owned Property
Public Access, Networked	$5,000 per plug or up to 100% of total project costs	$5,000 per plug or up to 80% of total project costs
Public Access, Non-networked	$5,000 per plug or up to 90% of total project costs	$5,000 per plug or up to 70% of total project costs
No Public Access	$4,000 per plug or up to 60% of total project costs	$4,000 per plug or up to 60% of total project costs

- **EVSE and Hydrogen Fuel Cell Infrastructure Grants**: DEP is offering $10 million in competitive grants over five years for the acquisition, installation, operation, and maintenance of publicly available DC fast-charging equipment and hydrogen fueling infrastructure. Grants are awarded after project completion for up to $500,000 or a percentage up to 75 percent of the cost of the DC fast-charging and hydrogen refueling station (DEP n.d.c).
- **The Alternative Fuels Incentive Grant (AFIG) Program**: The AFIG Program provides financial assistance for innovative, advanced fuel and vehicle technology projects. Eligible applicants include school districts, municipal authorities, political subdivisions, nonprofits, corporations, and limited-liability companies or partnerships, as well as projects that result in product commercialization and the expansion of Pennsylvania companies. Projects can include:
    - Incremental cost expenses relative to retrofitting vehicles to operate on alternative fuels
    - Incremental cost expenses to purchase vehicles to operate on alternative fuels
    - The cost to purchase and install the necessary fleet refueling or home-refueling equipment
    - The cost to perform research, training, development, and demonstration of new applications or next-phase technology related to AFVs (DEP n.d.b)
- **Pennsylvania FAST Act Alternative-fuel Corridor Infrastructure**: A special grant under the AFIG program provides reimbursement grants for the installation of alternative-fuel infrastructure along Pennsylvania interstate highway corridors. Grants are available for reimbursement of 50 percent of the cost, up to $500,000, to install public electric, hydrogen, propane, and CNG fueling infrastructure. Eligible applicants include Pennsylvania municipal authorities, political subdivisions, nonprofit entities, corporations, and limited-liability companies or partnerships (DEP n.d.b).
- **AFV Rebate:** The AFV rebate assists eligible residents with the incremental cost of the purchase or lease of new AFVs, including electric, plug-in electric, hydrogen fuel-cell electric, natural gas, and propane vehicles. Eligible vehicles must have a total purchase price not exceeding $60,000. An additional $500 rebate is available for low-income applicants. Rebates are available in the following amounts (DEP n.d.a).

EXHIBIT 7. AFV Rebates—Pennsylvania

Vehicle Type	Requirement	Rebate Amount
EV, PHEV, electric motorcycle, and low-speed EV	Battery capacity greater than or equal to 85 kWh	$2,000
	Battery capacity less than 85 kWh and equal to or greater than 30 kWh	$1,750
	Battery capacity greater than or equal to 10 kWh and less than 30 kWh	$1,000
Hydrogen fuel-cell electric vehicles	OEM or certified retrofit	$2,000
Natural gas and propane vehicles	OEM or certified retrofit	$1,000
One-time, pre-owned AFV	75,000 miles or less	$750

- **Alternative-fuel and Idle-reduction Grants**: The Small Business Advantage Grant Program provides matching grants of 50 percent, up to $9,500, to enable a Pennsylvania small business to adopt or acquire energy-efficient or pollution prevention processes or equipment, and Pennsylvania trucking companies and independent truckers may use the funding to purchase U.S. EPA SmartWay-verified anti-idling technologies (DEP n.d.d).
- **Idle-reduction and NGV Weight Exemption**: A vehicle equipped with qualified idle-reduction technology may exceed the state's gross and axle weight limits by up to 400 pounds to compensate for the additional weight of the idle-reduction technology (Pennsylvania Statutes, n.d.a).

Utility Incentives

- **PEV Incentive**: PECO provides rebates of $50 to residential customers who purchase a new, qualified PEV (PECO n.d.).
- **Commercial EVSE Incentive Program**: Duquesne Light Company (DLC) offers rebates to commercial customers for the installation of publicly available EVSE. Rebates are available for 100 percent of make-ready installation costs, up to $32,000 per site (Duquesne Light Company n.d.).
- **PEV Credit**: DLC offers a one-time bill credit of $60 to residential customers who purchase or lease a PEV (Duquesne Light Company n.d.).
- **EV Rebate**: Current employees and customers of DLC can receive a $3,500 rebate for the purchase of a new 2019 Nissan Leaf or a $2,500 rebate for the purchase of a new 2019 Nissan Leaf Plus (Duquesne Light Company n.d.).

Laws and Regulations

- **CAV Regulations and Committee**: PennDOT and Pennsylvania Turnpike Commission authorizes the locations to deploy and test CAVs. PennDOT established the Highly Automated Vehicle Advisory Committee to advise PennDOT on best practices, policies, and research and development (Commonwealth of Pennsylvania 2017).
- **State PEV Acquisition Requirements:** Pennsylvania state agencies must replace 25 percent of their passenger car fleets with PEVs by 2025, and agencies must collectively reduce all energy consumption by 3 percent annually, with a 21 percent reduction from a 2017 baseline by 2025 (Wolf 2019).
- **Renewable Fuels Mandate:** Pennsylvania established state requirements mandating gasoline to contain an increasing percentage of biofuel based on the state production of biofuel. As the state reaches new levels of biofuel production, the mandate increases (Pennsylvania Statutes, n.d.b).

- **Low-emission Vehicle Standards:** The Pennsylvania Clean Vehicles Program requires that all new passenger cars and light-duty trucks sold, leased, titled, or registered in Pennsylvania must meet California motor vehicle emissions and compliance requirements specified in Title 13 of the California Code of Regulations (PennDOT n.d.a).
- **Idle-reduction Requirement:** Diesel vehicles with a gross vehicle weight rating over 10,000 pounds may not idle for more than five minutes in any continuous 60 minute period (Pennsylvania Statutes n.d.c).
- **Alternative-fuels Vehicle Tax**: Alternative fuels used to propel vehicles of any kind on public highways are taxed at a rate determined on a gasoline gallon equivalent basis (Pennsylvania Statutes, n.d.d.).

Texas

Texas is an important state in almost all national conversations about energy. It is the leading producer of crude oil, natural gas, and electricity in the country, as well as the top state for carbon dioxide emissions. Texas is also in the top ten states for coal production and total energy consumption per capita, and regularly leads the nation in renewable energy generation (U.S. EIA 2019). Despite employing less of the state's workforce, the auto industry contributes a similar amount of state tax revenue in Texas as it does in Michigan, 8 percent to 10 percent (Alliance of Automobile Manufacturers 2019a; Alliance of Automobile Manufacturers 2019g). The state is also home to over 1,700 automaker facilities and has experienced over 15 percent growth in automotive manufacturing since 2014 (EDT n.d.). From an energy and automotive perspective, the development in Texas is some of the most important in the country.

One of Texas' programs for promoting AFVs is a rebate program for their purchase, managed by the Texas Commission on Environmental Quality (TCEQ). The program is funded by the Texas Emissions Reduction Plan (TERP), which was passed by the state legislature in 2001. The plan is regularly renewed as a way of reducing emissions from motor vehicles, particularly in areas that are out of compliance with National Ambient Air Quality Standards (Texas Commission on Environmental Quality 2019). When states exceed these standards, they must develop and follow state implementation plans and implement additional permitting for industrial facilities (Freer 2019). Texas businesses have generally been supportive of TERP-funded programs because the reduction of mobile emissions like smog and ozone reduces their regulatory burden (Sadasivam 2018).

The TERP-funded rebate for the purchase or lease of new AFVs is one way of trying to lower vehicle emissions. There used to be a similar incentive program offered in Texas, but it ended in 2015 (Mosier 2018). With vehicle emissions responsible for about half of the state's total emissions, an emission-reduction plan would not be complete or thorough without some sort of transportation component (Rapaport 2018). Considering this, the new rebate program began in 2018. The rebate program applies to a wide range of alternative fuel vehicles, in part because pickup trucks and heavier, nonelectric alternative fuel vehicles are simply too big a market in the state to exclude (Ganz 2018). Price is a significant barrier when it comes to the purchase of AFVs, however, and this rebate is a way to reduce this barrier and incentivize the purchase of these lower-emissions vehicles.

Texas is a national leader when it comes to energy and the automotive industry, and as such, so are its policies. Since its inception, TERP has consistently been a subject of debate amongst Texas legislators as they decide how much funding to allocate toward its programs. The number of rebates offered in Texas is still relatively low, but determining how to allocate funds among a wide range of AFVs is crucial for successful implementation of the program.

Case Study: Alternative Fuel Vehicle Purchase and Lease Incentive

The TCEQ's rebate program for the purchase or lease of new AFVs across Texas is intended to encourage greater use of these vehicles and thereby stimulate the market for those vehicles and fuels in Texas. The TCEQ implements the grant program at the behest of the state legislature in line with the TERP, and the increased use of these vehicles may have positive impacts on air quality in the state (Richardson 2018). The program is similar to a previous program that ended in 2015 (Mosier 2018).

The incentive is limited to light-duty vehicles, and it includes the following alternative-energy sources: CNG, liquefied petroleum gas (LPG), propane, hydrogen, or electricity. CNG, LPG, and propane vehicles are eligible for a rebate of $5,000. Electric drive vehicles powered by a battery or hydrogen fuel cell, including PHEVs with a battery capacity of at least four kilowatt hours, are eligible for a rebate of $2,500. Funding is limited to the first 1,000 applicants for CNG and LPG and the first 2,000 for electric drive or hydrogen fuel-cell vehicles. Eligible applicants include individuals, corporations, organizations, governments or governmental subdivisions or agencies, business trusts, partnerships, associations, or any other legal entity (State of Texas n.d.a).

Funding for this and other TERP programs is allocated on a biennial basis from the Texas Emissions Reduction Plan Account 5071, established by the state legislature in 2001. The fund is comprised of certificate of title fees, commercial motor vehicle registration and inspection fees, and surcharges on the sales and use tax for on-road and off-road heavy-duty diesel vehicles and equipment. The most recent funding allocation provides $7.3 million for the program from September 2018 through May 2019 or until all funds are awarded (Richardson 2018).

The program is limited to vehicles sold in Texas. Since Texas law requires all vehicles to be sold through dealerships, this prevents customers of some EV manufacturers, such as Tesla, from participating in the program, since Tesla sells their automobiles directly to consumers online and not through dealerships (Richardson 2018; Takahashi 2019).

Overview of Alternative Fuel Policies and Incentives

State Incentives

- **Light-duty AFV Rebates:** Texas provides incentives for the purchase or lease of new light-duty vehicles powered by CNG, propane, hydrogen, or electricity. CNG and propane vehicles are eligible for a rebate of $5,000 for the first 1,000 applicants. EVs powered by a battery or hydrogen fuel cell, including PHEVs with a battery capacity of at least four kilowatt hours, are eligible for a rebate of $2,500 for the first 2,000 applicants (State of Texas n.d.a).
- **NGV Grant:** The NGV Grant Program provides grants to replace existing medium- and heavy-duty vehicles with new, converted, or repowered natural gas or propane vehicles (State of Texas n.d.a).
- **Clean Vehicle and Infrastructure Grants**: As part of the TERP, the Emissions Reduction Incentive Grants Program provides grants for various types of clean air projects to improve air quality in the state's nonattainment areas and other affected counties. Eligible projects include those that involve replacement, retrofit, repowering, or lease or purchase of new heavy-duty vehicles; alternative fuel dispensing infrastructure; idle reduction and electrification infrastructure; and alternative-fuel use. Qualifying projects must reduce emissions of nitrogen oxides or other pollutants by at least 25 percent as compared to baseline levels and must meet operational and fuel usage requirements. (State of Texas n.d.a).

- **Clean Fleet Grants**: The Texas Clean Fleet Program provides grants to owners of fleets containing diesel vehicles to permanently remove the vehicles from the road and replace them with AFVs or HEVs. An entity that operates a fleet of at least 75 vehicles and commits to placing 20 or more qualifying vehicles in service for use in an 83 county clean transportation zone may be eligible. Qualifying AFV or HEV replacements must reduce emissions of nitrogen oxides or other pollutants by at least 25 percent as compared to baseline levels and must replace vehicles that meet operational and fuel usage requirements (State of Texas n.d.a).
- **Clean School Bus Program**: Any school district or charter school may receive a grant through the TCEQ to pay for the incremental costs to replace school buses or install other emission-reduction technologies in school buses. Funds may also be used to purchase qualifying fuels, including any liquid or gaseous fuel or additive registered or verified by the U.S. EPA (other than standard gasoline or diesel) that provides particulate matter emission reductions (State of Texas n.d.a).
- **Clean Vehicle Replacement Vouchers**: The AirCheckTexas Drive is a Clean Machine program managed by the TCEQ, provides vehicle replacement assistance for qualified individuals owning vehicles registered in participating counties. Vouchers in the amount of $3,500 are available toward the purchase of a hybrid electric, battery electric, or natural gas vehicle that is up to three model years old (State of Texas n.d.c).
- **Diesel Fuel Blend Tax Exemption**: The biodiesel or ethanol portion of blended fuel containing taxable diesel is exempt from the state's diesel fuel tax (State of Texas n.d.d).
- **Idle-reduction Weight Exemption**: Any motor vehicle equipped with qualifying idle-reduction technology may exceed the state's gross vehicle weight limits by up to 400 pounds to compensate for the additional weight of the idle-reduction technology. To be eligible for the weight exemption, the vehicle operator must be able to provide proof that the idle-reduction technology is fully functional (State of Texas n.d.e).
- **NGV Weight Exemption**: NGVs may exceed the maximum gross vehicle weight limit equal to the difference of the weight of the natural gas tank and fueling system and the weight of a comparable diesel tank and fueling system (State of Texas n.d.f).

Utility Incentives

- **PEV Charging Rate Incentive:** Austin Energy, the municipal utility for the City of Austin, offers a pilot time-of-use charging rate to residential customers with PEVs and EVSE (Austin Energy n.d.). CPS Energy also provides a charging rate incentive.
- **EVSE Incentive:** PEV owners in the Austin Energy service area may be eligible for a rebate of 50 percent of the cost to purchase and install an EVSE, up to $1,200 (Austin Energy n.d.).
- **Workplace EVSE Rebate:** Austin Energy offers a rebate for commercial customers to install approved EVSE at workplaces. Austin Energy provides a rebate of 50 percent of the cost to install approved level-one or level-two EVSE, up to $4,000, and provides rebates up to $10,000 to workplaces that install a DC fast charger (Austin Energy n.d.).
- **Multi-unit Dwelling EVSE Rebate:** Austin Energy also offers a 50 percent rebate up to $4,000 for multi-unit dwellings to install approved EVSE for use by all residents (Austin Energy n.d.).
- **NGV and Fueling Infrastructure Rebates:** The Texas Gas Service Conservation Program offers a rebate of up to $2,000 for the purchase of a qualified NGV or $3,000 for the conversion of a gasoline-powered vehicle to operate on natural gas.

- **Propane Vehicle and Equipment Incentive:** The Propane Council of Texas provides an incentive equal to the incremental cost, up to $7,500, for new dedicated propane vehicles and aftermarket conversions (Propane Council of Texas n.d.).

Laws and Regulations

- **Support for Automotive Vehicle Testing and Operation:** Texas state agencies must support the testing and operation of AVs if the driving system complies with state and federal laws and is equipped with a recording device.
- **Authorization of Governmental Alternative Fuel Fleet Grant Program:** The TCEQ provides grants for the purchase or lease of a new vehicle and the purchase, lease, or installation of alternative fueling equipment for government agencies. Eligible alternative fuels include natural gas, propane, hydrogen, and electricity.
- **Alternative Fuel Use and Vehicle Acquisition Requirements**: State agency fleets with more than 15 vehicles, excluding emergency and law enforcement vehicles, may not purchase or lease a motor vehicle unless the vehicle uses natural gas, propane, ethanol, or fuel blends of at least 85 percent ethanol; methanol or fuel blends of at least 85 percent methanol; biodiesel or fuel blends of at least 20 percent biodiesel; or electricity (including PHEVs). Covered state agency fleets must be least 50 percent vehicles that are able to operate on alternative fuels and use these fuels at least 80 percent of the time the vehicles are driven (State of Texas n.d.g).
- **Provision for Establishment of Hydrogen Program**: The Texas Department of Transportation may seek funding from public and private sources to acquire and operate hydrogen vehicles and establish and operate publicly accessible hydrogen fueling stations (State of Texas n.d.h).
- **Idle-reduction Requirement**: Vehicles may not idle for more than five minutes from April through October in cities and counties where the local government has signed an MOU with TCEQ. Certain vehicles are excluded, including emergency and law enforcement (State of Texas n.d.c).
- **Natural Gas Tax**: CNG and LNG dispensed into a motor vehicle is taxed at a rate of $0.15 per gasoline gallon equivalent or diesel gallon equivalent (State of Texas n.d.d).
- **Propane and Natural Gas Licensing and Safety**: The Railroad Commission of Texas regulates the safety of the natural gas and propane industries, and any business that engages in propane or natural gas activities in Texas must be licensed (State of Texas n.d.b).

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