

Philadelphia's Municipal Clean Fleet Plan Update

April 2024



THE CITY OF PHILADELPHIA
OFFICE OF
SUSTAINABILITY

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Abbreviations, Acronyms, and Definitions

Clean Fleet Committee (CFC): The CFC meets a few times a year to discuss barriers and solutions to electric vehicle deployment. The committee includes representatives from the Department of Fleet Services; Procurement Department; Office of Transportation, Infrastructure, and Sustainability; Department of Public Property; the Office of Sustainability / Municipal Energy Office; and liaisons from various departments.

Compressed Natural Gas (CNG): Natural gas is an odorless, gaseous mixture of hydrocarbons, predominantly made up of methane. CNG is produced by compressing natural gas to less than 1% of its volume at standard atmospheric pressure.

Department of Fleet Services (DFS): Previously known as the Office of Fleet Management, buys and maintains vehicles for City departments.

Electric Vehicle (EV): A vehicle powered at least in part by electricity, usually from an on-board battery – a Battery Electric Vehicle (BEV), Plug-in Hybrid Electric Vehicle, or a Hybrid Electric Vehicle (HEV).

Battery Electric Vehicle (BEV): A vehicle solely powered by electricity which has no internal combustion engine. It must be charged from a utility power supply and includes regenerative braking technology. An example of this vehicle would be the Chevrolet Bolt.

Hybrid Electric Vehicle (HEV): A vehicle with an internal combustion engine (ICE) which runs on gasoline or diesel. The vehicle has a regenerative braking system which captures energy as it slows down, stores it in a small battery, and then uses it to provide a boost to the vehicle upon subsequent acceleration. All power for the vehicle originates from gasoline or diesel. The hybrid technology only serves to improve fuel efficiency. An example of this vehicle would be a Ford Escape Hybrid.

Plug-in Hybrid Electric Vehicle (PHEV): A vehicle with the features of the HEV except the onboard battery is slightly larger and can be charged from a utility power supply while parked. Thus, these vehicles can be powered by gasoline or directly by grid charging. An example of this vehicle would be a Ford Fusion Energi.

Electric Vehicle Supply (or Support) Equipment (EVSE): A free-standing or mounted piece of equipment which supplies electric energy from a power source for the safe resupply (charging) of electric vehicle (EV) batteries. Typically referred to as charging stations with one or more units or ports, EVSE is often categorized by level which specifies the voltage input. For the City's immediate purposes, levels are simplified as follows:

Level 1 (AC, alternating current) at 120V. The most common types of charging/plug connectors are the SAE J1772.

Level 2 AC at up to 240V. The most common types of charging/plug connectors are the SAE J1772.

Level 3 (DC, direct current) at 400-600+V. Also referred to as a DC Fast Charger. The most popular type of charging/plug connectors is CCS. In the future, the North American Charging Standard (NACS), currently

being standardized as SAE J3400 and known as the Tesla charging standard, will become the standard EV charging connector system.

Greenhouse Gas (GHG): Gases such as carbon dioxide, methane, nitrous oxide, and certain synthetic chemicals, trap some of the Earth's outgoing energy, thus retaining heat in the atmosphere. This heat trapping causes changes in the radiative balance of the Earth that alter climate and weather patterns at global and regional scales.

Inflation Reduction Act (IRA): Signed into law by President Biden in 2022. It is the most significant climate legislation in U.S. history, offering funding, programs, and incentives to accelerate the transition to a clean energy economy and will likely drive significant deployment of new clean electricity resources. Most provisions became effective 1/1/2023.

Internal Combustion Engine (ICE) vehicle: A vehicle whose propulsion is powered by the combustion (burning) of fuel and oxidant which produces heat and power – as well as carbon monoxide, nitrogen oxides, hydrocarbons, other pollutant vapors, and greenhouse gases.

Kilowatt-hour (kWh): A unit of energy equivalent to one kilowatt of power expended for one hour. It is commonly used as a measure of electrical energy consumption or production.

Metric Tons of Carbon Dioxide Equivalent (MTCDE or MT CO_{2e}): A metric measure used to compare the emissions from various greenhouse gases based on their global warming potential.

Municipal Energy Office (MEO): The Municipal Energy Office sits within the Office of Sustainability. It promotes municipal energy conservation, efficiency, and emissions reductions.

Office of Sustainability (OOS): Works with partners around the city to improve quality of life in all of Philadelphia neighborhoods through addressing environmental justice, reducing the city's carbon emissions, and preparing Philadelphia for a hotter and wetter future.

Executive Summary

In the United States, transportation is one of the largest contributors to carbon emissions. Recognizing this, the Biden Administration has prioritized vehicle electrification as a key strategy to address climate change, grow American jobs, and promote sustainable practices. Government agencies across the country are transitioning their fleets to clean alternatives, reaping operational savings, and lowering their greenhouse gas emissions.

The City of Philadelphia committed to electrifying and cleaning our municipal fleet in 2021 with the release of the [Municipal Clean Fleet Plan](#). The plan outlines a strategic approach to transition the City's fleet to clean and electric vehicles. Beyond setting an example in carbon pollution reduction, this transition is expected to yield cost savings, support local job creation, and enhance Philadelphia's competitiveness among peer cities. This ambitious goal is part of the City's larger goal to eliminate emissions in the buildings, energy, transportation, and waste sectors by 2050, aligning with expert recommendations to mitigate the worst effects of climate change.

Transitioning a large and multifunctional fleet to clean alternatives is a large undertaking, but Philadelphia has made steady progress. This report provides updates on the City's advancement towards clean fleet goals since the initial plan was released in 2021 under the Kenney Administration. Today, under Mayor Cherelle L. Parker, Philadelphia will continue to transition the municipal fleet with clean and alternative vehicles. The long-term vision in Mayor Parker's 100-Day Action Plan includes prioritizing environmental sustainability and meeting the city's carbon neutrality goal.



Introduction



Philadelphia city government provides its residents with essential services and amenities needed to thrive in today's world. The City collects trash and recycling, sweeps city streets, cleans and delivers drinking water, and many other responsibilities. City staff would not be able to complete their jobs without the various vehicles in the municipal fleet. These vehicles are procured and maintained by the Department of Fleet Services (DFS), which cares for cars and trucks across 35+ departments.

The City's fleet of 6,300+ vehicles is vital for the city to function. However, municipal cars and trucks were responsible for over 15% of government greenhouse gas emissions (GHG) in 2022. Most of the City's vehicles are powered by gasoline and diesel, which produce GHG emissions that cause climate change and pollute local air. The Department of Fleet Services collaborates with the Municipal Energy Office (MEO) to continually lower the fleet's GHG emissions by replacing vehicles with electric and clean alternatives.

Since the publication of the original [Municipal Clean Fleet Plan](#) in 2021, the City has made steady progress in converting the City's fleet to clean alternatives and preparing the needed infrastructure. The Department of Fleet Services has continued to replace internal combustion engines (ICE) with electric models and it is expected that the City's EV fleet will reach over 300 cars in 2024. The City's MEO has been working with electric vehicle (EV) experts to develop a comprehensive charging plan that will grow with the EV fleet. However, the cost of EV charging infrastructure has acted as a barrier to the City procuring and installing equipment as quickly as possible. The City is evaluating opportunities for federal, state and local grants and rebates to help offset the cost of charging infrastructure and EVs. Over time, the local electricity grid continues to use cleaner electricity sources, which makes EVs more appealing despite their cost, as the City works to lower GHG emissions and improve local air quality.

This update to the Municipal Clean Fleet Plan uses the most recent fleet data from DFS and energy data from MEO. The City's current fleet and emissions is compared with earlier years to understand the City's progress towards its clean fleet goals.

Action Plan Updates

1. Pathways to a zero emissions fleet:

- DFS prioritizes the purchase of electric sedans, sport utility vehicles (SUVs), vans, and light duty pickup trucks when gas- or diesel-powered models are ready to retire.
- In 2023, emissions from light- and medium-duty vehicles were reduced by 10% from 2019 levels. This is on track to reach our goal of reducing emissions from light- and medium-duty vehicles by at least 45% by 2030.
- The City is on target to stop the procurement of ICE light-duty vehicles after 2030. Procurement of clean, alternative medium- and heavy-duty vehicles is dependent on technological advancements and lower prices.

2. Institute a Clean Fleet Procurement Policy.

DFS procures electric sedans, SUVs, vans, and light duty pickup trucks when ICE models are ready to retire. The EV model must meet the same standards as the ICE model being replaced. Exemptions to this policy require the approval of the Managing Director's Office or its designee. More details can be found in the [Managing Director's Directive #69: Clean Fleet Procurement Policy](#). The City is investigating clean alternatives for medium- and heavy-duty vehicles as technology improves and costs become more affordable.

3. Limit procurement of medium and heavy-duty vehicles in the short term; pilot new fuels or procure compressed natural gas (CNG) vehicles where feasible.

The number of medium- and heavy-duty vehicles decreased by 3 vehicles from 2019 to 2023. However, 28 of the heavy-duty vehicles now use CNG, a cleaner alternative to diesel. Many of the CNG vehicles are used by the Sanitation Department. Clean alternatives for medium- and heavy-duty vehicles are being investigated as technology advances and costs decrease.

4. Conduct an EV Suitability Assessment.

Working with a contractor, the City conducted a comprehensive evaluation of the fleet to site EV chargers. In addition, DFS identifies appropriate EV replacements for vehicles at the time of retirement.

5. Establish a Clean Fleet Committee (CFC) to support infrastructure coordination and to track goals.

The CFC has met quarterly since the beginning of 2023. The committee has worked together to identify

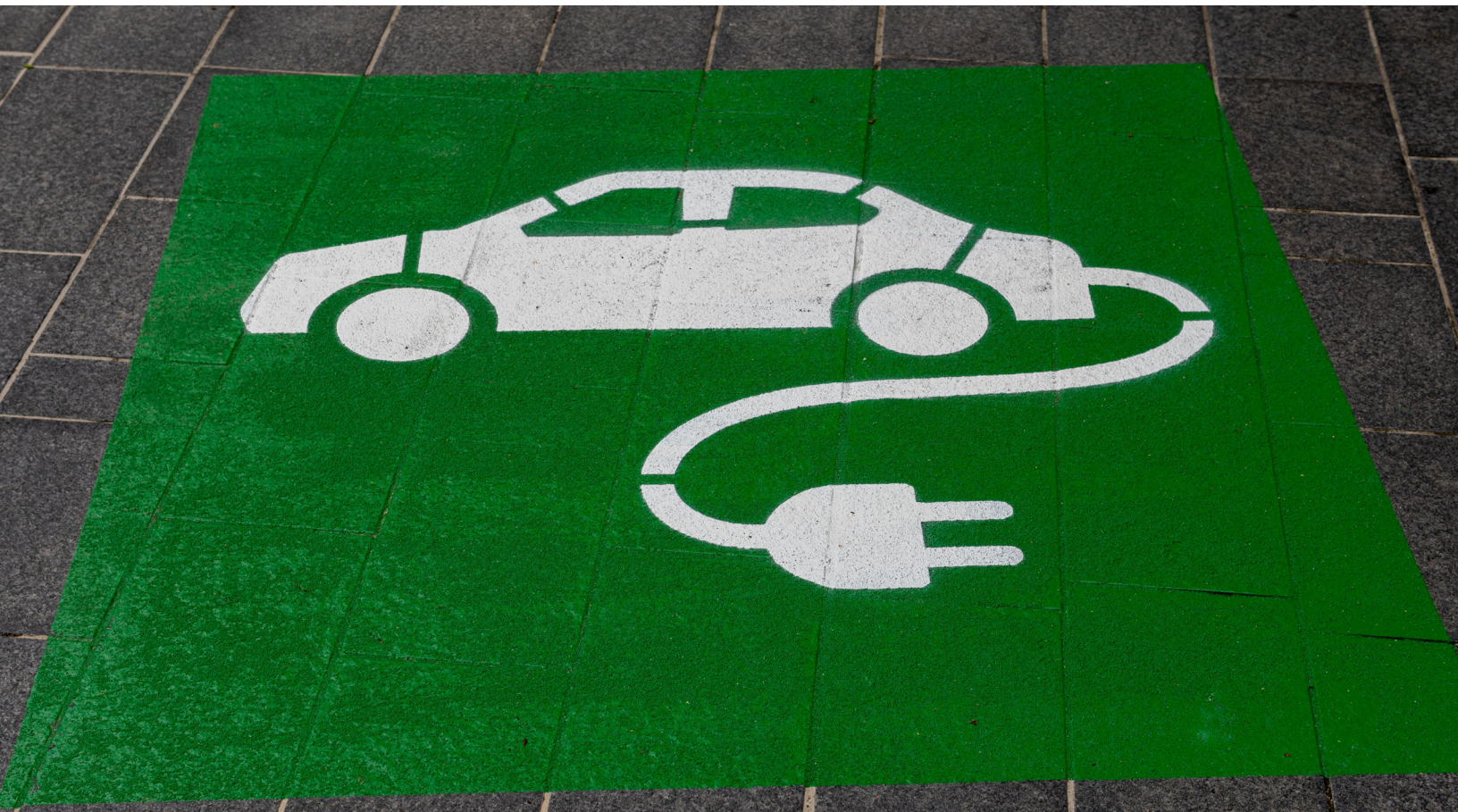
problems, find solutions, and coordinate EV charging capabilities.

6. Develop funding programs to connect capital procurement and fuel cost/operational savings.

A portion of the Office of Sustainability's (OOS) capital funds are shared with departments so that they can procure and install EV chargers. Similarly, DFS has procured chargers that departments can install at their facilities. MEO is applying for grants and rebates through the Commonwealth of Pennsylvania and PECO to help fund EV charger projects. The Biden Administration has also provided grants and refunds through the Inflation Reduction Act (IRA). The City plans to utilize the IRA's Carbon Pollution Reduction Grant as a possible source of funding for EV charging projects. Additionally, the IRA has allowed governmental entities like the City of Philadelphia to receive tax refunds for the purchase of electric vehicles and EV chargers.

7. Optimize Alternative Fueling and Electric Vehicle Supply Equipment (EVSE).

The City finalized a contract to streamline the procurement, installation, and maintenance of EV charging stations throughout the City. A tool was developed by a consultant to identify the number and type of charging stations needed at each City-owned facility.



Part I: Vehicles



City of Philadelphia's Fleet

Fleet Makeup

As of December 2023, the City of Philadelphia owned a fleet of approximately 6,300 vehicles, including machinery and equipment that requires fuel. The municipal fleet assists City employees with tasks such as trash pick-up to transportation for inspections. These vehicles are spread across 35+ departments within the City (Figure 1) and vary in terms of vehicle class and fuel type (Figure 2 and Figure 3).

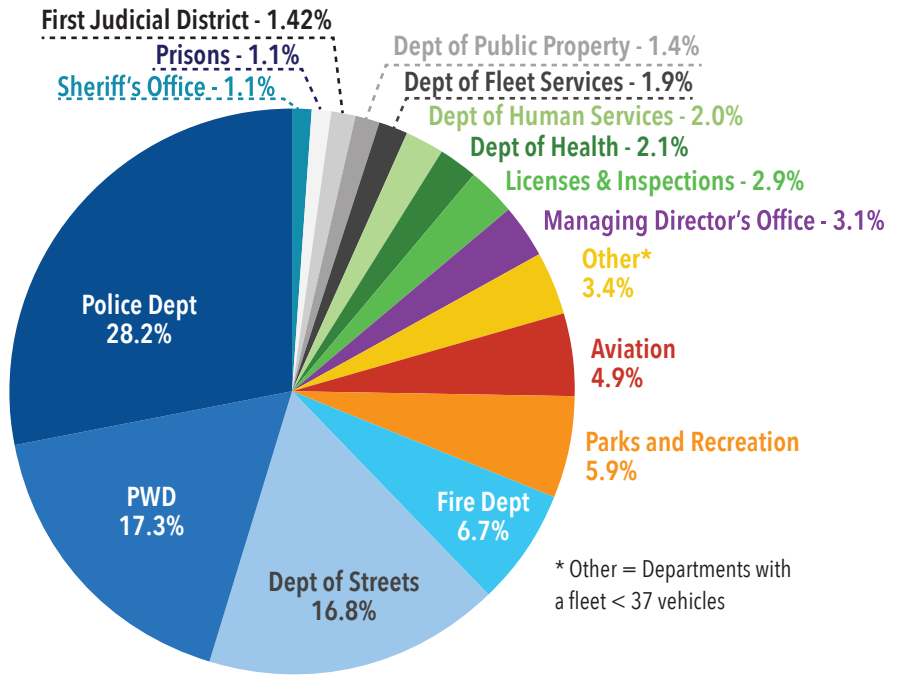


Figure 1. Vehicle Count by Department

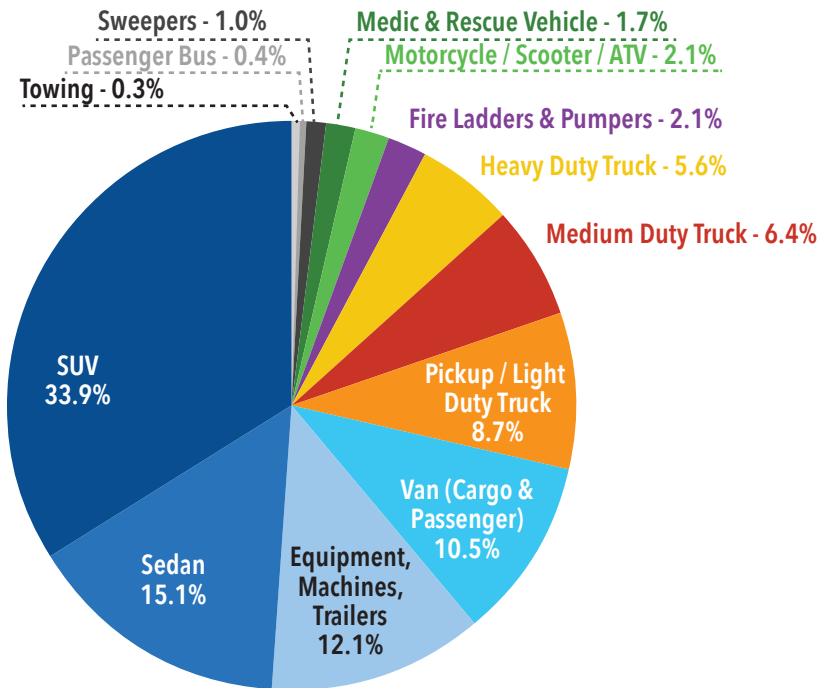


Figure 2. Vehicle Count by Vehicle Type

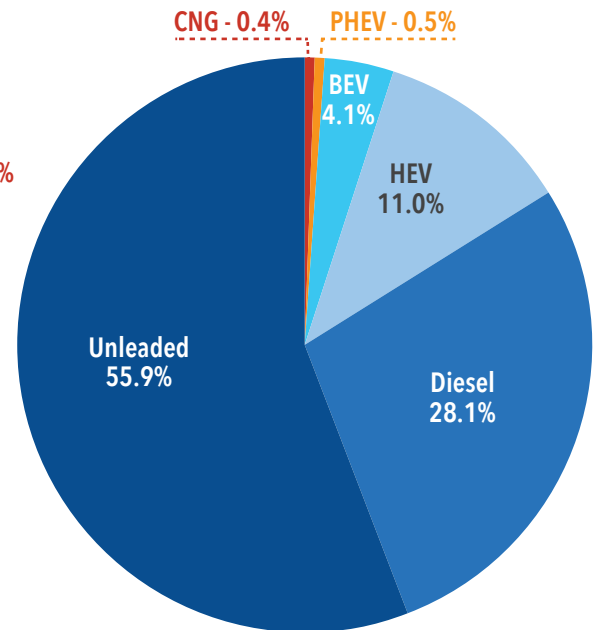


Figure 3. Vehicle Count by Fuel Type

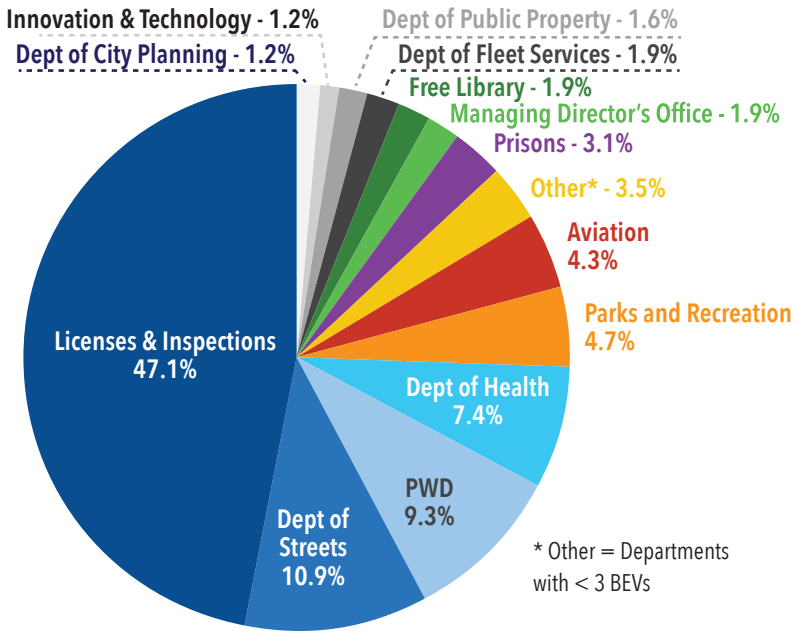


Figure 4. BEV Count by Department

Light-Duty Electric Vehicles

By the end of 2023, the City's fleet included 248 battery electric vehicles (BEV). Almost half of the BEVs are used by the Department of Licenses and Inspections (L&I) (Figure 4). Staff from L&I use their BEVs to drive throughout Philadelphia to complete inspections for various permits and licenses.

As light-duty vehicles are retired, they are replaced with similar electric models. It is expected that the City will own over 300 BEVs by the end of 2024.

“So far everything is going well. The vehicle holds enough charge to get through the week with only one or two charges a week. I find it beneficial to have a city vehicle as it adds to the positive image that should be perceived by the public.”
 – Licenses & Inspections Employee

Heavy- and Medium-Duty Vehicles

The City is continuing to monitor opportunities for heavy-duty vehicles as existing policy and programs progress in other large cities. For example, New York City operates over 100 CNG vehicles, including sanitation trucks, sweepers, passenger vans, and Honda Civic sedans. They also operate three CNG fuel sites for their fleet.¹ Moreover, the New Jersey Department of Environmental Protection offers incentives to cover the incremental cost of switching to an electric vehicle. Shuttle buses, school buses, garbage trucks, and transit buses are all eligible for the funds, making switching to clean vehicles more affordable for municipal organizations.² With ongoing advancements in heavy-duty vehicle technology, the City will continue to incorporate best practices into action.

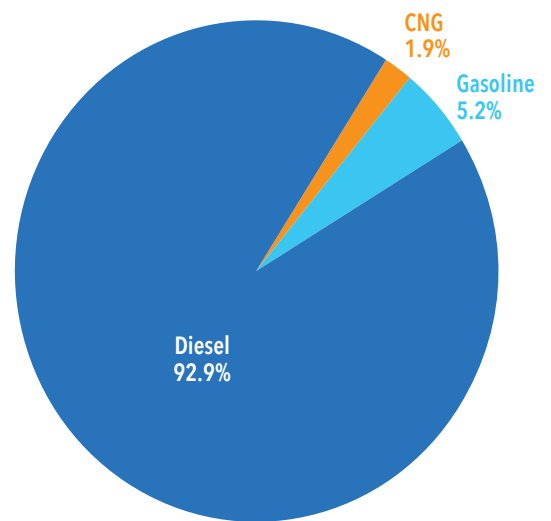


Figure 5. Fuel Type of Medium- and Heavy-Duty Vehicles

1 Fleet Sustainability - Department of Citywide Administrative Services. (n.d.). www.nyc.gov/site/dca/s/agencies/fleet-sustainability.page

2 Alternative Fuels Data Center: New Jersey laws and incentives. (n.d.). afdc.energy.gov/laws/all?state=NJ

Fleet Use and Emissions

In 2022, Philadelphia’s municipal fleet was responsible for 15.7% of all municipal emissions. This is up by 2% from 2017 due to the fact that overall municipal emissions are decreasing, specifically the portion attributable to buildings as a result of a cleaner electricity grid and large energy efficiency projects. This further increases the incentive for electrification of the City’s fleet to meet the City’s GHG emission reduction goals.

At the end of 2023, BEVs made up about 4% of the City’s fleet and hybrid EVs (HEVs), plug-in HEVs (PHEVs) and BEVs together made up 15.6% of the fleet. The municipal BEV fleet used 353,323 kilowatt-hours (kWh) of electricity in 2023. This amount of electricity is equivalent to 17,199 gallons of gasoline.³ Driving electric vehicles instead of similar ICE models allowed the City of Philadelphia to avoid over 3,000 MTCDE. This offset is an estimate based on the average GHG emissions of all light-duty gasoline vehicles in the fleet — including HEVs and PHEVs — and average Scope 2 emissions from various BEV models. It does not consider the specific make, model, year, or use

cases of each individual vehicle in the fleet. Future analysis of GHG savings may be reevaluated to utilize GHG emissions data for each specific model of vehicle. *Table 1* at left exhibits the amount of annual GHG emissions offset when a single light-duty gasoline car or truck is replaced with the selected clean transportation technologies.

Fuel Type	Count	GHG Savings	MTCDE Avoided Per Vehicle
Unleaded	3,287	—	—
Diesel	28	—	—
Hybrid EV (HEV)	694	37%	2.4
Plug-In Hybrid EV (PHEV)	31	61%	4.0
Battery EV (BEV)	248	77%	5.1

Table 1. Count of light-duty cars and trucks by fuel type, GHG savings, and MTCDE avoided in 2023

A decrease in GHG emissions from the City’s fleet means cleaner air for all Philadelphia residents. GHG emissions from cars and trucks release compounds like carbon monoxide and

nitrogen oxides into the air, which can cause or exacerbate health-related issues, like asthma. Electric vehicles have zero tailpipe emissions which helps keep our air healthy to breathe. Reducing emissions from the City’s fleet will help improve local air quality and decrease related healthcare costs for Philadelphians.

Figure 6 on the next page illustrates the fuel used and GHG emitted by the 13 top departments as a percent of the City’s total in 2023. The entire fleet emitted over 50,000 MTCDE in 2023 due to gasoline and diesel use.



3 Greenhouse Gas Equivalencies Calculator. (2024, January 31). US EPA. epa.gov/energy/greenhouse-gas-equivalencies-calculator

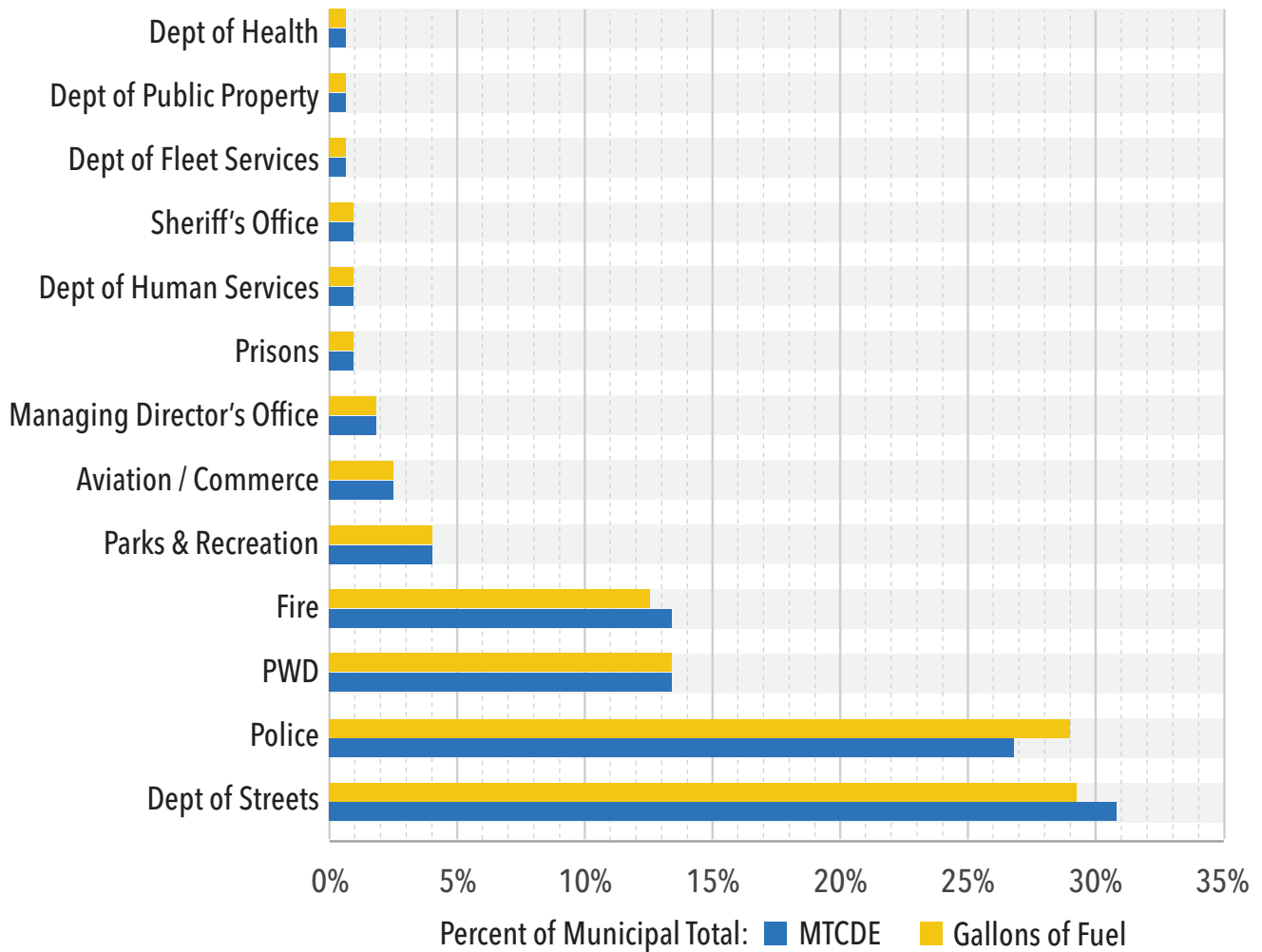
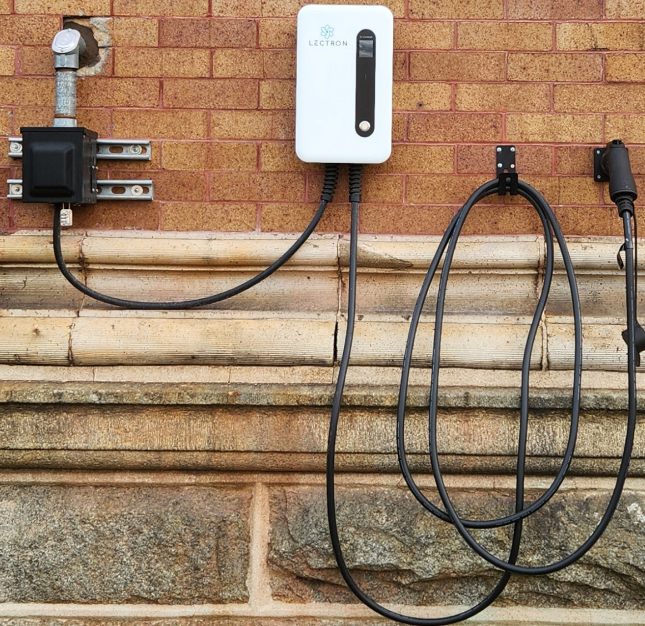


Figure 6. The percent of fuel used and GHGs contributed by each of the top departments in 2023.

Key Takeaways

- In 2023, the City used over 5,458,500 gallons of fuel and emitted over 50,000 MTCDE for municipal operations.
- Information regarding the total miles driven by each department was not available, which could offer additional insights into the extent of vehicle usage. Nevertheless, the chart above offers valuable understanding into the potential fuel savings and reductions in GHG emissions by substituting ICE vehicles with more fuel-efficient, cleaner alternatives.
- The Department of Streets, Police, and PWD were the top three users of fuel in 2023. These large departments rely heavily on vehicles for their daily responsibilities.
- The Department of Public Health decreased its proportion of municipal fuel use and GHG contribution to become the lowest ranked department in 2023.

Part II:
Electric Vehicle
Charging
Infrastructure



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WASTE WATER PUMPING
OPERATIONS

Emissions from Electricity

Electricity is one of the power options with the least net Scope 2 GHG emissions. As such, EVs contribute to Scope 2 GHG emissions since they charge from electricity sourced from the local grid, which is powered in part by coal and natural gas plants. Luckily, as Philadelphia's municipal government transitions exclusively to renewable energy sources — a target set for 2030 — Scope 2 emissions from electric vehicles will essentially diminish to zero. In fact, since early 2024, about 30% of municipal electricity comes from solar panels or other renewable power sources. Despite their current Scope 2 emissions, EVs are noted to produce at least 68% fewer GHG emissions than gasoline vehicles in Pennsylvania.

Pennsylvania electricity is sourced from different fuels (Figure 7), which exhibit variations in emissions, cost, energy density, accessibility, infrastructure demands, extraction and refinement techniques, and regional availability, among other aspects. The Commonwealth of Pennsylvania, and thus the City of Philadelphia, receives its electricity from the PJM electricity grid. The PJM Interconnection is a regional transmission organization that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia.

State Averages for Pennsylvania

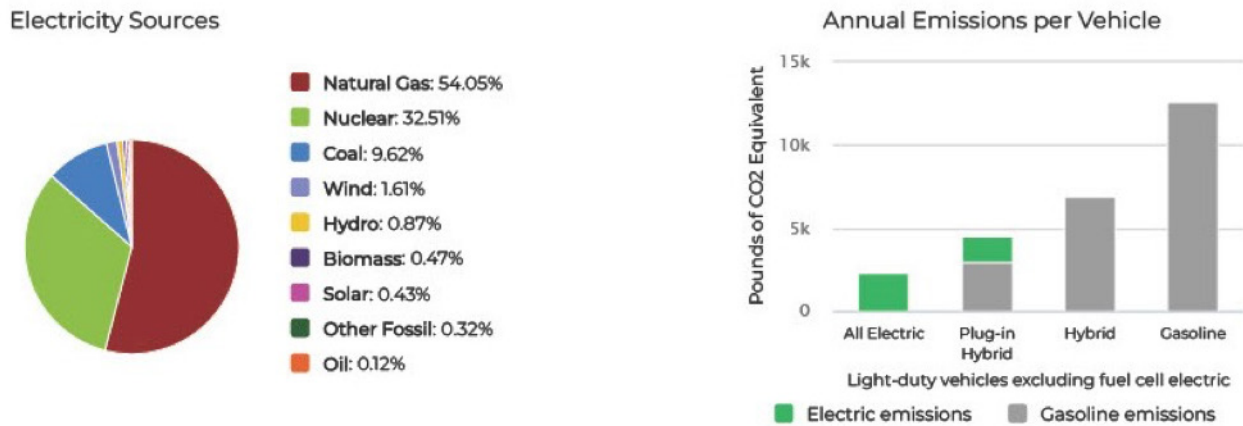


Figure 7. Electricity Sources and Emissions – Averages for Pennsylvania in 2022.
 Source: [Alternative Fuels Data Center](#)

Electric Vehicle Charging Infrastructure

As the City of Philadelphia continues to grow its EV fleet, more EV charging infrastructure will be needed. In 2023, the City possessed over 100 level two EV charging ports across 54 municipal facilities (Figure 8). MEO is planning to contract with an EV charging company that can procure, install, and maintain EV chargers at City facilities. This contract will be available to all departments and will streamline the process for obtaining EV chargers. As such, a large increase in City-owned EV chargers is expected in 2024.

MEO has been working with experts at ICF International Inc. to assess the EV charging needs for each department and each municipal facility. The consultants designed a tool that MEO staff can use to understand the number, type, and potential cost of chargers for various facilities. Reports will be created for each department and distributed to the respective fleet liason so that each department can plan for their EV charging needs.

DFS is planning to install DC Fast Chargers (DCFCs) at municipal facilities in the coming months. DCFCs have more electric capacity to charge EVs in minutes instead of hours. The City's first DCFC will be installed before the end of fiscal year (FY) 2024 at a maintenance facility, thanks in part to the City of Philadelphia's Operations Transformation Fund⁴. This project was supplemented by DFS's capital budget to double the initial scope of work. An additional four DCFCs will soon be installed at a Public Safety facility. This project is expected to commence by the end of FY24 and be completed in early FY25. Finally, another DCFC will be installed at a body shop, paid for by DFS capital funds. This project may double in scope if grant funds are awarded by Pennsylvania's Department of Environmental Protection.

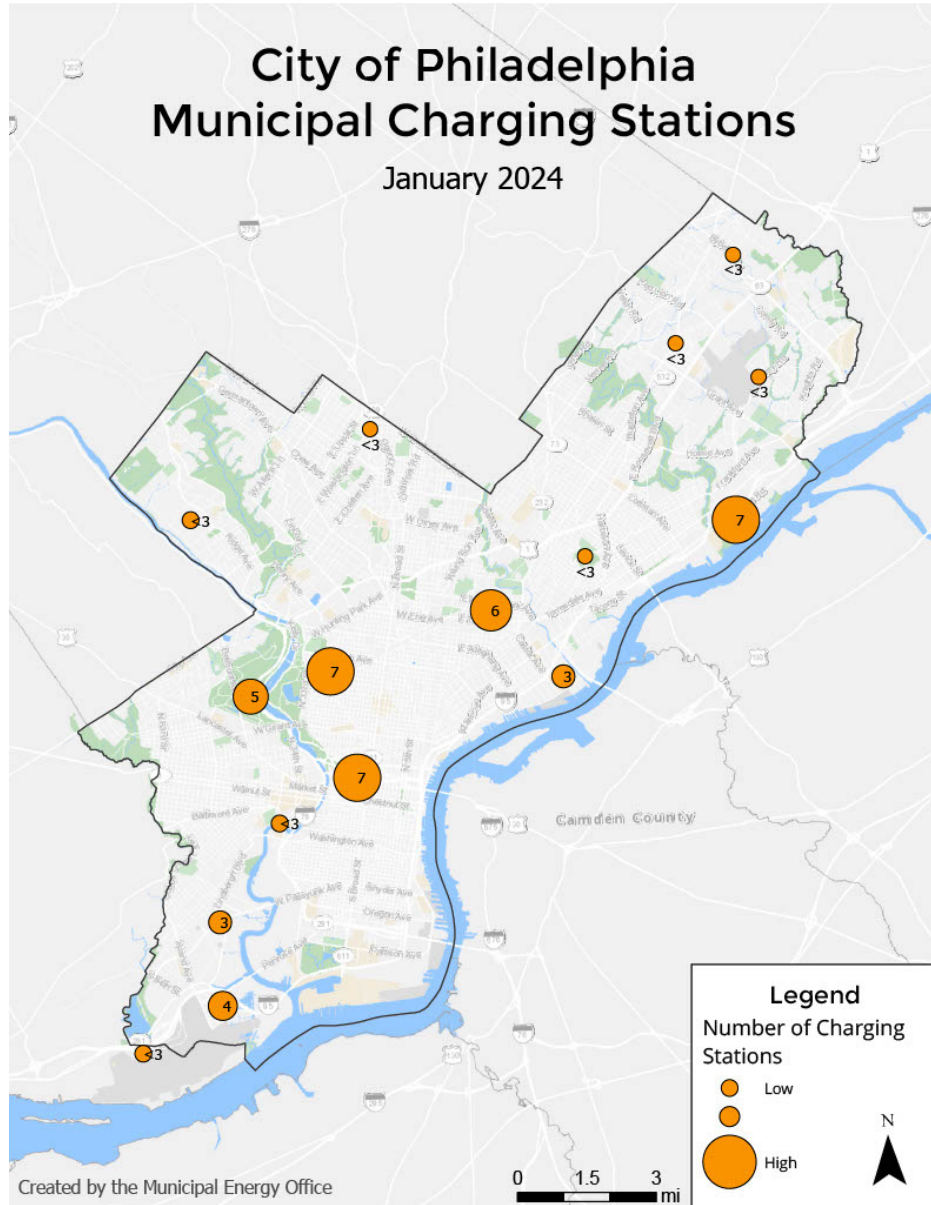


Figure 8. Map of municipally owned EV charging stations. Stations located near each other are clustered together as a single circle. Some stations have multiple charging ports.

⁴ Operations Transformation Fund: Spring 2022 Grantees. (2022, July 8). City of Philadelphia. www.phila.gov/2022-07-08-operations-transformation-fund-spring-2022-grantees/

The City's goal is to acquire enough EV chargers to support all municipally owned electric vehicles. However, funding, old electric infrastructure, and a limited number of electricians on staff have acted as barriers to installing chargers quickly. Overcoming these barriers and building up the City's charging infrastructure is a priority as we enter 2024.

In an attempt to mitigate the demand for charging access, a contract with the private charging company, EVgo, has been established to supplement the necessary EVSE. EVgo has DC Fast Chargers located in and around Philadelphia that can charge electric light-duty vehicles in about 20 to 60 minutes. The contract with EVgo is meant to be a temporary solution as departments install more chargers. The necessity of this contract is reviewed each year. The City acknowledges that using publicly accessible charging stations comes with its own difficulties, such as longer wait times to use the chargers.



Part III: Next Steps and Future Opportunities



Next Steps and Future Opportunities

Successes and Barriers

Since the release of the *Municipal Clean Fleet Plan* in 2021, the City of Philadelphia has made great progress towards clean fleet recommendations. This includes:

- growing the BEV fleet to about 250 vehicles;
- installing over 100 EV charging ports across 54 municipal facilities;
- increasing the heavy-duty CNG fleet to 28 vehicles;
- procuring the City's first DC Fast Charger that will be installed in early 2024;
- establishing the CFC and holding four meetings with the Clean Fleet Liaisons; and
- gasoline and diesel usage has continued to decline (*Figure 9*) as more of the fleet is replaced with electric and energy efficient vehicles.

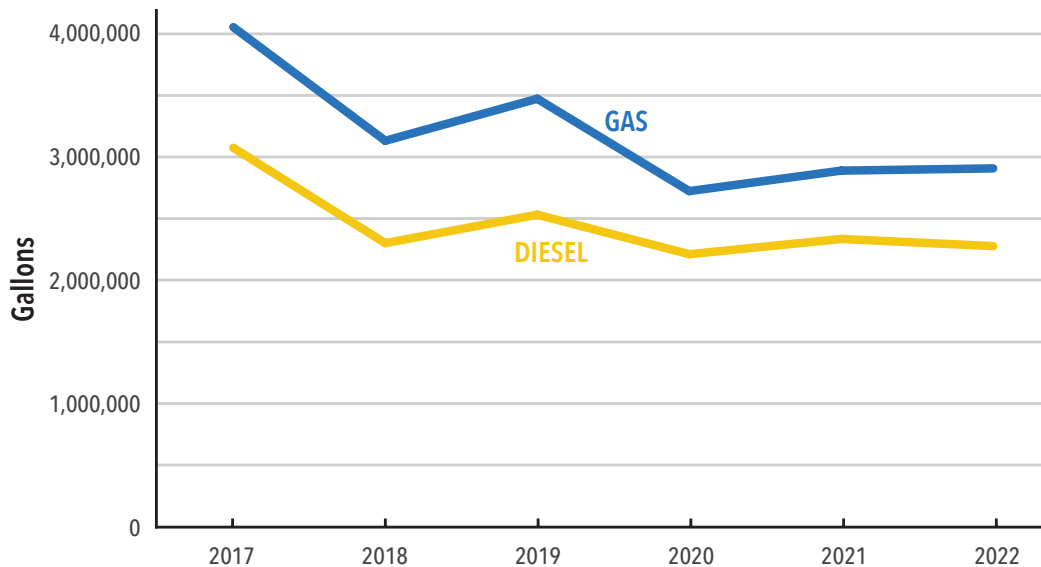


Figure 9. City of Philadelphia General Fund Gasoline and Diesel Usage, 2017 - 2022

The City has made great progress towards clean fleet recommendations; however, there are barriers to overcome including the cost premiums for EVs, old electric infrastructure at municipal facilities, and hiring electricians that are trained to maintain EV charging stations. These barriers will be addressed as MEO explores contractor opportunities for EV charger procurement, installation, and maintenance.



President Biden speaking at the Philadelphia Shipyard, Inc. in July 2023.

Federal, State and Local Incentives

The City will continue to replace light-duty ICE vehicles with similar EV models as each vehicle is retired. DFS estimates that the EV fleet will reach over 300 vehicles in 2024. Grant funding and rebate opportunities through the federal government, state government, and PECO, will help lower the initial cost of purchasing EVs and associated charging equipment.

The Inflation Reduction Act (IRA), signed into law in 2022 by President Biden, presents an important opportunity for the City to leverage federal money for EVs and associated charging infrastructure. Previously, most federal tax refunds were not accessible to municipal agencies like city governments; however, after the IRA was signed into law, it allows non-profits and municipal agencies to take advantage of tax refunds on purchases like electric vehicles and EV charging stations. The City expects that it will be eligible for up to \$7,500 per EV on the 150+ EVs put into active service in 2023. This refund is part of the Commercial Clean Vehicle Credit under the IRA.

Similar to the Commercial Clean Vehicle Credit, the City may be eligible for a refund on EV charging stations placed into service in fiscal year 2023. The Alternative Fuel Vehicle Refueling Property Credit under the IRA offers a tax refund if qualified vehicle refueling and recharging equipment was installed on municipal property within low-income communities. The City will pursue this opportunity further once instructions and guidance for the 2023 tax year

are released by the Internal Revenue Service. Money from these tax refunds can be allocated to buy additional EV charging stations, as needed by each department.

MEO and DFS collaborated to apply for Pennsylvania's Department of Environmental Protection's Alternative Fuels Incentive Grant. This state grant awards up to \$300,000 to public entities and businesses for projects associated with electric vehicles and charging infrastructure. If won, this grant will be used to purchase and install additional DC Fast Chargers. Winners should be notified in April 2024. Other state funding programs like the National Electric Vehicle Infrastructure program may become available if funding is allocated for private EV chargers.

Locally, PECO is offering rebates on level two and DC Fast Chargers that are installed before the end of 2024. Through its Public Benefit Program, PECO is offering rebates of 50% of the cost of equipment, installation, and make ready work, up to \$60,000 per customer. MEO plans to work with departments to help them apply for this rebate as chargers are installed.

Opportunities for Alternative Heavy-Duty Vehicles

The City of Philadelphia is proud to collaborate with the Mid-Atlantic Clean Hydrogen Hub Group, a coalition of states including Delaware, New Jersey, and Pennsylvania dedicated to promoting clean energy. The group has been working to leverage existing technology and infrastructure and was recently awarded federal money to develop a hydrogen hub.⁵ With this grant, the Biden Administration will invest \$750 million to build the renewable Mid-Atlantic Clean Hydrogen Hub (MACH2) in Philadelphia and participating states. The MACH2 will create over 20,000 jobs in Philadelphia and the surrounding region. The City is excited to explore opportunities through this grant that will lead to improved hydrogen production, transportation infrastructure, and end-use sites across the region.⁶

The expansion of hydrogen fuel in Philadelphia presents a great opportunity for the City's heavy-duty fleet through clean, alternative fuels. However, due to the current costs of hydrogen-powered vehicles, installation of compatible filling stations, and maintenance, there are financial challenges to procurement and implementation.⁷ Despite these barriers, there is still great potential for hydrogen and CNG fuels in the future, as options become more cost efficient. The City looks forward to exploring these options as technology advances.

5 *Mid-Atlantic Clean Hydrogen Hub (MACH2)*. (n.d.). mach-2.com

6 Ickes, P. (2023, October 13). Governor Josh Shapiro: Pennsylvania the Only State to Secure Two Regional Clean Hydrogen Hub Projects. *Pennsylvania Department of Community and Economic Development*. dced.pa.gov/newsroom/governor-josh-shapiro-pennsylvania-the-only-state-to-secure-two-regional-clean-hydrogen-hub-projects/

7 Spiller, B., Lohawala, N., & DeAngeli, E. (2023). Medium- and Heavy-Duty Vehicle Electrification: Challenges, Policy Solutions, and Open Research Questions. *Resources for the Future*, 23(03). media.rff.org/documents/Report_23-03_v3.pdf

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SUSTAINABILITY

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