Center for Transportation and the Environment's Response to the Select Committee on the Climate Crisis's Request for Information

Background:

The Center for Transportation and the Environment (CTE) is a nonprofit, member-based organization whose mission is to improve the health of our climate and communities by bringing people together to develop, commercialize and implement clean, efficient, and sustainable transportation technologies. Since 1993, CTE has worked with federal, state, and local governments to improve the efficiency and sustainability of the United States' transportation and energy systems. CTE works at every stage of the technology development process, from fundamental prototyping and development to full fleet transition and operations planning. CTE helps companies introduce their products into the market and supports end users deploying new transportation technologies. Currently, CTE is involved with 60 active deployment projects, 29 prototype development and demonstration projects, and 10 fleet transition projects. These 99 projects span 30 states and represent medium- and heavy-duty zero-emission vehicles including transit buses, delivery vans, and trucks. CTE estimates that collectively, these projects have reduced CO_2 emissions by more than 4,703,550 tons.

Response:

The transportation sector accounts for 29% of the total greenhouse gas (GHG) emissions in the US with more than 23% of the emissions in this sector attributed to the medium- and heavy-duty vehicle markets (EPA, 2019). Medium- and heavy-duty trucks, however, represent only 4% of the total US vehicle fleet, indicating medium- and heavy-duty vehicles emit more than seven times the GHG's of light-duty vehicles on a per-vehicle basis. As such, implementing policies to decarbonize these highest-emitting vehicles presents a significant opportunity for Congress to make a substantial impact on reductions in the nation's GHG emissions.

Our response to the Committee's Request for Information includes the following policy suggestions for the medium- and heavy-duty vehicle markets:

What policies should Congress adopt to decarbonize the transportation sector consistent with meeting or exceeding net-zero emissions by mid-century?

1. Improve and Expand the Federal Transit Administration's (FTA) Low or No Emission Vehicle (Low-No) Program – 5339(c).
    a. Increase the funding available for the program and extend its availability beyond FY2020.
    b. Create minimum funding levels for individual awards made through the Low-No Program.
    c. Allocate specific funding amounts from the program in support of battery electric projects as well as fuel cell electric bus projects.
    d. Revise program guidelines to encourage applicants to complete a Fleet Transition Plan as a pre-requisite to requesting funding for vehicles; the

Fleet Transition Plan should be eligible for funding under the Low-No Program.

e. Continue to encourage and fund technical assistance as part of the Low-No Program.

2. Consider a national policy similar to the California Air Resources Board's Innovative Clean Transit regulation requiring all transit agencies to convert their entire bus fleet to zero-emission vehicles by 2040.

3. Consider a national policy to encourage or require all US airports in non-attainment areas to convert to zero-emission ground support equipment and to allow only zero-emission buses, zero-emission taxis, and zero-emission ride sharing service vehicles to provide on-site service, or promote their ability to serve airports via priority lanes.

What policies should Congress adopt to ensure that the United States is a leader in innovative manufacturing clean technologies; creating new, family-sustaining jobs in these sectors; and supporting workers during the decarbonization transition?

1. Congress should create a focused research program around prototype development and demonstration of zero-emission medium- and heavy-duty vehicles.
   a. Include automated vehicle research for transit applications within medium- and heavy-duty vehicle research program(s) to dramatically increase vehicle efficiency and range, enable the US to become a leader in this emerging market, and create a new base for US jobs.
   b. Spur development of domestic capabilities in zero-emission technology and manufacturing through a non-profit led consortia defense research program.

These ideas are described in more detail in the following pages.

What policies should Congress adopt to decarbonize the transportation sector consistent with meeting or exceeding net-zero emissions by mid-century?

1. **Improve and Expand FTA's Low or No Vehicle (Low-No) Emission Program 5339(c).**

   a. **Congress should dramatically increase the funding for FTA's Low-No Program and extend its availability beyond FY2020.**

   FTA's Low-No program is a competitive grant program that effectively covers the incremental cost between a bus with standard propulsion technologies and a bus with zero-emission, electric-drive propulsion technologies. The transit bus industry in the US stands ready to be the first fleet market to make a complete transition to zero emissions. As a result of the California Air Resources Board's Innovative Clean Transit (ICT) Regulation, transit operators in California are

required to convert their entire bus fleet to zero emission by 2040. Some agencies have committed to the transition as early as 2030. Although California has mandated this fleet transition, the number of transit agencies outside of California pursuing transitions to zero-emission fleets is growing as well, reflecting the growing interest in zero-emission buses across the US.

FTA's Low-No program is a powerful tool providing valuable and needed support to transit operators deploying zero-emission buses (ZEBs). While ZEBs are commercially available, they cost more than diesel, hybrid, or compressed natural gas (CNG) buses, and require significant investment in charging or fueling infrastructure. However, ZEBs will accrue operational savings with lower maintenance costs and potentially lower energy costs, depending on their local utility rates. In addition to operating savings, ZEBs eliminate harmful emissions that are the leading cause of lung disease and contribute to climate change. The Low-No program provides vital support to help transit agencies offset the incremental capital costs of ZEBs. Increasing the availability of this funding will dramatically increase the number of ZEBs that are placed into passenger service.

The Low-No program has been vastly oversubscribed since becoming a capital program. In FY2019, $85 million was available in competitive funding through the Low-No Program. FTA received a total of 155 applications requesting $498 million in federal funds, leaving a gap of $413 million gap compared to what the industry requested (FTA, 2019). These numbers provide solid evidence that transit operators want these vehicles in numbers that well exceed FTA's current ability to fund them.

The US transit market is poised to make a complete transition to ZEBs, and serves as a model for all other medium- and heavy-duty vehicle markets in their transition to zero-emission fleets. Programs and policies supportive of these transitions will enable the US transportation sector to dramatically reduce carbon emissions.

b. Congress should create minimum grant awards for individual projects awarded through FTA's Low-No Program.

Minimum grant awards will help increase the effectiveness of ZEB deployments. For the ZEB market to be viable, transit agencies need to initiate their fleet transition with more than just one or two buses. Small bus deployment projects are more likely to fail because agency staff do not invest the time required to train staff to operate and maintain one new technology bus, particularly if they are able to complete service without deploying the new technology. CTE experience has shown that transit agencies need to start with at least five buses to properly initiate the transition to zero emission.

The following is a suggested minimum award amount for battery electric bus projects funded through the Low-No Program:

- Minimum Project Size: **5 buses**
- Minimum Federal Share: **$3 million**

This assumes:

- The agency uses federal funds (i.e., 5307, 5311, etc.) and 20% local cost share for base cost of the bus, and applies Low-No funds and 15% local cost share to the incremental cost difference for the zero-emission technology
- Project management and technical assistance is allowed with 100% federal funding
- Infrastructure equipment, design, construction, and installation are eligible for Low-No funding at 90% with 10% local cost share

*** Note:** these federal/local share requirements are consistent with the current Low-No program

The total project budget would be approximately $5.7 million as follows:

- Low-No **$3.0 million**
- 5307/5311 (or other federal funds) **$1.8 million**
- Local Match **$0.9 million**

c. Congress should prescribe specific funding amounts within FTA's Low-No Program in support of battery electric bus projects and fuel cell electric bus projects.

Fuel cell electric buses (FCEB) are expected to maintain a sizeable market share in the ZEB future due to infrastructure cost and operational advantages at scale. However, current zero-emission deployments are predominantly battery electric buses (BEB) in spite of their range and weight limitations. FCEBs address these issues with a proven range of up to 300 miles and a significant reduction in vehicle weight, enabling transit agencies to maximize passenger loads. FCEBs are more likely to allow for a 1:1 replacement of conventional buses (compared with BEBs), enabling greater flexibility for route planning and operations. The FCEB sector of the ZEB market is currently less developed and would benefit from mandated allocations to the technology available through the Low-No Program.

Providing mandated funding amounts by technology is also important because FCEB projects will have considerably higher infrastructure costs per bus in smaller deployments compared with BEB projects. If the technologies are evaluated side-by-side on a single project basis, FCEB projects will likely score lower in cost-related categories. That cost differential is largely neutralized with FCEB deployments at scale. Similar to CNG fueling infrastructure, there is a

relatively small cost differential between a hydrogen fueling station to support five FCEBs compared to 50 FCEBs.

The following should be the minimum allocations by technology under the Low-No Program:

- 70/30 split BEB/FCEB; for example - for a $400 million program, $280 million would be allocated to BEB projects and $120 million would be allocated to FCEB projects
- All FCEB awards should include station capacity to fill a minimum of 50 buses
- Minimum of four FCEBs per project

d. Congress should encourage and fund Fleet Transition Plans as a pre-requisite to a request for deployment funding.

ZEB fleet transition planning is critical to understanding and managing the challenges associated with deploying zero-emission technologies into transit revenue service. Advances in zero-emission technology are occurring rapidly. This affects an agency's ability to plan for fleet improvements and procurements as well as facility upgrades. Deploying zero-emission buses at scale will impact an agency's service, operations, and maintenance, as well as the facilities where the vehicles are maintained and fueled. Planning is necessary to determine the appropriate technology required that allows transit agencies to provide a consistent level of service. Options include: BEBs supported by depot and/or on-route charging, FCEBs, or a fleet comprised of both BEBs and FCEBs. Planning is also required to define infrastructure improvement projects, including major utility upgrades, changes to maintenance and operations schedules, and other associated costs to support zero-emission bus procurement and deployment. Planning studies help provide transit agencies with a roadmap to support a successful transition to zero-emission technology by identifying selected technologies, necessary facility and infrastructure improvement projects and the associated schedules, a bus procurement schedule, and training.

e. Congress should continue to encourage and fund technical assistance as part of the Low-No Program.

Technical assistance is crucial for the success of ZEB deployments. The lack of industry experience with low or no emission buses can result in challenges for transit agencies unfamiliar with zero-emission technology, as there are specific operating characteristics and charging/fueling requirements associated with the deployment of these vehicles. Technical support helps reduce deployment risks, maximize service efficiency, and minimize operating costs. This type of support is particularly valuable for transit agencies with limited experience in zero-emission technology, but it can also prove valuable to agencies with more experience in the ZEB market. There will also be new planning challenges, as

transit agencies transition to deployments at scale, that should be addressed prior to these deployments. Such challenges include space required for charging, handling demand charges, and battery degradation over time.

2. **Congress should consider a policy requiring all transit agencies to transition to zero tail-pipe emission fleets within a specified time frame.**

The California Air Resources Board (CARB) unanimously voted to require all newly purchased public buses in California to be carbon-free by 2029, which in turn would phase out all diesel or natural-gas-powered buses by 2040. According to CARB, the Innovative Clean Transit Regulation is "expected to reduce greenhouse gas emissions by nearly 21 million tons from 2020 to 2050—the equivalent of taking four million cars off the road" (California Air Resources Board, 2018).

Nearly 70,000 transit buses are in service in the US and more than 60% of these buses run on diesel. If all of the diesel-powered transit buses in the US were replaced with zero-emission buses by following California's regulation in some way, more than two million tons of greenhouse gas emissions could be saved per year (Miller, Kim, Robinson, & Casale, 2018). Some parts of the US will have a more difficult transition due to colder climates that impact battery range. Congress should work with FTA to help develop strategies that mitigate the increased risks of deploying zero-emission technologies in extremely cold climates. These strategies could include the use of diesel-fired heaters for extremely cold days and adding some flexibility on spare ratios for transit operators located in cold climates.

Fighting climate change will not be easy, and comes at a great cost, but ignoring problems created by continuing with the status quo in the transportation sector is proving even more costly. It is vital to create policy that effectively addresses the challenges; however, such policies cannot be implemented as unfunded mandates. A mandated transition to zero tail-pipe emission fleets will require additional support to cover the current higher upfront capital costs. Legislators must be willing to provide the FTA with higher funding levels. FTA has established the minimum useful life of a bus at 12 years. In 2016, the average age of US public buses was 7.3 years (Hughes-Cromwick, 2018). As current buses meet and/or exceed their useful life, federal financial assistance such as the Low-No program can then be used to replace the buses with ZEBs. The buses are still more expensive and are not yet 1:1 replacements for diesel or CNG, so while the transition is feasible, it will cost more.

3. **Congress should consider a national policy to encourage or require all US airports in non-attainment areas to convert to zero-emission ground support equipment (GSE) and to phase in a plan that will ultimately allow only zero-emission buses, zero-emission taxis, and zero-emission ride sharing service vehicles to provide on-site service, or promote their ability to serve airports via priority lanes.**

Major airports in large cities across the United States are huge contributors to both criteria pollutants and greenhouse gases. While in development, technology options for fueling aircraft are not expected in the near future and thus will require continued reliance on fossil fuels. To help offset pollution inevitably caused by air traffic, airports should focus on a transition to zero-emission vehicles for other airport-related transportation modes with viable zero-emission options.

The most logical first step is to convert all ground support equipment (GSE) to zero emissions. Zero-emission GSE technology is available and it works. Most airport GSE is classified under the sub-category of nonroad vehicles (Airport Cooperative Research Program, 2015). The EPA emissions standards for nonroad vehicles are much less strict (i.e. having much higher allowable emission rates) compared to on-road vehicles. Initiatives to transition GSE fleets to zero-emission will provide immediate and significant emissions reductions.

Airports should also focus on the vehicles that transport passengers to and from the airport. Passenger loading and unloading areas remain highly polluted with hundreds of diesel shuttle buses and thousands of personal vehicles idling around the clock, often under canopies that restrict air flow. Two existing Federal Aviation Administration (FAA) programs—the Airport Zero Emissions Vehicle and Infrastructure Pilot Program and the Voluntary Airport Low Emissions (VALE) Program—provide funding to help address these issues, but these programs should be expanded to encourage increased participation from airports.

Earlier this year, the California Air Resources Board unanimously passed a zero-emission airport shuttle policy, which is a first of its kind in the US. This policy would require that all airport fixed-route shuttle fleets at 13 different California airports transition to 100% zero-emission vehicles by 2035. The policy applies to vans, buses, and similar vehicles that have typical routes of 30 miles or less, and that use a depot site that is within 15 miles of the specific airport (Mulkern, 2019). This policy is estimated to cut 35,000 metric tons of greenhouse gas emissions annually, once fully implemented (Mulkern, 2019). This policy could serve as a model for a national policy of similar scope.

What policies should Congress adopt to ensure that the United States is a leader in innovative manufacturing clean technologies; creating new, family-sustaining jobs in these sectors; and supporting workers during the decarbonization transition?

1. **Congress should create a focused research program around prototype development and demonstration of zero-emission medium- and heavy-duty vehicles, and in particular transit buses.**

The private sector may be reluctant to make investments in emerging technologies in the absence of demonstrated demand for new products. This is problematic in that it inhibits job growth in the US around these technologies, and limits the ability of the US to become a leader in new product development and commercialization.

Support from the federal government to encourage research and development into emerging transportation technology markets can be valuable. A prime example is the story of Proterra, Inc and the Federal Transit Administration's National Fuel Cell Bus Technology Development Program (NFCBP). FTA's NFCBP not only jumpstarted the ZEB market in the United States, but also started a thriving new business and created hundreds of high-tech US jobs. Proterra is an American company founded in 2004 by Dale Hill. Proterra designs and manufactures electric transit buses and electric charging systems. In 2005, Proterra had two employees. They partnered with CTE under FTA's NFCBP to build their first bus, a fuel cell electric bus, designed from the ground up to be zero emission and to support both batteries and fuel cells. CTE and Proterra used NFCBP research funds to build Proterra's first prototype and to demonstrate the bus across the US. Without support from this research program, Proterra would not exist. Today, the company has more than 400 employees located in South Carolina and California, and is the national leader in delivering ZEBs.

However, CTE recognizes the importance of finding ways for the federal government to effectively leverage its limited research funds. A government-supported research-funding program should provide transparency, feedback to the government and public on the demonstrations conducted, and carry a commitment to fiscal and programmatic efficiency. Using a government-industry consortia model to manage such programs is a proven approach to achieve these objectives.

The consortia model offers a number of benefits to both funders and project team members, and results in the most efficient use of federal funds and personnel in advancing program objectives. Consortia led by nonprofit organizations offer an added benefit in that nonprofits are not beholden to stockholders, ensuring an independent and objective perspective. The Department of Defense followed a consortia model with the DARPA Electric and Hybrid Electric Vehicle program and the NFCBP was also administered through a consortia. CTE participated in both programs, and cites them as successful examples of prototype development using a consortia model.

CTE sees a continued need for transportation-related research and development activities for the transit market funded through the federal government that could be administered through a consortia-based program. Automated vehicle research for transit applications within the medium- and heavy-duty vehicle market offers opportunities to increase vehicle efficiency and range. While programs such as the Department of Energy's ARPA-E NEXT-Generation Energy Technologies for Connected and Automated On-Road Vehicles (NEXTCAR) is supporting automated vehicle research and development, to date efforts focused on the zero-emission transit market are limited.

a. **Include automated vehicle research for transit applications within medium- and heavy-duty vehicle research program(s) to dramatically increase vehicle efficiency and range, enable the US to become a leader in this emerging market, and create a new base for US jobs.**

Developing automation capabilities is a costly endeavor for bus manufacturers with an uncertain commercialization horizon, and lack of dedicated funding will likely prolong that timeline and delay recognition of expected benefits, which heightens the importance of additional funding for these types of programs. Transit bus automation has the potential to support ZEB adoption by increasing energy efficiency and reducing capital costs associated with their operation. CTE has supported BEB deployments at more than 20 agencies to date, and has seen up to a 25% battery range reduction just from inefficient acceleration and braking behavior. Even with additional power load requirements for automated driving, automating these functions could significantly improve range. Drivers would still remain behind the wheel to assist passengers, ensure their safety, and be available to take control of the vehicle should the automated driving systems fail for any reason.

Automation would also reduce the number of chargers an agency needs to procure to support their BEB fleet, and furthermore, would also reduce depot storage requirements. Most agencies today procure a charger for every one or two BEBs to avoid having staff manage charging cycles overnight. Automating this process would reduce the number of depot chargers needed, saving agencies between $80,000 and $120,000 per charger. Moreover, automation allows tighter parking arrangements, reducing yard capacity needed to store a fleet. Because BEBs currently lack the range of their diesel or CNG counterparts, agencies cannot replace their legacy vehicles on a one to one basis, often needing to retain more legacy vehicles as spares for contingency. Therefore, automated parking offers even greater benefits to agencies operating in denser urban areas, where real estate is more expensive.

ARPA-E recently released a Request for Information (RFI) pertaining to connected and automated vehicle (CAV) technologies supporting increased energy efficiency across all vehicle platforms. Though the RFI carried no promise of follow-on funding opportunities, it should promote further opportunities to improve energy efficiency and support carbon emissions reduction through CAV development. Financial support from federal agencies would incentivize the light vehicle and trucking industries to focus resources on CAV technology development specifically directed at these outcomes. And finally, it would support similar development in the transit bus industry, where commercial incentives are much lower for doing so.

b. Spur development of domestic capabilities in zero-emission technology and manufacturing through a non-profit led consortia defense research program.

The Department of Defense (DOD) has identified climate change as a significant threat to DOD objectives and operations, however, it has not succeeded in attaining its statutory goals to reduce fossil fuel consumption—reductions that would serve to mitigate climate threats (Capaccio, Dlouhy, & Natter, 2019). For example, only 5.9% of the mandated 7.5% of the

Department's electricity use was from renewable sources in 2018. Likewise, regarding transportation energy specifically, DOD has increased petroleum use by 0.1% and decreased alternative fuel use by nearly 11% from FY 2016 to FY 2018 (Department of Defense, 2018). These trends are particularly concerning given the scale of DOD operational energy consumption of more than 85 million barrels in FY 2018 (Department of Defense, 2019) including consumption from approximately 250,000 vehicles (Amadeo, 2019).

Beyond the environmental benefits, technology development for DOD operations would provide a significant benefit to US technology developers, and US manufacturing. Requirements in the Buy American Act and the Berry Amendment would ensure that firms developing technology, producing alternative fuels, and manufacturing the hundreds of thousands of vehicles DOD needs to reduce carbon emissions would be predominantly US-based. Furthermore, this technology development and production scaling would pave the way for spin-off civilian capabilities that would multiply the environmental benefit of investment in zero-emission technology for DOD applications.

Tactically, reduced dependence on fossil fuels is a benefit for the DOD generally by:

1) reducing DOD's reliance on battlefield fuel convoys,
2) decreasing DOD's obligation to protect fossil-fuel shipping routes through unstable regions, and
3) eliminating the heat signature and operating noise of fossil-fueled battlefield vehicles and equipment.

As stated, DOD efforts to reduce dependence on fossil fuels have not tracked with statutory mandates and would benefit from alternative approaches. DOD has successfully used an external technology development approach for similar objectives through the DARPA Electric and Hybrid-Electric Vehicle Program started in 1992. This program relied on US nonprofit companies, with direct experience with technology developers in alternative transportation and energy technology, to lead and manage defense research projects conducted by consortia of vehicle and zero-emission technology developers. This nonprofit-led consortia approach reduces the cost-risk to DOD while increasing access for non-traditional defense technology contractors that bring outside experience with technologies vital to decarbonizing defense.

In the interest of reinforcing US Leadership in innovative manufacturing and family-sustaining jobs, and supporting DOD's associated objectives, Congress should establish a nonprofit-led consortia technology development program to develop zero-emissions DOD technology.

***Please see the attached Supplemental Form that discusses light-duty vehicle market policy ideas.**

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Supplemental Form: Light-Duty Vehicle Market Policy Ideas

Transportation accounts for 29% of the total greenhouse gas emissions in the US with 59% of this coming from light-duty vehicles (EPA, 2019). Below are policy ideas within the light-duty market.

1. Policies for Electric Vehicle Readiness
2. Policies that provide public charging locations for fleet vehicles and public use at points of interest.
3. Policy to create a system of battery charging and hydrogen fuel cell refueling stations nationwide.
4. Policies requiring states to increase the availability of electric vehicles.
5. Policy requiring certain efficiencies for U.S. taxis and drive share vehicles.

1. Electric Vehicle Readiness policies.

As policies are put in place that will increase the number of electric vehicles in a community, the proper infrastructure would need to be implemented in order to have successful electric vehicle experiences. Electric Vehicle Readiness policies would involve communities assessing the existing electric infrastructure already available and identifying areas that need to be improved upon. Resulting actions could include: new construction of conduit and panel space for future charging stations, standardizing charging station signage, determining the best locations for public charging stations, public events to educate community members on electric vehicles, etc. Cities could commit to requiring new building and parking structures to be EV ready by having the proper conduit and wiring in place. Installing EV-friendly wiring at the time of construction can be 64-75% less expensive than post-construction installations (Pike, Steuben, Kamei, 2016).

California's Energy Commission conducted a report that was published in 2018 that analyzed the electric vehicle infrastructure needs in the state (California Energy Commission, 2018). California conducted this study in order to provide infrastructure solutions to promote the EV market in order to reach California's ZEV goals, specifically the goal to have 5 million ZEVs on the roads by 2030. Reports like this should go hand-in-hand with policies that promote the ZEV market.

2. Policies that provide public charging for fleet vehicles, as well as the public, to charge at points of interest.

Providing an increased availability and accessibility of charging/hydrogen fueling stations creates a more convenient environment to own or use a ZEV. The U.S. Department of Energy (DOE) developed the Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite, which is a tool used to project consumer demand for electric vehicle charging infrastructure. Specifically, the tool helps estimate the

quantity and the type of charging infrastructure that is necessary for a specific state as a whole or a city. This DOE tool would be a good resource for cities and states in the initial planning stages of electric charging infrastructure.

Knowing the quantity of charging/hydrogen fueling stations needed for an area is key, as well as the best location to put those charging/hydrogen fueling stations. A study done by researchers from Ohio State University developed "a model to optimize the location of public fast charging stations for EVs" (Wu & Sioshansi, 2017). One of the co-researchers for the study, Ramteen Sioshansi, has stated that the method is generic so that data sets from any metropolitan area can be used in order to determine the best sites for charging stations (McCauley, 2017). Models like this one can be used to help different areas determine where the optimal places to put charging stations are in order to best support users of electric vehicles.

3. **Congress should implement a policy that creates a system of battery charging and hydrogen fuel cell refueling stations nationwide.**

As the ZEV market continues to gain momentum, the need for large-scale charging networks is becoming more pressing. A 2019 American Automobile Association (AAA) research study interviewed 1,000 people and found that 6 in 10 of those surveyed raised the concern about charging as a reason they were unlikely to buy, or unsure about buying, a battery electric vehicle (Edmonds, 2019).

The Obama White House in 2016 announced a plan that would expand the number of charging stations in the United States. It proposed establishing 48 new charging corridors that would span almost 25,000 miles of major US highways, making it so that there would be a charging station within at least every 50 miles on that specific network of highways (2016). Plans like this that would increase the availability of charging stations are needed so that ZEV users have the appropriate infrastructure to feel prepared using a ZEV. Plans of this nature should also include fuel cell refueling stations.

4. **Policies that require states to increase the availability of electric vehicles.**

Colorado's Air Quality Control Commission voted to adopt a Zero Emission Vehicle (ZEV) standard for cars and trucks in August 2019. The standard will increase the availability of electric vehicles in the entire state of Colorado. The program requires that by 2025, 4-5% of the vehicles that automakers deliver for sale to dealers would need to be electric. If electric vehicle sales were to reach 8% in Colorado, carbon pollution is estimated to be reduced by 2.2 million metric tons through 2030 (Mui, 2019).

This is just the amount of carbon that could be reduced in one state. If all states were required to increase the availability of electric vehicles in some capacity, then that number could increase significantly. These types of standards do not require

customers to purchase ZEVs, instead they just enhance the consumer's choice when deciding on a vehicle because ZEVs would be made more available and visible to the consumer.

5. **Green Taxi/Ride Share policies that require a certain percentage of the vehicles be zero-emission.**

Oslo, Norway has a policy in place that requires from 2023 onward, all taxis in the city will have to be zero-emission. The city will install wireless charging systems for the electric taxis that uses induction technology to allow taxis to charge as they wait at taxicab stands. This infrastructure will help to make recharging quick and convenient for the taxis. Beijing is also converting their nearly 69,000 city taxi fleet to electric vehicles (Hall, Cui, & Lutsey, 2017). Policies such as this one should be implemented in the U.S.

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