

Planning for a Sustainable Future: Inver Grove Heights Efficient City Fleet

MS-STEP Plan C Paper

In Partial Fulfillment of the
Master of Science in Science, Technology, and Environmental Policy

Degree Requirements

The Hubert H. Humphrey School of Public Affairs

The University of Minnesota

Ally Hillstrom

May 2018

*Signature below of Paper Supervisor certifies successful completion of oral presentation **and** completion of final written version:*

Dr. Gabriel Chan, Paper Supervisor

Date, oral presentation

Date, paper completion

Frank Douma, J.D., Committee Member

Date

Table of Contents

Abstract	3
1. Policy Problem and Importance	4
1.1 Policy Problem and Importance	4
1.2 Policy Purpose	6
1.3 Research Objectives and Framework	6
2. The City of Inver Grove Heights	7
2.1 Background of Inver Grove Heights	7
2.2 Inver Grove Heights Vehicle Fleet	8
2.2.1 Vehicle Categories	9
2.2.2 Composition of Fleet	10
2.2.3 Expenses of Vehicle Fleet	12
2.2.4 Fleet Emissions	14
2.2.5 Vehicle Replacement Process	17
3. Fleet Management Through Comprehensive Framework and Best Practices	18
3.1 Overview of Fleet Management Frameworks and Best Practices for Government Fleets	18
3.2 Energy Policy Act 1992	19
3.2.1 Alternative Fuels Defined by EPA Act 1992	20
3.3 Federal Executive Order 13693 (2015)	24
3.3.1 Step 1: Plan	25
3.3.2 Step 2: Collect Data	26
3.3.3 Step 3: Strategize	27
3.3.4 Step 5: Implement	31
3.4 Minnesota State Executive Order 17-12 (2017)	31
3.5 Minnesota GreenStep Cities	32
4. Case studies	35
4.1 Case study #1: Dakota County, Minnesota	35
4.2 Case study #2: City of Elk River, Minnesota	37
5. Inver Grove Heights Fleet Management Options	39
5.1 Option #1: Implement New Fleet Management Practices	39
5.1.1 Practice #1: Develop Fleet Management Committee	40
5.1.2 Practice #2: Develop Action Plan: Goals, Objectives, and Outcomes	41
5.1.3 Practice #3: Collect Additional Vehicle Use Data and Analyze	42
5.2 Option #2: Implement Sustainable Fleet Management Policy	42
5.3 Option #3: Revise Vehicle Use Policy	44
5.4 Cost Benefit Analysis	46
5.4.1 Data and Assumptions Used in Cost Benefit Analysis	47
5.4.2 Vehicles in Cost Benefit Analysis	50
5.4.3 Cost Benefit Analysis Results	51
6. Summary of Cost Benefit Analysis and Fleet Management Recommendations for Inver Grove Heights	52
7. Work Cited	55

Abstract

The objective of this paper is to identify actions the City of Inver Grove Heights can take to increase the fuel efficiency of their vehicle fleet, reduce fleet management costs, and reduce fleet emissions. This paper begins with an overview of the City of Inver Grove Heights existing fleet management conditions including fleet composition, expenses, emissions, and replacement process. The next section of this report reviews fleet management frameworks currently followed by government agencies. Next, fleet management case studies are presented of two local government organizations in Minnesota based on defined criteria. Each case study showcases how local government organizations have implemented fleet management practices included in the previous fleet management framework section to also achieve similar fleet management goals as defined by the City of Inver Grove Heights. Additional information regarding the organizations' fleet management policies and policy outcomes are included. Drawing from transferrable lessons learned from a literature review of government fleet management frameworks and case studies collected through interviews, best management practices and policy options are presented for the City of Inver Grove Heights updated fleet management process and are evaluated based on a cost-benefit analysis. This paper concludes with final recommendations for the City of Inver Grove Heights to increase the fuel efficiency, reduce fleet management costs, and reduce vehicle emissions based on this multi-method analysis. The Cost Benefit Analysis presented in this paper suggests that the greatest impact on all three goals could be achieved by reducing inefficient driving behavior (Fig. 16.1 through 16.4). It is recommended the City continues to collect more comprehensive vehicle use data to identify the cause of inefficient driving behaviors and to identify strategies to potentially reduce inefficient driving behavior, such as through employee education.

1. Policy Problem and Importance

1.1 Policy Problem and Importance

Federal, State, and Local Governments are responsible for maintaining public affairs for their geographically defined constituent base. These affairs include, but are not limited to, maintaining law and order, the economy, social well-being, transportation systems, and the environment. In some cases, laws and policies have been adopted to define implementation standards for these government services (such as public safety) and operations (such as solid waste management). In other cases, laws and policies have not been adopted to define implementation standards, which gives the government agency autonomy to manage these affairs.

This paper presents a case study of *local government fleet management*; an internal government operation unregulated by state or federal legislation. Unlike the Federal and State governments, local Minnesota governments are under no legal obligation to meet fleet operational standards to reduce emissions, increase efficiency, or right-size assets. Additionally, unlike private businesses who have taken great strides to right-size fleet assets, maximize vehicle efficiency, and incorporate alternative fuels, cities have demonstrated a slower adoption of fuel efficient vehicles and alternative fuel vehicles.

The lack of standards provides greater flexibility for cities to develop their own fleet management programs, however, this can also create an opportunity for the *principal-agent problem* to arise. This problem arises when the *agent* acts on the behalf of the *principal* in a way that does not align with the *principal's* interests. In the case of local government fleet management, the principal-agent problem can arise when governments (the agents) prioritize services provided by the fleet to the community (the principal) but do not account for the benefits the principal would also receive from implementation of sustainable fleet practices, such as the reduction of fleet costs while still meeting operational needs. Consequently, focusing only on the provision of services may lead to an accumulation of unnecessary or inefficient vehicles remaining in the fleet, resulting in higher fleet management costs over time.

Although specific management, performance, and emission standards do not exist for local government fleets, local governments should recognize they are still responsible for the well-being of their community and maintaining good stewardship of public funds.

Fortunately, cities have the financial capital to make fleet management investments that can benefit the well-being of their community and reduce fleet management costs overtime. Many cities throughout Minnesota have right-sized fleet assets to reduce fleet costs while still meeting operational needs. Others have incorporated alternative fuel vehicles into their fleet by purchasing electric vehicles. Overtime, these sustainable fleet management practices can reduce expenditure of tax revenue, free up dollars for other services, and reduced air pollution. Additionally, decreasing fuel consumption can benefit the community by lowering a city's exposure to risk in the form of gas price volatility. A city that is less dependent on gas will not be as exposed to the financial risk of gas prices suddenly increasing (CNBC, 2018). Additionally, various Minnesota cities have also taken leadership to install charging stations available to the public, city employees, and city vehicles. Cities can also contribute to the electric vehicle adoption within the community by encouraging private development to install charging stations during development. These investments and influence on the private sector have a great potential to contribute to development of a wider charging network for the community and beyond, however implementation of these initiatives is driven only by voluntary action. Because no legislation exists for local Minnesota government fleets, cities are left to develop their own fleet management goals, practices, and policies.

Although comprehensive framework exists publicly for Minnesota city fleets, various governmental and professional organizations have set best practice standards. This paper presents a case study of fleet management at the City of Inver Grove Heights, Minnesota, and showcases how the city, along with other Minnesota cities with a comparable size fleet, can follow best practices from a variety of resources to meet financial and environmental sustainability goals.

1.2 Policy Purpose

The City of Inver Grove Heights currently manages 121 vehicles within their fleet and spends approximately \$1.44 million dollars annually on vehicle fleet management. The City's leadership has directed staff to reevaluate their existing fleet management processes and conditions with a goal to identify opportunities to increase the fuel efficiency, reduce fleet management costs, and reduce vehicle emissions through adoption of new policies and practices. The research objectives of this paper are to complete a cost-benefit analysis of fleet management options to present policy and best practice recommendations for the City of Inver Grove Heights to consider while updating its fleet management process.

1.3 Research Objectives and Framework

These policy recommendations were developed based on two types of research: case studies of comparable cities and cost-benefit analysis. The first section of this paper provides a description of the City of Inver Grove Heights and outlines the composition, expenses, emissions, and replacement process of the fleet as of December 2017. This is followed by a literature review of fleet management frameworks used by government agencies to meet fleet management goals. Following this section, fleet management case studies are presented of two local government organizations in Minnesota based on defined criteria. Each case study showcases how the local government has implemented fleet management practices included in the previous fleet management framework section to also achieve similar fleet management goals as defined by the City of Inver Grove Heights. Both the literature review and case studies were used to inform and develop policy options for the City of Inver Grove Heights. A cost benefit analysis was then presented and evaluates ten fleet management options by based on costs associated with fuel, capital, maintenance and repair, and risk management, and benefits associated with the financial savings of implementing the fleet management option.

2. The City of Inver Grove Heights

2.1 Background of Inver Grove Heights

The City of Inver Grove Heights is located in Dakota County, Minnesota and has a current estimated population of 35,077 with a growth rate of 0.46% (Data USA, n.d.; U.S. Census Bureau, 2017). Dakota County is now the third most populated county within Minnesota and is one of seven counties in the Twin Cities Metropolitan region (U.S. Census Bureau, 2017). Only 60 years ago, however, the County's population was only 1/6 of its current population (U.S. Census Bureau, 2017). During that time, the Metropolitan region's population was growing rapidly along with the demand for solid waste management. As interest in landfill development increased, Dakota County offered open land for landfill placement. This land was nearby transportation corridors but outside urban and suburban cities, presenting an opportunity to locate refuse disposal out of sight. For this reason, Dakota County has acquired more landfills over time than any other county in Minnesota, which currently amounts to five open landfills; three of which are in the City of Inver Grove Heights (Star Tribune, 2017).

Hosting open landfills poses unique challenges to the host communities such as increased road traffic from elevated waste hauling rates, suppressed property values, air and water quality concerns, and soil contamination (Dakota County, 2017; Star Tribune, 2017). Like other host communities, the City of Inver Grove Heights receives host community funds annually from the landfill owners for the City to offset the challenges posed by the landfill. These agreements provide significant revenue for the City's operations today, however, the revenue is projected to last only until 2031 or once the landfills have reached collection capacity. For the City to continue to provide high quality services to residents and businesses within the community after the host community revenue ends, the City must consider how to offset the financial impact of this revenue loss. Opportunities to offset the financial impact of this revenue loss can be identified through long-range planning initiatives with an emphasis on financial and environmental sustainability. These sustainability planning initiatives can assist the City in evaluating

existing operating conditions and identifying opportunities to increase operational efficiency and reduce expenditures. Evaluating the operational efficiency of the City's fleet is one approach, among others, that the City can take to determine if cost savings opportunities exist.

In March 2016, the City Council passed a resolution to commit to participating in the Minnesota GreenSteps Cities Program (GCS), a voluntary assistance and recognition program for cities to receive guidance in achieving their sustainability and quality-of-life goals (Minnesota Pollution Control Agency, n.d.-b, 2018). The program provides cities implementation strategies of 29 best practices that emphasize cost savings and energy use reduction opportunities (Minnesota Pollution Control Agency, n.d.-b). As of June 2018, Inver Grove Heights will receive a recognition award for achieving Step 2 of 5 by completing 12 best practices (Minnesota Pollution Control Agency, 2018). To support identification and prioritization of new energy and environmental planning initiatives, the City also plans to create a Sustainability Program with full-time staff support in 2018. Once the Sustainability Program is developed, one sustainability initiative the City can pursue is to update the fleet management process to prioritize efficiency and cost savings, which is recommended in *Best Practice 13: Efficient City Fleets* of the GSC program. This research presents a long-term fleet management sustainability initiative the City can consider implementing to target cost savings, energy efficiency, emission reduction, and other GSC goals.

2.2 Inver Grove Heights Vehicle Fleet

This section presents the City of Inver Grove Heights' fleets conditions between January 1st, 2017 through December 31st, 2017, unless otherwise stated. An overview of the fleet's composition, expenses, emissions, and vehicle replacement process are presented in the following sections.

2.2.1 Vehicle Categories

In this report, Inver Grove Heights' fleet is divided into two categories; on-road vehicles and non-road vehicles. The six vehicle classifications used to describe Inver Grove Heights' fleet vehicles in this report and are defined below in Section 2.2.1.1.

2.2.1.1 On-Road Vehicles

Light Duty Vehicles

- Sedans: A passenger car capable of carrying four to five passengers.
- Large Passenger Vehicles (LPVs): This category consists of two types of passenger vehicles;
 - Sports Utility Vehicles (SUVs): Passenger vehicle capable of carrying four to five passengers. These are typically built on a light-duty truck frame and provide higher ground clearance and storage than a sedan.
 - Minivans: Passenger vehicle that can hold up to eight passengers and has a Gross Vehicle Weight Rating (GVWR) of less than 8,500 pounds (U.S. Department of Energy; Alternative Fuels Data Center, n.d.). Rear seats can also be removed or laid down to increase room for storage.
- Light-Duty Pickups: A flat-bed truck that has a GVWR of less than 8,500 pounds (U.S. Department of Energy; Alternative Fuels Data Center, n.d.). These vehicles typically provide higher ground clearance and storage than sedans and LPVs.

Heavy Duty Vehicles

- Heavy-Duty Pickups: A flat-bed truck that has a GVWR of more than 8,500 pounds (U.S. Department of Energy; Alternative Fuels Data Center, n.d.).
- Heavy-Duty Trucks: This category consists of two types of specialty non-pickup vehicles;
 - Trucks: A non-pickup truck with specialty construction or maintenance duties and a GVWR of more than 8,500 pounds (U.S. Department of Energy; Alternative Fuels Data Center, n.d.).
 - Cargo Vans: A passenger van that can hold up to eight passengers and has a GVWR of more than 8,500 pounds (U.S. Department of Energy; Alternative Fuels Data Center, n.d.). Rear seats can be removed or laid down to increase room for storage.

2.2.1.2 Non-Road Vehicles

- Non-Road Vehicles: A vehicle or piece of equipment that is driven and operated for construction and maintenance duties. For the purposes of this study, this category includes all non-road vehicles such as street maintenance vehicles, construction loaders, and riding lawnmowers.

2.2.2 Composition of Fleet

As of December 2017, the City owned and managed 121 vehicles within their fleet. Based on 2017 data, the City of Inver Grove Heights's fleet is made up of 77% on-road vehicles and 23% non-road vehicles (Fig. 1). There are slightly more heavy-duty vehicles (heavy-duty pickups and heavy-duty trucks) than light-duty vehicles (sedan, large passenger vehicles, and light-duty pickups), which account for 42% and 35% of on-road vehicles, respectively (Fig. 1).

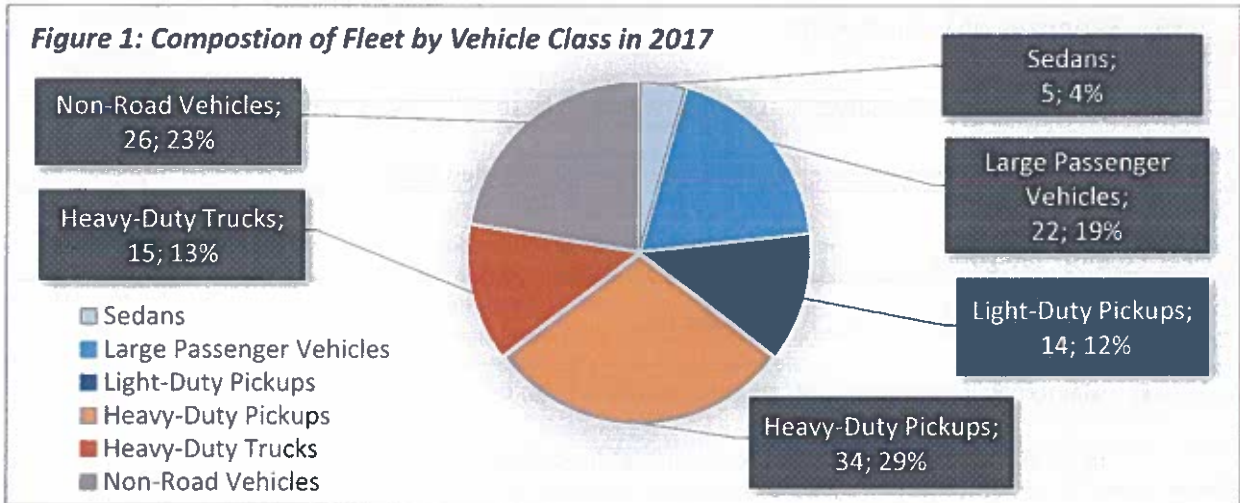


Figure 1: Composition of Fleet by Vehicle Class in 2017

Figure 2 outlines the vehicle ownership by department in 2017. All non-road vehicles are owned by the Streets Department and the Parks and Recreation Department (Fig. 2). The Streets Department also has the largest proportion of on-road vehicles compared to all other departments (Fig. 2). The Police Department owns the second largest proportion of on-road vehicles, the most SUVs, and the only minivan within the fleet (Fig. 2). The smallest department fleet is owned by the Administration Department, which consist of one on-road vehicle (Fig. 2).

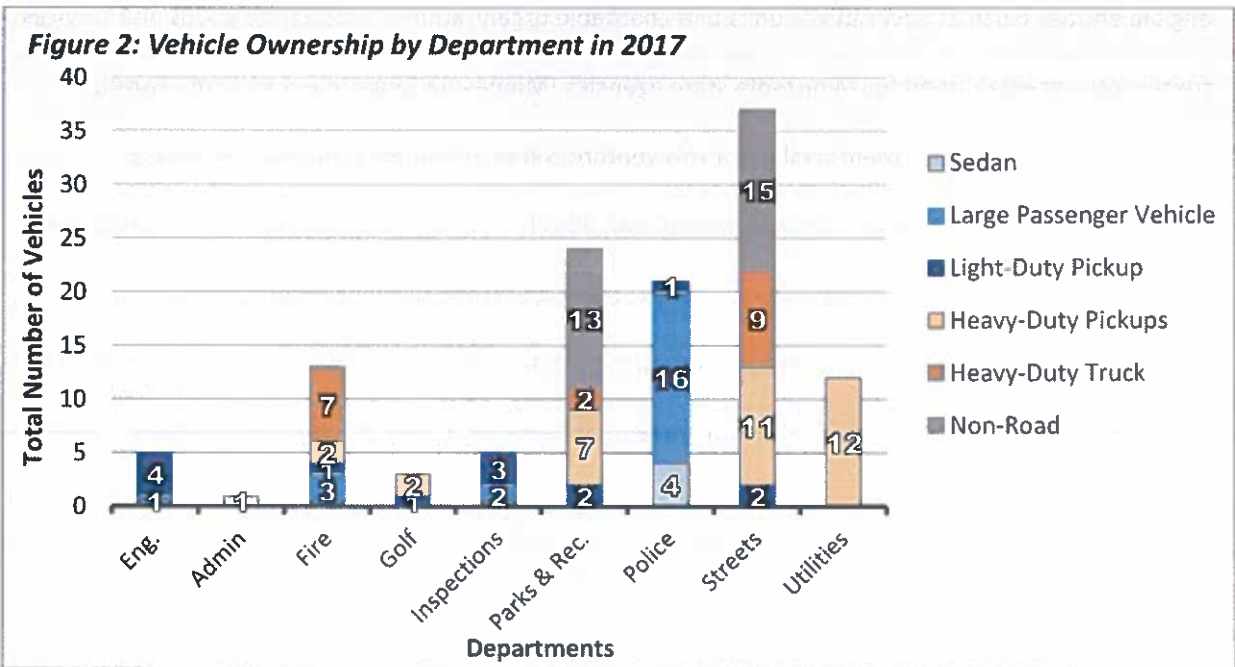


Figure 2: Vehicle Ownership by Department in 2017

2.2.3 Expenses of Vehicle Fleet

There are four expenditure categories associated to the City's fleet management. A description of each fleet expense category referred to in this report is included below:

Fleet Expense Categories

- Capital: Includes upfront cost of vehicles.
- Maintenance: Includes costs of parts supplied (e.g., oil, replacement parts) and labor costs (e.g., in-house service, out sourced service) for vehicle maintenance.
- Fuel: Includes both gas and diesel expenses for fleet vehicles.
- Risk Management: Includes liability and physical damage insurance for fleet vehicles.

To maintain the vehicle fleet, the City spends an annual average of \$800,000 on capital costs, \$350,000 on maintenance costs, \$200,000 on fuel costs, and \$40,000 on risk management (Fig. 3). The cost for fuel and vehicles is typically dependent on Minnesota's Cooperative Purchasing Venture (CPV) contracts, which are the main fleet management purchasing resources used by the City. CPV allows eligible entities (such as government units and charitable organizations) to purchase goods and services from contracts established for Minnesota state agencies (Minnesota Department of Administration: State Procurement, 2017). Membership for this venture is free and offers time and cost saving purchasing opportunities to members (Procurement, 2017). Currently, fuel and vehicles are purchased from the CPV contacts by the City unless a product required for the City's fleet operational needs is not available. On average, capital costs account for approximately 55% of annual fleet expenses, making this the largest expenditure category for fleet management, followed by maintenance costs (28%) (Fig. 3).

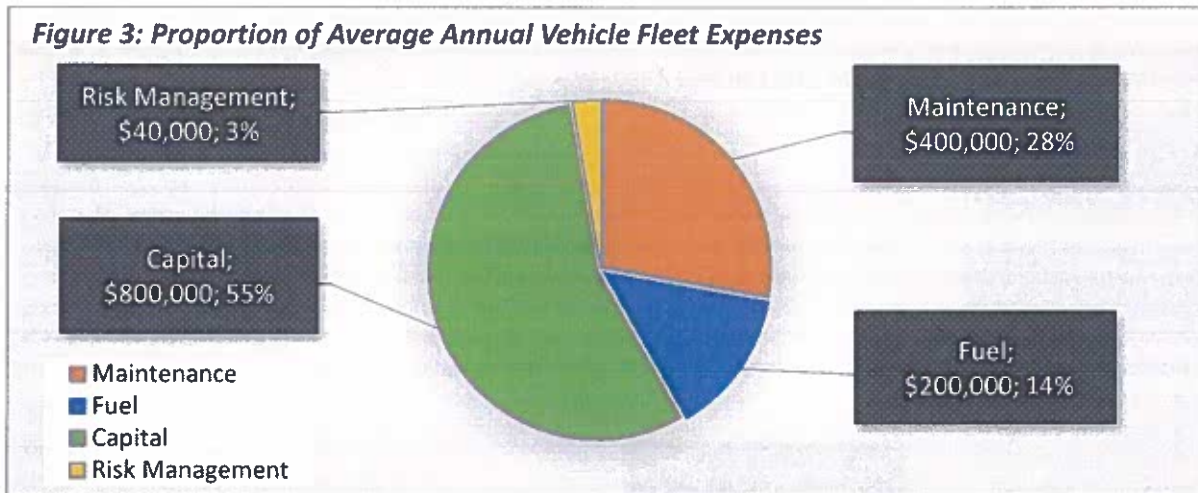


Figure 3: Proportion of Average Annual Vehicle Fleet Expenses

On-road vehicles account for approximately 60% of capital costs on average (Fig. 4). In 2017, on-road vehicles accounted for the majority of maintenance costs (Fig. 5; 64%; \$229,800) and fuel costs (Fig. 6; 89%; \$175,000). Compared to other on-road vehicle classes in 2017, heavy-duty vehicles accounted for the majority of maintenance costs (72%; \$162,000).

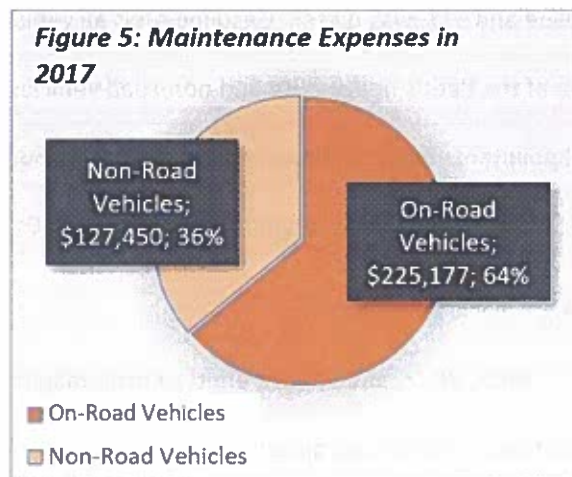
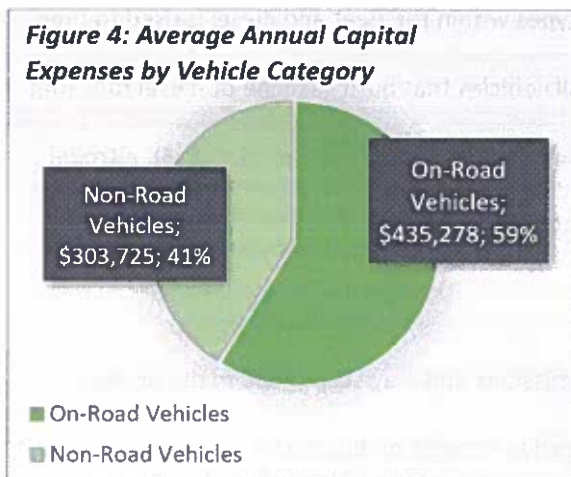


Figure 4: Avg. Annual Capital Expenses by Vehicle Category Figure 5: Maintenance Expenses in 2017

Additionally, in 2017, light-duty vehicles accounted for the majority of fuel costs (Fig. 6; 50%; \$96,500), where Large Passenger Vehicles consumed the highest portion of fuel compared to all other vehicle classes (Fig. 6; 47%; \$88,044). Approximately 68% of these vehicles are owned by the Police Department (Fig. 2).

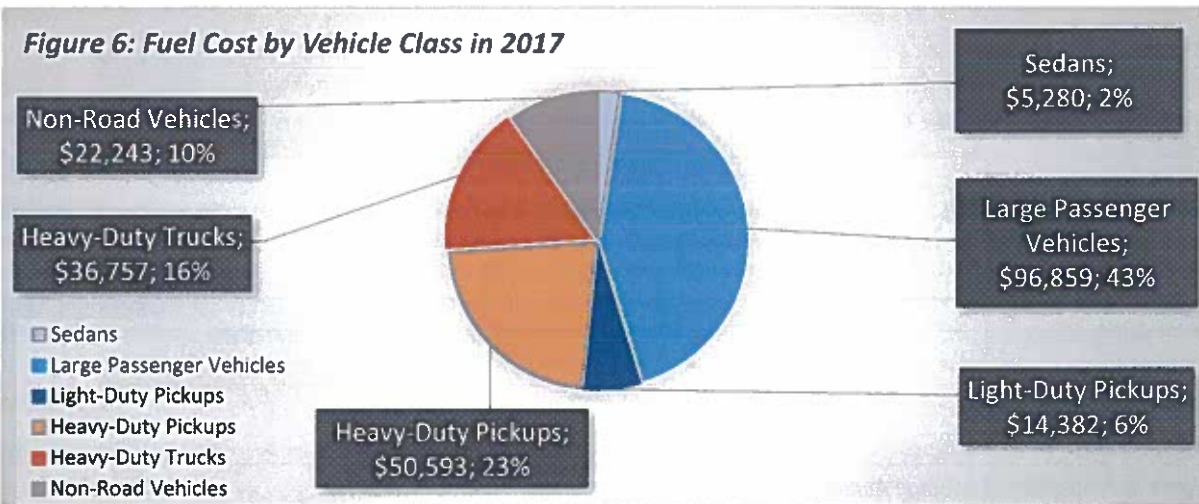


Figure 6: Fuel Cost by Vehicle Class in 2017

2.2.4 Fleet Emissions

All vehicles in the City’s fleet have internal combustion engines (ICE) that burn gasoline or diesel fuel. In 2017, the Inver Grove Heights’ fleet consumed about 95,318 gallons of fuel, of which 68% was gasoline and 31% was diesel. Gasoline fuels all vehicle types within the fleet and diesel is used to fuel some of the fleet’s heavy-duty and non-road vehicles. All vehicles that burn gasoline or diesel fuel emit local pollutants and greenhouse gases such as carbon dioxide (CO₂), particulate matter (PM), nitrogen oxides (NOx), and volatile organic compounds (VOCs) (OA US EPA, n.d.).

2.2.4.1 Local Air Pollutants

NOx, VOCs, and PM are emitted from tailpipe emissions and stay suspended in the air near ground-level. These local air pollutants are linked to negative impacts on human health, social welfare, and environmental impacts (U.S. Environmental Protection Agency, n.d.; OAR,OTAQ,TCD US EPA, n.d.). When NOx and VOCs are emitted into the air, they react with sunlight and create ozone that stays at ground-level, creating the main component in smog (US EPA, OAR, n.d.). At ground-level, ozone is harmful to human health by triggering a variety of respiratory health problems, particularly in children, elderly, or individuals with existing lung diseases (US EPA, OAR, n.d.). PM, another form of local air

pollutant emitted by ICE vehicles, refers to a mixture of solid particles and liquid droplets. ICE vehicle emissions react in the atmosphere and create a form of PM known as secondary particles (US EPA, OAR, n.d.). These fine particles are associated to respiratory health problems, non-fatal heart conditions, reduced visibility, and acidification of lakes and streams (US EPA, OAR, n.d.). The rate that ICE vehicles emit local air pollutants is dependent on multiple variables such as a vehicle's age, fuel economy, and overall engine performance which is not currently documented for the City of Inver Grove Heights fleet.

2.2.4.2 Greenhouses Gases

When ICE vehicles burn fossil fuels such as gasoline and diesel, greenhouse gas (GHG) emissions are released into the atmosphere from a vehicle's tailpipe (OAR,OTAQ,TCD US EPA, n.d.). Once emitted, these gases trap heat energy in the atmosphere which can alter the earth's climate, raise sea levels, and negatively impact human health, welfare, and ecosystems (OAR,OTAQ,TCD US EPA, n.d.). In 2015, on-road ICE vehicles accounted for 75% of U.S. transportation related GHG emissions, of which 96.4% was the greenhouse gas CO₂ (Epa, of Transportation, Quality, & Division, 2017). Although CO₂ represents the largest sources of GHG emissions of vehicle emissions, ICE vehicles also emit small amounts of other GHGs such as methane (CH₄), nitrous oxide (N₂O), and hydrofluorocarbons (HFCs) into the atmosphere (Epa et al., 2017).

The City's gas engine vehicles are fueled with E10 gasoline due to Minnesota Statute 2017, section 239.791 that requires all gasoline sold in Minnesota to contain at least 10% biofuel in the form of ethanol (The Office of The Revisor of Statutes, 2017). E10 is a gasoline fuel blend mixed of 10% ethanol and 90% gasoline. When ethanol is blended into gasoline, it decreases the pounds of carbon emitted per gallon of fuel burned (Wang, Han, Dunn, Cai, & Elgowainy, 2012). According to the EPA's Greenhouse Gas Inventory Guidance document, to calculate greenhouse gas emission factors per gallon of E10 gasoline burned, the total consumption is treated as 10% ethanol and 90% gasoline (Environmental Protection Agency, 2016). Using this method and the CO₂ emission factor for

transportation fuel defined by ICLEI Local Governments for Sustainability's GHG Protocols, combusting one gallon of E10 emits approximately 18.69 pounds of CO₂ $\{[0.1936 \text{ lbs CO}_2/\text{gallon of gasoline} \times 0.9] \times [0.1268 \text{ lbs CO}_2/\text{gallon of E100} \times 0.1]\}$ (ICLEI - Local Governments for Sustainability, 2013).

The City's diesel engine vehicles are fueled with B5 and B10 due to a Minnesota Statute 2017, section 239.77 that requires all diesel fuel sold in Minnesota for use in internal combustion engines to contain at least 10% biofuel during April through September (The Office of the Revisor of Statutes, 2017b). The rest of the year, the minimal amount of biofuel required in diesel is 5% (The Office of the Revisor of Statutes, 2017b). Similar to E10, B10 is a diesel fuel blend mixed of 10% biofuel and 90% diesel, where B5 is a blend of 5% biofuel and 95% diesel. The City fuels diesel vehicles with B10 from April through September, and B10 from October through March. Using the same method used to calculate CO₂ emission factors for E10, combusting one gallon of B10 or B5 emits approximately 22.34 or 22.43 pounds of CO₂ per gallon of fuel, respectively $(B10: [0.2251 \text{ lbs CO}_2/\text{gallon of diesel} \times 0.9] \times [0.2083 \text{ lbs CO}_2/\text{gallon of B100} \times 0.1]; B5: [0.2251 \text{ lbs CO}_2/\text{gallon of diesel} \times 0.95] \times [0.2083 \text{ lbs CO}_2/\text{gallon of B100} \times 0.05])$ (ICLEI - Local Governments for Sustainability, 2013). For the purposes of this study, an average of B10 and B5 CO₂ emission factors (22.39 pounds of CO₂) was used to calculate diesel fuel emissions for fleet vehicles. ICLEI's emissions factors indicate that diesel emits more GHGs per gallon of fuel burned than gasoline (ICLEI - Local Governments for Sustainability, 2013). Based on these emissions factors, in 2017, the City of Inver Grove Heights' fleet emitted approximately 842 metric tons of CO₂ into the atmosphere, where 40% was emitted by Large Passenger Vehicles and 40% was emitted by Heavy-Duty Vehicles (Fig. 7).

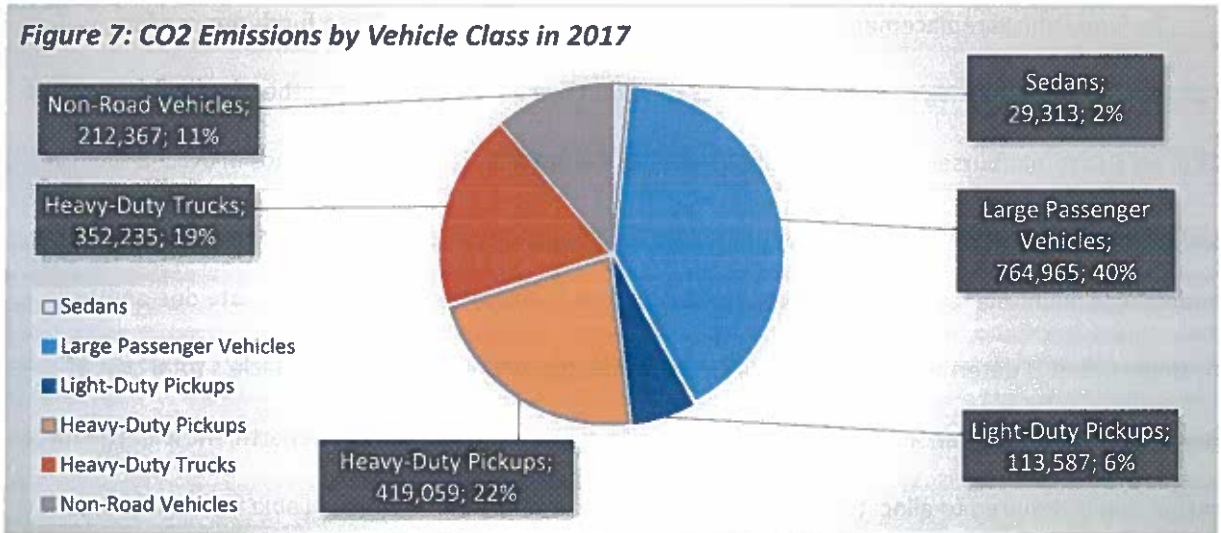


Figure 7: CO2 Emissions by Vehicle Class in 2017

2.2.5 Vehicle Replacement Process

When purchased, each vehicle is assigned to one of following nine departments: Streets, Fire, Police, Engineering, Inspections, Utilities, Administration, Parks and Recreation, or the Golf Course. Every year following the City’s annual budgeting process, the fleet manager meets with each department’s division head to determine the state of their department’s fleet vehicles. Most fleet vehicles are replaced based on a 10-year vehicle replacement guideline developed by the City, aside from police patrol vehicles and fire trucks that are replaced on varying schedules. Although the replacement schedule is generally followed, the vehicle’s true replacement date is determined based on the condition of the vehicle and replacement needs.

To determine a vehicle’s condition and ensure it warrants replacement in the following fiscal year, the fleet manager completes a Vehicle Condition Index for vehicles up for replacement. This index was developed by the American Public Works Association and uses a point system based a set of criteria such as: age of the vehicle; vehicle’s mileage (gas engines) or hours operated (diesel engines); frequency and costs of repairs; vehicle’s body condition; and costs per mile.

To fund vehicle replacements, the City uses Internal Services funds. These funds are used to “account for the financing of goods or services provided by one department to other departments of the City, on a cost reimbursement basis” (City of Inver Grove Heights, 2016). These funds allow the City to charge each department the cost of compensated liability, vehicles, vehicle equipment (parts and fuel), and vehicle maintenance on an annual basis (City of Inver Grove Heights, 2016). The rate due annually by department is determined by the City’s Finance Director, who estimates the vehicle’s total cost of replacement based on an annual 3% inflation rate. To replace the vehicle, the department who will have ownership is required to allocate a fixed annual rate that ensures funds are available for vehicle replacement when needed. Additionally, money received when selling the existing vehicle is used towards the vehicle’s replacement. The City typically sells the used vehicles by trading into the dealer or by selling the vehicle online.

3. Fleet Management Through Comprehensive Framework and Best Practices

3.1 Overview of Fleet Management Frameworks and Best Practices for Government Fleets

All levels of government own and maintain vehicle fleets to provide services to the community and transportation to employees. Although Federal and State Government fleets are required to implement best practices defined in federal and state legislation, Local Governments, such as City and County Governments are not. Fleet management legislation currently sets operational goals for Federal and State fleets and provides guidance through structured frameworks on how best to manage vehicle fleets to meet defined goals. Minnesota cities are not required to; however, many have taken voluntary

action to update their fleet's management practices to meet similar goals defined by federal and state legislation.

The following sections present fleet management frameworks and best practices developed by federal and state legislation, and sustainability coalitions for government agencies to meet operational goals. When considering updating fleet management practices, Inver Grove Heights and other cities can review the following fleet management framework currently utilized by other government fleets to learn which best practices can be followed to meet operational goals defined by the City such as; increasing fleet fuel efficiency, reducing fleet management costs, and reducing vehicle emissions.

3.2 Energy Policy Act 1992

The Energy Policy Act of 1992 (EPAct 1992) was adopted to increase use of alternative fuels, production of renewable energy, and implementation of energy efficiency improvements within the United States (Alternative Fuels Data Center, 2018b; Public Law 102-486, 1992). This legislation set goals to: Strengthen energy security by reducing dependence on imported oil; Increase energy efficiencies at lowest cost to the Nation; Reduce air, water and environmental impacts of energy systems; Stimulate economic growth through technology development; and Improve fuel economy while reducing emissions of air pollutants (Public Law 102-486, 1992). Section 303 of EPAct 1992 sets alternative fuel vehicle purchasing requirement for federal and state fleets that contain at least 20 vehicles and are located in a metropolitan area with a 1980 population at least 250,000 (Public Law 102-486, 1992). By 1999, these fleets were required to purchase alternative fuel vehicles for 75% of newly acquired light-duty vehicles (Public Law 102-486, 1992). Specialty vehicles such as emergency vehicles, non-administrative law enforcement vehicles, and non-road vehicles are excluded from this requirement.

3.2.1 Alternative Fuels Defined by EPC Act 1992

The EPC Act 1992 defines alternative fuel as a list of eight commonly-known types of alternative fuels. The following section discusses the alternative fuels defined by the EPC Act 1992 in terms of their current use by Minnesota governments, their environmental impacts, and their implementation feasibility for Minnesota local governments based on their costs and infrastructure requirements.

Electricity

Electricity can be used to fuel all-electric vehicles and plug-in hybrid electric vehicles. All-electric vehicles, also known as battery electric vehicles (BEV), are powered by only electricity drawn from an electrical power source such as the grid or batteries. Plug-in hybrid electric vehicles (PHEV) are powered by a combination of electricity and liquid fuels, such as gasoline or diesel. The following organizations are examples of Minnesota government fleets using electricity to power selected light-duty fleet vehicles: State of Minnesota, Dakota County, Ramsey County, Hennepin County, Minneapolis, St. Paul, Elk River, Edina, Burnsville, Woodbury, and Maplewood.

Electric vehicles produce no tailpipe emission, however there are greenhouse gas emissions from the production of electricity used to charge the vehicle (Alternative Fuels Data Center, 2017). Emissions of electricity can be calculated by two different factors, average emission factors (AEFs) and marginal emission factors (MEFs). In Minnesota, each are based off the energy production profile of the U.S Midcontinent Independent System Operator (MISO). MISO operates the transmission system and manages the wholesale electric market in portions of 15 states (FERC: Federal Energy Regulatory Commission, 2017). Given that many generators produce and sell electricity within this market, AEFs are used to reflect grid-average emissions of all generators within the MISO profile (Li, Smith, Yang, & Wilson, 2017). As more renewable energy is added to the grid however, MEFs may be a more appropriate metric to calculate energy emissions as these reflect emissions relative to changes in production based on changes in demand (Li et al., 2017).

Charging infrastructure is required to deliver electricity from the grid to the plug-in vehicle.

Charging stations can be wall-mounted within a residential or workplace garage or ground mounted indoors or outdoors and shared within a public space. The infrastructure costs can vary greatly based on the designated installation location and what outlets and electrical lines currently exist. The length of charging time to fully charge a vehicle depends on the battery's current state of charge, the power coming from the charging station, and the rate a vehicle can accept power, which may be lower than the supply power (U.S. Department of Energy, 2015). There are three levels of charging stations that can be installed.

Level 1 charging stations charge vehicles through a 120-volt AC plug and provide about 4 to 6 miles of range per 1 hour of charging (U.S. Department of Energy, 2015). Using a Level 1 charging station, a typical PHEV with an electric-only range of 50 miles would take about 12 hours to fully charge, and a typical EV with an electric-only range of 130 miles would take about 30 hours to fully charge. Due to slower charging rates these chargers are used by one vehicle during the standard work day. Costs can range between \$300 to \$1,500 per charging unit and \$0 to \$3,000 for installation (U.S. Department of Energy, 2015).

Level 2 charging stations charge vehicles through a 240-volt or 208-volt AC plug and provide 10 to 60 miles of range per 1 hour of charging (U.S. Department of Energy, 2015). Using a Level 2 charging station, a typical PHEV with an electric-only range of 50 miles would take about 4.5 hours to fully charge, and a typical EV with an electric-only range of 130 miles would take about 10 hours to fully charge. Costs can range between \$400-\$6,500 per charging unit and \$600-\$12,700 for installation (U.S. Department of Energy, 2015).

Level 3 charging stations charge vehicles through a 208-volt or 480-volt AC plug and provide 24 to 90 miles of range per 20 minutes of charging (U.S. Department of Energy, 2015). Costs can range between \$10,000-\$40,000 per charging unit and \$4,000-\$51,000 for installation (U.S. Department of Energy, 2015). Using a Level 3 charging station, a typical PHEV with an electric-only range of 50 miles

would take about 2 hours to fully charge, and a typical EV with an electric-only range of 130 miles would take about 5.5 hours to fully charge. The faster charging rates of level 2 and 3, allows multiple vehicles to be charged per day. Charging rates are set by the electricity provider and are charged per kilowatt-hour. Typically, electricity prices are cheaper at night when demand is lower.

Blends of 85% alcohol with gasoline

Although Minnesota mandates the use of 10% ethanol in all gasoline sold in Minnesota, only fuel with 85% alcohol or more (or 70% or more if approved by the U.S. Secretary of Energy for specialty vehicle requirements such as cold starts or safety) are considered an alternative fuel by the EPA 1992 (Alternative Fuels Data Center, 2018b). This includes alcohols such as methanol and denatured ethanol (Alternative Fuels Data Center, 2018b). In Minnesota, E85 is a gasoline fuel blended can contain 51% to 85% ethanol by volume mixed, however the ethanol content must comply with ASTM standards for uses an alternative fuel (The Office of the Revisor of Statutes, 2017a). E85 is used to power flexible fuel vehicles (FFVs), which have an internal combustion engine that can be powered by both E85 and gasoline (Alternative Fuels Data Center, 2018a). The following organizations are examples of Minnesota government fleets that have used E85 to power selected fleet vehicle: State of Minnesota, Dakota County, Hennepin County, Minneapolis, St. Paul, Burnsville, Golden Valley, Fergus Falls, and Woodbury.

According to the CO₂ emission factor for transportation fuel defined by ICLEI Local Governments for Sustainability's GHG Protocols, combusting one gallon of E85 with 83% ethanol emits approximately 13.81 pounds of CO₂ $\{[0.1936 \text{ lbs CO}_2/\text{gallon of gasoline} \times 0.17] \times [0.1268 \text{ lbs CO}_2/\text{gallon of E100} \times 0.83]\}$ (ICLEI - Local Governments for Sustainability, 2013). Mixtures with a higher volume of ethanol will decrease the pounds of carbon emitted per gallon of fuel (Wang et al., 2012). Some view ethanol as a carbon-neutral fuel, as ethanol production in theory also sequesters carbon. However, it should be considered that when increased demand for crops leads to cropland expansion and indirect land-use change effects that results in GHG emissions (Jason Hill, Liailia Tajibaeva, 2016). As a result, it is unclear whether some biofuels, in particular corn ethanol, actually reduce GHG emissions (National Research Council of The

National Academies, 2011). Although, the carbon emissions emitted directly from combusting ethanol decrease with higher contents of ethanol, the impacts of the alcohol on fuel efficiency should be considered as well.

Ethanol contains about 30% less energy than gasoline per gallon, however the impact on fuel economy is dependent on the ethanol content in the fuel and the vehicle performance (“Alternative Fuels Data Center: Ethanol Fuel Basics,” n.d.). Given that alternative fuels have a lower energy content than gasoline, dollars per gallons per gasoline equivalent are generally higher than the prices per gallon (O. of E. E. & R. E. U.S. Department of Energy, 2018). In January 2018, the average fuel price for E85 per GGE within the Midwest Petroleum Administration for Defense Districts (PADD) defined by the U.S. Energy Information Administration was \$2.64 (GGE). Over the last decade, E85 when converted to GGE has been on average been slightly more expensive than gasoline on an annual basis (Fig. 8) (U.S. Energy Information Administration, 2018). Cost of E85 for cities will vary annually however based on the price set by the Minnesota state purchasing contract or vendor they choose to purchase from.

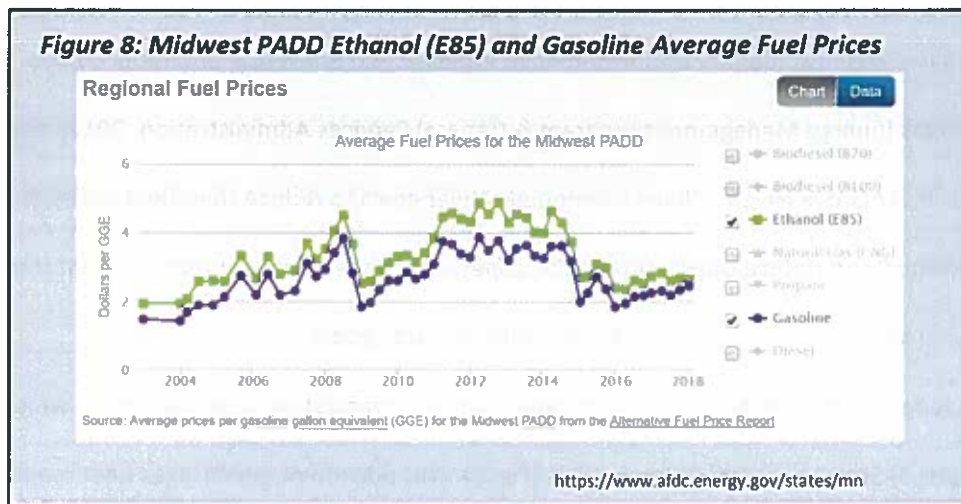


Figure 8: Midwest PADD Ethanol (E85) and Gasoline Average Fuel Prices

Additional Alternative Fuels

The remaining alternative fuels are; compressed natural gas (CNG), liquified petroleum gas (LPG), hydrogen, pure alcohols (E100), biodiesel (B100), coal-derived liquid fuels, fuels (other than

alcohol) derived from biological materials, and P-Series fuels. These fuels are not currently used by Minnesota cities' vehicle fleets of comparable size to the City of Inver Grove Heights due to a variety of obstacles. For fleets of this size, these alternative fuels present challenges such as large capital infrastructure requirements, high production costs, limited supply, undesired bi-product, and lack of alternative fuel vehicles equivalents.

3.3 Federal Executive Order 13693 (2015)

In 2015, the Federal Government established fleet management goals for federal fleets as defined in Executive Order (E.O.) 13693: *Planning for Federal Sustainability in the Next Decade* (E.O. 13693). Following the adoption, the U.S. Department of Energy and U.S. General Services Administration produced a comprehensive manual titled *Guidance for Federal Agencies on Executive Order 13693: Federal Fleet Management* that outlines a strategic plan to assist federal fleets in meeting the goals of E.O. 13693 (Energy Management Program & General Services Administration, 2017). This document presents a framework for federal fleet managers to follow to ensure their agencies reduce vehicle greenhouse gas emissions, identify opportunities to increase fuel efficiency, and reduce fleet operational costs (Energy Management Program & General Services Administration, 2017). Given that cities, such as Inver Grove Heights, have developed similar goals to reduce their fleet emissions, increase fuel fuel efficiency, and reduce operational costs, aspects of the federal fleet management framework may be transferrable to any organization targeting these same goals.

This federal framework includes four steps to meet organization needs and goals which are: 1) Plan; 2) Collect; 3) Strategize; and 4) Implement (Fig. 9). This document encourages fleet managers to review and update each step annually to ensure the fleet is meeting operational needs and goals. Each step of this framework is described below and can be altered by an organization to fit their fleet's needs.

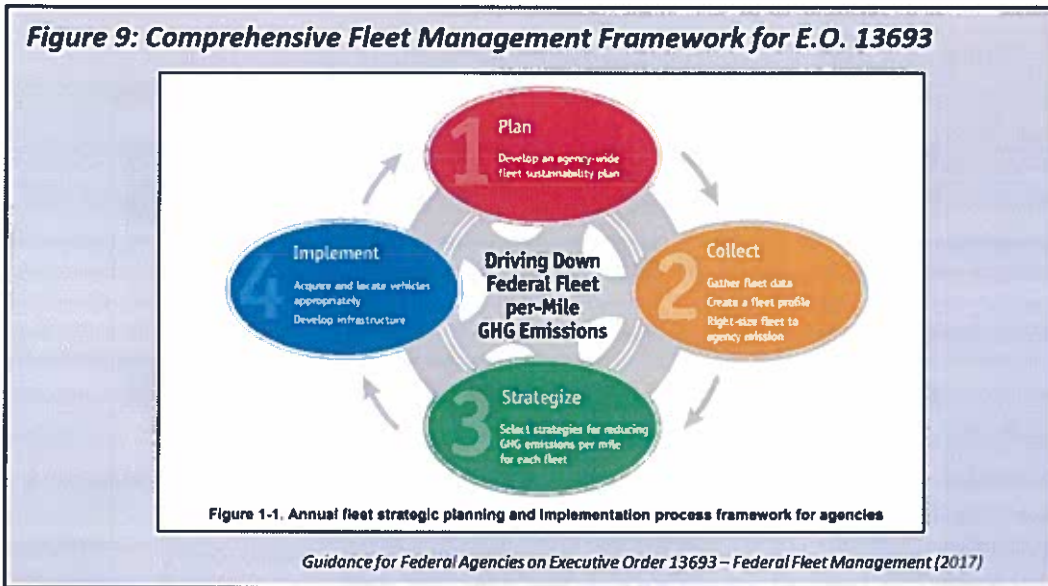


Figure 9: Comprehensive Fleet Management Framework for E.O. 13693

3.3.1 Step 1: Plan

Step 1 of E.O. 13693 framework requires federal fleet managers to develop an agency-wide fleet plans to meet the executive order’s goals by 2025. The plan must be written to, “reduce overall and fleet-wide per-mile GHG emissions by right-sizing fleets to the mission, increasing fleet fuel efficiency, deploying ZEVs (Zero Emission Vehicles) including all-electric vehicles and fuel cell electric vehicles, PHEVs, and related charging and refueling infrastructure, increasing alternative fuel use, and improving fleet management”. Figure 10 contains a complete list the strategies to be included in the federal fleets action plans to meet the Executive Order’s goals.

Figure 10: Emission Reduction Strategies to meet E.O. 13693 Goals

Table 1-1. Greenhouse Gas Emission Reduction Strategies and Relevant Federal Fleet Requirements				
GHG Reduction Plan or Strategy	Additional Information Source	Fleet Requirement	Statute or Executive Order	Requirement
Overarching E.O. 13693 Federal Fleet Goals				
Reduce fleet-wide per-mile GHG emissions	Guidance Chapter 3	Reduction in fleet-wide per-mile GHG emissions	E.O. 13693, Sec. 3(g)(i)	Not less than 4 percent total reduction from FY 2014 to end of FY 2017 Not less than 15 percent total reduction from FY 2014 to end of FY 2021 Not less than 30 percent total reduction from FY 2014 to end of FY 2025
Reduce overall fleet GHG emissions	Guidance Chapters 2 & 3	Reduction in annual/overall fleet GHG emissions	E.O. 13693, Sec. 2	Reduce fleet GHG emissions as part of agency-established scope 1 and 2 reduction targets for FY 2008 to FY 2025
Plan, Collect, Strategize, and Implement				
Develop agency-wide fleet management plan	Guidance Chapter 2	Agency plan to achieve fleet goals	E.O. 13693, Sec. 14	Develop (and update annually) a fleet management plan (FMP) to achieve the E.O. 13693 fleet goals
Develop agency profile and right-size fleets	Guidance Chapter 5	Vehicle Allocation Methodology (VAM)	E.O. 13693, Sec. 3(g)(i)	Establish a structured VAM to determine the appropriate size and number of vehicles
Increase fleet fuel efficiency	Guidance Chapter 2 & Handbook	Reduction in fleet-wide per-mile and annual/overall fleet GHG emissions	See E.O. 13693 overall fleet and fleet-wide per-mile GHG emission reduction requirements above	
Acquire AFVs and use alternative fuel		Alternative fuel use in AFVs	EPAct 2005, Sec. 701	Dual-fueled vehicles must use alternative fuel unless waived due to non-availability or cost (subject to approval by DOE)
Use biodiesel blends (B20 or greater) in diesel vehicles		Alternative fuel infrastructure	EISA, Sec. 248	Every federal fleet fueling center must install a renewable fuel pump
Acquire electric vehicles (EVs)				
Implement sustainable vehicle acquisitions	Guidance Chapter 4	Acquisition of ZEVs and PHEVs	E.O. 13693, Sec. 3(g)(v)	20 percent of new passenger vehicle acquisitions must be ZEVs or PHEVs by FY 2020 and 50 percent by FY 2025
	Guidance Chapter 6	Vehicle telematics deployment	E.O. 13693, Sec. 3(g)(ii)	Deploy vehicle telematics in all new LDV and MDV acquisitions no later than March 19, 2017 (except where the agency determines that it is not appropriate)
	Handbook	Acquisition of AFVs	EPAct 1992	At least 75 percent of LDVs acquired in MSAs/CMSAs must be AFVs
		Acquisition of low GHG-emitting vehicles	EISA, Sec. 141	Prohibits agencies from acquiring LDVs or passenger MDVs that are not low-GHG-emitting vehicles, unless no model is available that meets the fleet's functional needs or the agency has taken alternative measures to reduce GHG emissions
Monitor fleet performance	Handbook	Annual agency compliance report	EPAct 1992 ECRA 1998	Each agency must report to Congress annually on compliance with federal fleet AFV acquisition requirements
Reevaluate strategies	Handbook	Agency implementation plans	See E.O. 13693 fleet plan requirements above	

Guidance for Federal Agencies on Executive Order 13693 – Federal Fleet Management (2017)

Figure 10: Emission Reduction Strategies to Meet E.O. 13693 Goals

3.3.2 Step 2: Collect Data

Step 2 of E.O 13693 requires fleet managers to compile and manage accurate and comprehensive asset-level fleet data (Energy Management Program & General Services Administration, 2017). This is required to, “enable the agency to optimize fleet decision making, establish a baseline fleet profile, and use that profile to right-size the fleet’s inventory and vehicle sizes to the agency mission” (Energy Management Program & General Services Administration, 2017). Collecting data on a fleet and ensuring its accuracy and comprehensiveness is critical to provide decision makers the information needed to make decisions to meet their defined goals. This can be done by creating a fleet management inventory of all fleet vehicle

to develop a baseline of the fleet's existing conditions (Energy Management Program & General Services Administration, 2017). The framework recommends the fleet inventory includes all fleet vehicles and documents the use, mileage, fuel usage, and maintenance costs for each vehicle (Energy Management Program & General Services Administration, 2017). This data is imperative to informing the implementation strategies included in the following section.

3.3.3 Step 3: Strategize

Step 3 of E.O. 13693 requires fleet managers to evaluate strategies to reduce GHG emissions absolutely and to reduce per-mile GHG emissions (Energy Management Program & General Services Administration, 2017). To meet emissions reduction goals, the framework lists three strategies, called core principals, for greenhouse gas emission reduction. These are listed in Figure 11 and described below:

Core Principals of Greenhouse Gas Emission Reductions Goals for E.O. 13693

- Core Principal 1: Right-size fleet by evaluating the minimum vehicle requirements needed to support the agency's mission;
- Core Principal 2: Identify opportunities to eliminate vehicles with low fuel efficiency;
- Core Principal 3: Increase use of alternative fuels (Energy Management Program & General Services Administration, 2017)

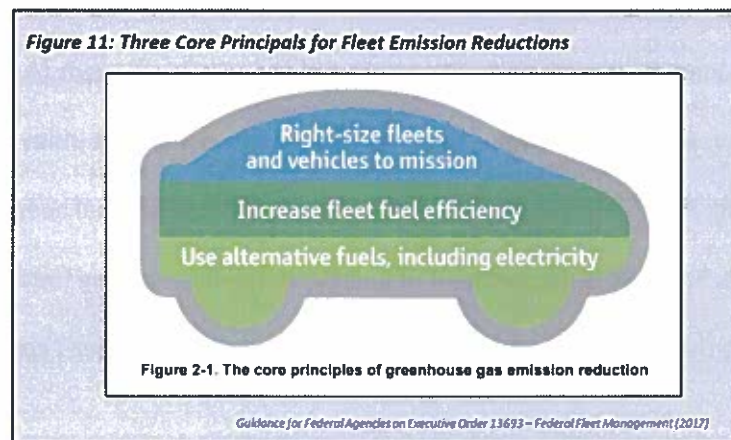


Figure 11: Three Core Principals for Fleet Emission Reductions

These core principals are not unique to federal fleets, and instead, are widely used as best management practices throughout the fleet management industry. Both the private and public sector implement these fleet management practices to minimizing the fiscal and environment impact of their fleets. Each strategy is described below based on information retrieved from the E.O. 13693 framework and additional fleet management resources online.

Right-Size Fleet to Mission

The purpose of right-sizing a fleet is to critically review the each existing fleet vehicle and associated use to identify under-utilized and inefficient vehicles within the fleet (Energy Management Program & General Services Administration, 2017). The process begins with collecting and consolidating vehicle data into an inventory, which is outlined in Step 2 (Collect Data) of the E.O. 13693 framework. Once the inventory is complete, the fleet manager can collaborate with staff to define operational needs and sustainability goals unless already defined. After the needs and goals of the fleet are defined, the fleet manager can then review how well the existing conditions of vehicles within the inventory align with those needs and goals (Energy Management Program & General Services Administration, 2017). During this process, the fleet manager may identify opportunities to eliminate unnecessary or inefficient vehicles from the agency's fleet inventory (Energy Management Program & General Services Administration, 2017).

During the right-sizing process, fleet managers may also identify ways to reassign vehicles or downsize vehicles to meet fleet goals without compromising operational needs (A. F. D. C. U.S. Department of Energy, 2017). For example, fleets comprised of mostly sport utility vehicles (SUV) may discover that replacing these with a mid-sized sedan can still fulfil operational needs while significantly reducing fuel costs (A. F. D. C. U.S. Department of Energy, 2017). By analyzing the inventory data and using it to right-sizing the fleet, fleet managers are able to optimize their fleet's composition over time

to reduce fleet maintenance costs, risk management costs, and capital costs (A. F. D. C. U.S. Department of Energy, 2017).

Increase Fleet Fuel Efficiency

Fuel economy is calculated by how many miles a vehicle can travel per gallon of fuel which indicates how efficient the vehicle's engine is at combusting fuel, such as gasoline or diesel. The farther the vehicle can travel per gallon of fuel, the greater the fuel efficiency of the vehicle. Increasing the fuel efficiency of a vehicle reduces fuel costs, dependence on oil and the oil market, and vehicle emissions (Department of Energy, n.d.-b). Fleet managers can increase the fuel efficiency of their fleet by implementing the following strategies;

- Fuel Economy: Fleet managers can replace existing vehicles with vehicles with higher fuel economy and reducing inefficient driving behaviors (Energy Management Program & General Services Administration, 2017). For example, replacing an existing internal combustion engine (ICE) vehicle with a larger engine (ex. 6-cylinder), with a more efficient ICE vehicle (ex. 4-cylinder) will increase the fleets fuel efficiency (A. F. D. C. U.S. Department of Energy, 2017). Additionally, in many cases, newer vehicles with smaller engines have nearly the same horsepower as older vehicles with larger engines (A. F. D. C. U.S. Department of Energy, 2017). An existing ICE vehicle could also be replaced by an electric vehicles with greater fuel efficiency such as hybrid electric vehicle, plug-in hybrid electric vehicle, or all-electric vehicles (Energy Management Program & General Services Administration, 2017). Additionally, replacing existing vehicles with a lighter alternative can provide an opportunity to decrease fuel consumption (A. F. D. C. U.S. Department of Energy, 2017). Lighter materials, smaller components, and removal of unnecessary heavy accessories can increase a vehicle fuel economy (A. F. D. C. U.S. Department of Energy, 2017). For example, reducing a vehicle's weight by 10% can increase the fuel economy between 6-8% (A. F. D. C. U.S. Department of Energy, 2017)

- **Maintenance: Implementing best maintenance practices can also maintain fuel economy.**
Examples of best practices include retaining recommended tire pressure (0.6% increase in fuel economy), routinely tuning your engine (4.0% increase in fuel economy), using recommended grade of motor oil (1-2% increase in fuel economy) (Department of Energy, n.d.-a; Energy Management Program & General Services Administration, 2017).
- **Efficient Driving: Fuel efficiency can be increased by using best driving practices such as driving the speed limit, removing excess weight, using cruise control, and choosing fuel-saving routes (Energy Management Program & General Services Administration, 2017). Efficient driving can reduce fuel use by 5-10% on moderately driven trips and up to 20% on aggressively driven trips(Gonder, Earleywine, & Sparks, 2012).**
- **Anti-Idling: Fuel efficiency can also be increased turning off the vehicle when not in use or utilizing idling mitigation systems (Energy Management Program & General Services Administration, 2017). These systems are used to power select features of the vehicle without running the engine (Energy Management Program & General Services Administration, 2017). Idling for more than 10 seconds uses more fuel and pollutes more CO₂ than turning off your engine and restarting it (A. N. L. U.S. Department of Energy, n.d.). Idling increases both engine wear and wastes fuel, resulting in increased costs of fuel, maintenance, and capital expenses(A. F. D. C. U.S. Department of Energy, n.d.).**

Use Alternative Fuels

Transitioning existing fleet vehicles to alternative fuel vehicles presents a variety of opportunities for fleets to reduce fuel consumption, reduce emissions, and reduce dependency on oil (O. of E. E. & R. E. U.S. Department of Energy, n.d.-b). However, to maximize these benefits, the federal framework suggests that fleet managers consider the following strategies when adding alternative fuel vehicles to their fleet:

- Fueling: Ensure that dual-fuel vehicles are fueled with alternative fuel unless waived by the DOE due to lack of availability or cost (Energy Management Program & General Services Administration, 2017).
- Infrastructure: Ensure AFV fueling or charging infrastructure is at or near where the alternative fuel vehicles will be stored and that infrastructure is in place prior to acquisition of the vehicles (Energy Management Program & General Services Administration, 2017). It is also recommended alternative fuel vehicles fueling and charging infrastructure is install in locations with the highest alternative fuel vehicles concentrations that use that fuel type (Energy Management Program & General Services Administration, 2017)
- Community Coordination: Speak with private and public-sector fleets within the community to aggregate demand for alternative fuel (Energy Management Program & General Services Administration, 2017).

3.3.4 Step 5: Implement

Once the organization has identified goals and determined which strategies would assist them in meeting that goal, the organization can decide which strategies should be prioritized and implemented. For example, E.O. 13693 the goal for their agencies is to optimize its fleet is to ensure every vehicle; 1) is as fuel efficient and cost effective as possible; 2) meets the fleet's operation needs; and 3) meets the fleet's regulatory requirements and fleet management goals (Energy Management Program & General Services Administration, 2017).

3.4 Minnesota State Executive Order 17-12 (2017)

The State of Minnesota is required to comply with the alternative fuel vehicles purchasing requirement the EPA Act 1992 just as the Federal Government. This has led to the state purchasing more than 1,200 E85 flexible-fuel vehicles, 78 hybrid vehicles, and 6 electric vehicles (State of Minnesota, n.d.). Since 2013, the state fleet has reduced fuel consumption by 16% (State of Minnesota, n.d.).

Minnesota has also adopted state legislation that imposes additional goals and requirements for its fleet management. In November 2017, Governor Mark Dayton adopted E.O. 17-12: *Directing State Agencies to Conserve Energy and Water, and Reduce Waste to Save Money* to set sustainability goals for state agencies. The policy states the problem that, “operation of Minnesota state government generates pollution, consumes energy and natural resources, and contributes to climate change” (State of Minnesota, 2017). It emphasizes through changes in daily operations, programs, and long-range planning, the State can have a significant positive impact on “environment, economic efficiency, character of communities, and leave a better world for future generations” (State of Minnesota, 2017). It continues to add that “strengthening sustainability in State operations leads to better government and smart stewardship of taxpayer dollars” and that Minnesotans deserves “improvements that will help save taxpayer dollars through avoided costs, increased efficiencies, and more resilient facilities and operations, along with enhanced, environmental and health protection and job creation” (State of Minnesota, 2017). The executive order outlines several sustainability goals, some of which are related to the State’s use of fleet vehicles;

- Reduced Fleet Fossil Fuel Consumption: 30% reduction of State Fleet consumption of fossil fuels by 2027 relative to a 2017 adjusted baseline;
- Sustainable Procurement: 25% of total spend on priority Contracts are sustainable purchases by 2025; and
- Greenhouse Gas Emissions: 30% reduction of Greenhouse Gas emissions by 2025 relative to a 2005 calculated baseline (State of Minnesota, 2017).

3.5 Minnesota GreenStep Cities

Unlike the federal and state governments, U.S. cities do not have to comply with the legislation presented above, and therefore cities have their own autonomy to develop fleet management goals and frameworks. Although not required, cities can set goals to reduce financial and environmental impacts

of their fleet to benefit their communities greatly. When determining how to meet fleet goals, cities who have joined the Minnesota GreenStep Cities (GCS) can reference one of the twenty-nine GCS best practices; *Best Practice 13: Efficient City Fleets*. This best practice is related to fleet management and focuses on city fleet investments, operations, and maintenance plans (Minnesota Pollution Control Agency, n.d.-c). Each of the 29 best practices have a list of actions cities can considered completing. To receive recognition credit for completing *Best Practice 13*, cities must complete the number of actions required according to their city's category requirements. Inver Grove Heights is a Category A city because it is within a metro area, is served by regular transit routes, and has distinct commercial and industrial areas (Minnesota Pollution Control Agency, n.d.-a). To receive credit for *Best Practice 13: Efficient City Fleets*, Category A cities must complete at least two of the following actions listed under the *Best Practice 13*:

Best Practice 13: Efficient City Fleets

- 13.1. Efficiently use existing fleet of city vehicles by encouraging trip bundling, video conferencing, carpooling, vehicle sharing and incentives/technology.
- 13.2. Right-size/down-size the city fleet with the most fuel-efficient vehicles that are of an optimal size and capacity for their intended functions.
- 13.3. Phase-in no-idling practices, operational and fuel changes, and equipment changes including electric vehicles, for city or local transit fleets.
- 13.4. Phase in bike, foot or horseback modes for police, inspectors and other city staff.
- 13.5. Document that the local school bus fleet has optimized routes, start times, boundaries, vehicle efficiency and fuels, driver actions to cut costs including idling reduction, and shifting students from the bus to walking, biking and city transit.
- 13.6. Retrofit city diesel engines or install auxiliary power units, utilizing Project GreenFleet or the like.

Each action has three different levels of achievement, which are called star ratings. Cities must achieve at least a one-star rating to complete the action, however Cities can take further initiative to complete two and three-star ratings. These achieve levels are listed below in Figure 12.

Figure 12: Minnesota GreenStep Cities Best Practice 13: Efficient City Fleets

Best Practice 13: Efficient City Fleets		
Action Number	Action Description	Star Requirements
13.1	Efficiently use existing fleet of city vehicles by encouraging trip bundling, video conferencing, carpooling, vehicle sharing and incentives/technology.	<ol style="list-style-type: none"> 1. Provide training and systems for employees to facilitate one or more of trip bundling, car-pooling, vehicle sharing and the like. 2. Install and use video conferencing equipment, automatic vehicle locator technology and the like. 3. Report more work being done with existing fleet or report total fleet VMT reductions year over year and/or implement an employee incentive program for reducing city vehicle use.
13.2	Right-size/down-size the city fleet with the most fuel-efficient vehicles that are of an optimal size and capacity for their intended functions.	<ol style="list-style-type: none"> 1. Survey each fleet vehicle by type, MPG and use; implement at least one right-size or down-size improvement (for example, use of a sedan instead of a pick-up truck for inspection work, use of a full electric utility vehicle in parks/public works, or one multi-purpose vehicle instead of two vehicles). 2. Adopt a vehicle purchasing policy/practice; right-size all vehicles in one portion of the city's fleet (for example, police, fire, public works, inspections) and report any vehicle reductions and improvement in the fleet's average MPG. 3. Right-size all vehicles in the city's fleet and report vehicle reductions and improvement in the fleet's average MPG.
13.3	Phase-in no-idling practices, operational and fuel changes, and equipment changes including electric vehicles, for city or local transit fleets.	<ol style="list-style-type: none"> 1. Monitor fuel usage and costs on a regular basis; report data to fleet managers and users; implement maintenance schedules that optimize vehicle life and fuel efficiency; replace solvent-based vehicle parts washing with aqueous-based; adopt a no-idling policy/practice or conduct training for more efficient driving. 2. Achieve a 1-Star rating and complete one or more of: (a) purchase or lease at least one hybrid-electric vehicle (EV); (b) add vehicles (and fueling stations as needed) using lower-carbon fuels (ethanol [E85], compressed natural gas, straight vegetable oil, biodiesel above the State-mandated 5%, other advanced biofuels); (c) add other alternative fuel vehicles. 3. Achieve a 1-Star rating and add a highway-capable full-electric vehicle, and/or install a solar-charging EV station (or purchase renewable electricity for EV charging).
13.4	Phase in bike, foot or horseback modes for police, inspectors and other city staff.	<ol style="list-style-type: none"> 1. Police patrols on bike, foot, Segway or horseback. 2. City inspectors or other staff on bike, foot or horseback. 3. Report outcome measures resulting from actions: decreased costs, reduced vehicle miles traveled, fleet reductions, or other metrics.
13.5	Document that the local school bus fleet has optimized routes, start times, boundaries, vehicle efficiency and fuels, driver actions to cut costs including idling reduction, and shifting students from the bus to walking, biking and city transit.	<ol style="list-style-type: none"> 1. Implement at least two strategies, which can include training drivers in fuel-efficient driving, adopting a no idling policy/practice. 2. Use of route optimizer software, or city buses, or other techniques to reduce bus usage. 3. Documentation (including energy and costs) of implementation of actions.
13.6	Retrofit city diesel engines or install auxiliary power units, utilizing Project GreenFleet or the like.	<ol style="list-style-type: none"> 1. Retrofit several city diesel engines 2. Retrofit all exhaust systems of city heavy-duty diesel truck models with diesel oxidation catalysts or filters. 3. Install at least one APU. Report business participation in U.S. EPA's SmartWay Transport program under best practice action 23.4

Minnesota GreenStep Cities (2017)

4. Case studies

Below are case studies of local government agencies who have implemented sustainable fleet management practices. This information was collected through the GreenStep Cities website, phone interviews, email conversations, and additional online resources. A set of criteria was used to select case studies that would provide information relevant to the City of Inver Grove Heights based on a combination of population size, location, and lessons learned. To be included in this paper, a case study was required to meet each of the following criteria.

Case Study Selection Criteria

- ✓ A Minnesota local government agency
- ✓ Government agency located in the Metropolitan Council region or an adjacent county to the Metropolitan Council region
- ✓ Have implemented a sustainable fleet management practice as outlined in the Comprehensive Fleet Management Framework
- ✓ Have responded to interview requests

4.1 Case study #1: Dakota County, Minnesota

Dakota County, Minnesota is located Southwest of the Minneapolis-St. Paul Metropolitan area and is the third most populated county in Minnesota with a population of 417,486. The County maintains a land use mixture of 1/3 urban, 1/3 suburban, and 1/3 rural and is approximately 587 square miles (Bureau, n.d.; Dakota County, 2018). The County's vehicle fleet management is managed by Dakota County Fleet Management who oversees 301 on-road vehicles (Kevin Schlangen, 2018). Since 2016, Dakota County has been recognized as a Sustainable Fleet by the National Association of Fleet Administrators (NAFA) for having "successfully demonstrated a credible sustainability plan and having made meaningful progress toward reducing their total emissions and the negative environmental impact

made by extraneous carbon fuel usage” (NAFA Fleet Management Association, 2017). Additionally, Dakota County has received over twenty fleet management awards from multiple organizations for achieving fleet best practices and high achieving outcomes (Kevin L. Schlangen, 2017). Most recently, the Association of Equipment Management Professionals (AEMP) and Construction Equipment Magazine awarded Dakota County Fleet Management the *2017 Fleet Master Award for Medium Fleets* (City of Maplewood, 2013). Each year, this award is presented to equipment professionals “who excel in meeting the unique challenges inherent in cost-effective, efficient and effective management of mixed fleets” (Association of Equipment Management Professionals, 2017).

In 2007, Dakota County reorganized their fleet management process and merged all fleet-related budgets and operations from 16 departments into one department responsible for administering the fleet operation programs and database (Association of Equipment Management Professionals, 2017). This organizational shift has resulted in more accurate calculations of total lifecycle costs of fleet vehicles by allowing the department to combine standard daily operating costs such as fuel and repairs with annual costs including insurance, license fees, and depreciation (Association of Equipment Management Professionals, 2017). After this organizational shift, the County also developed a Fleet Capital Replacement Plan (Fleet CEP) to guide replacement of vehicle while simultaneously meeting sustainability goals, linking capital program to operational program, and communicating value to user groups, decision makers and elected officials (Kevin L. Schlangen, 2017). This program includes a Fleet Council that meets quarterly to assist with meeting with individual departments, gaining user group feedback, and developing fleet management policies (Kevin L. Schlangen, 2017). Additionally, the following goals are outlined in the County’s CEP: 1) Replace vehicles and equipment according to life-cycle costs; 2) Reduce repair & maintenance costs; 3) Increase fuel efficiency; 4) Reduce greenhouse gas emissions; 5) Increase safety; 6) Meet user needs to perform essential services; 7) Review lower and

upper 10% utilization rates; 8) Use telematics to evaluate utilization and driver behavior; and 9) Recommend replacements by applying Fleet CEP points replacement criteria” (Kevin L. Schlangen, 2017).

In 2005, the County began collecting telematics data for snowplows and has now expanded telematics collection to over 260 vehicles (Association of Equipment Management Professionals, 2017). Through use of these devices, Dakota County Fleet Management monitors equipment use, operator behavior, maintenance and repair scheduling, cost per mile/hour for individual vehicle, and more (Association of Equipment Management Professionals, 2017). This data has enabled the County to right-sized their fleet by eliminating 129 units and reducing the rate of inefficient driving behaviors (Kevin L. Schlangen, 2016, 2017). The County has also added two plug-in hybrid vehicles (Chevrolet Volts), 20 non-plug-in hybrid gas/electric vehicles (combination of Ford Fusion Hybrid sedans and Toyota Prius sedans), and 58 flexible-fuel vehicles to their fleet (Dakota County, 2016; Kevin Schlangen, 2018). Additionally, the County has installed five electric vehicle charging stations that are available to County employees and the public for free of charge (Kevin Schlangen, 2018). Since 2005, these fleet management initiatives have realized a capital savings of more than \$3.0 million and an operation savings greater than \$300,000 for Dakota County (Association of Equipment Management Professionals, 2017). The County has also achieved a 31% increase in average miles per gallon and a 34% reduction in greenhouse gas emissions (Kevin L. Schlangen, 2017).

4.2 Case study #2: City of Elk River, Minnesota

The City of Elk River is located in Sherburne County which borders the Twin Cities Metropolitan and has a population of 24,367 (Minnesota State Demographic Center, n.d.). As of June 2017, the City of Elk River reached Step 5 of the Minnesota GreenStep Cities program by; 1) Completing 21 of 29 best practices; 2) Collecting metrics on energy use, transportation, land use, environmental management, and economic development; and 3) Improving Step 5 metrics on an annual basis (City of Elk River, n.d.-b; Minnesota Pollution Control Agency, 2017). Additionally, since 1997, Elk River has been named "Energy

City" after being selected among 30 other communities by Minnesota Environmental Initiative (City of Elk River, n.d.-a). Through this award, Elk River was chosen to serve as a geographic focal point for demonstration of energy efficiency and renewable energy products, services, and technologies (City of Elk River, n.d.-a). In 2014, the City created a 10-year *Energy City 2024 Action Plan* with collaboration of the Energy City Commission, City staff, and City partners to develop a clear vision of how energy related goals should be met through targets and metrics (City of Elk River, 2017). The four overarching goals of their Action Plan are to: 1) Promote the City of Elk River as the "Energy City"; 2) Expand economic development of the "Energy City"; 3) Showcase ideas of the "Energy City"; and 4) Engage the public in "Energy City" initiatives through education programs (City of Elk River, 2017). The document is reviewed annually for validation and congruence with annual budgets and is amended and reapproved as needed at that time by the Energy City Commission and Economic Development Authority (City of Elk River, 2017).

In 2016, the City completed a Greenhouse Gas Baseline Inventory to measure the City's greenhouse emissions by City operation and inform the City of energy planning opportunities (paleBLUEdot, 2016). This study found that 12.5% (744.08 metric tonnes) of the City's GHG emissions were emitted annually by the fleet (paleBLUEdot, 2016). In the City's Action Plan, "High Priority Action Tasks" defines the ways the City will meet each goal. The "High Priority Action Task #A13" is oriented towards fleet management, which includes the goal to "convert at least 1 fleet vehicle to an [electric vehicle] based on 2017 results of Fleet Carma pilot program" (City of Elk River, 2017). From March to December 2017, the City of Elk River worked with Fleet Carma, a telematics information systems company, to record vehicle usage of twelve fleet vehicles (Amanda Bednar, 2018). These twelve vehicles were selected for the program after being identified as potential candidates to transition from vehicles with internal combustion engines to an electric or hybrid electric vehicle (Amanda Bednar, 2018). After the telematics data was collected and analyzed, the City approved the replacement of two Chevy Impalas shared between Planning, Engineering and Environmental Departments with a leased plug-in

hybrid Mitsubishi Outlander in February 2018. This vehicle will be used as a shared vehicle which allows staff from multiple departments to test the vehicle out. Elk River chose to procure this SUV through a three-year lease off the Minnesota's Cooperative Purchasing Venture (CPV) contract to provide their City a trial period with an electric vehicle before purchasing one (Amanda Bednar, 2018). Based on Total Cost of Ownership calculations completed by the information systems company, Elk River expects to see cost savings and emission reductions from this lease over the 3-year lease term (Amanda Bednar, 2018).

5. Inver Grove Heights Fleet Management Options

The City's leadership has directed staff to reevaluate their existing fleet management process and conditions with a goal to identify opportunities to increase the fleet's fuel efficiency, reduce fleet management costs, and reduce fleet vehicle emissions through adoption of new practices and policies. The following section of this report lists new fleet management practices (options 1) and policies (options 2 & 3) the City of Inver Grove Heights can consider implementing to simultaneously meet fleet sustainability goals and operational needs. These recommendations are developed based off the fleet management frameworks, best practices, and case study research presented in previous sections.

5.1 Option #1: Implement New Fleet Management Practices

Like the comprehensive framework and the case studies presented in previous sections, the City can update their fleet management process to incorporate collaborative goal setting, data collection, and data analysis. The following three practices can be implemented independently or collectively to assist the City in identifying new opportunities to reduce fleet costs, right-size fleet assets, and reduce emissions.

5.1.1 Practice #1: Develop Fleet Management Committee

The existing fleet management process requires collaboration between the City's Fleet Manager, Division Heads, and the Financial Director during the City's annual budget process. To begin updating the City's fleet management process, the City can determine if they want to prioritize fleet management as a sustainability initiative to begin in Summer 2018, once the Sustainability Program is developed. At that time, the full-time sustainability staff member can provide project support and guide implementation of the initiative. To begin prioritizing sustainability program initiatives the City can create a Sustainability Program Committee that can consist of a similar shareholders group involved in Elk River's creation of City of Elk River's *Energy City 2024 Action Plan*. This committee can be made up of the following staff with associated responsibilities:

Sustainability Committee Members and General Responsibilities:

- *Environmental Commission*: Responsible for setting broad Sustainability Program goals and approving Sustainability Action Plans.
- *Department Heads*: Responsible for informing the Sustainability Committee of operational needs and provide suggestions for program efficiency improvements.
- *Sustainability Coordinator*: Responsible for researching and presenting sustainability best practice opportunities for City operations.
- *Financial Director*: Responsible for directing staff to prioritize sustainability initiatives based on existing budgetary needs and constraints.

Like Dakota County's Fleet Council, Inver Grove Heights can further support development of fleet management initiative by developing a Fleet Management Committee to oversee and inform the new sustainable fleet management process. The Fleet Management Committee can be a sub-committee

of a larger Sustainability Program Committee that is made up of the following staff with associated responsibilities:

Fleet Management Sub-Committee Members and General Roles

- *Fleet Manager*: Responsible for identifying and ensuring each department's fleet operational needs are met.
- *Division Heads*: Responsible for informing the Fleet Management Committee of operational needs.
- *Sustainability Coordinator*: Responsible for researching and presenting opportunities to right-size fleet assets, reduce fleet expenses, and reduce fleet emissions.
- *Financial Director*: Responsible for ensuring adequate funds will be allocated by each department's Internal Service Fund for annual vehicle replacement, risk management, maintenance and repair, and fuel costs.

5.1.2 Practice #2: Develop Action Plan: Goals, Objectives, and Outcomes

Once the Sustainability Program is developed in Summer 2018, the City can develop a Sustainability Action Plan, like the City of Elk River's *Energy City 2024 Action Plan*. Like Elk River's Action Plan, Inver Grove Heights can prioritize fleet management initiatives and goals within a broader sustainability action plan. The full-time sustainability staff member can provide project support and guide implementation of the Action Plan initiative. This staff member can then begin forming and collaborating with the committees described in section 5.1.1 to develop the Action Plan. Similar to the City of Elk River's *Energy City 2024 Action Plan*, Inver Grove Heights can define Sustainability Goals within this document including fleet management goals, list associated objectives such as measurable actions taken to meet the goal, and the anticipated outcomes of the completed task. Inver Grove Heights can also choose to set objectives Given that each goal has unique objectives and outcomes

associated to it, the City effectively prioritizes what will be accomplished by the initiative when setting a goal.

5.1.3 Practice #3: Collect Additional Vehicle Use Data and Analyze

Once goals are defined and prioritized the City can determine which vehicle usage data is needed to meet these goals, and which, if any, is not currently being collected. For example, the City does not have vehicle usage information on hours operated, time spent idling, number of daily trips, distance per trip, average speed, emission rates, and more. Like the City of Elk River, Dakota County, and Federal fleets complying with E.O. 13693 framework, Inver Grove Heights can collect and aggregate this data into a database to be more informed of the current daily duty cycle of each vehicle. Just as these governments have, Inver Grove Heights can use this information to help identify under-utilized vehicles, inefficient driving behavior, and vehicles with duty cycles compatible with electric vehicles.

5.2 Option #2: Implement Sustainable Fleet Management Policy

In addition to setting goals, the City of Inver Grove Heights can adopt a policy to formalize their fleet management process, similar to Dakota County's CEP. This policy can define the following practices:

Administrative Oversight

- Develop a fleet management committee to guide annual vehicle replacement, vehicle data collection, and vehicle data analysis.

Vehicle Use Inventory

- Develop a baseline of existing fleet conditions that includes information such as; number of vehicles, annual GHGs emissions, quantity of annual fuel consumption, annual miles driven or hours operated, and annual fuel cost.
- Maintain a vehicle inventory database that documents each vehicle's intended use.

Replacement Process

- Develop descriptions of the vehicle types needed to complete the required duty of each department.
- Require vehicle usage and emission data to be reviewed before replacing a vehicle to: 1) Approve the proposed use of the replacement vehicle and that determine it is essential for city services and operations; 2) Approve the intended use of the requested replacement vehicle provides a need-based justification for the vehicle replacement size, fuel type, and weight; 3) Ensure the vehicle is the optimal size for the use and down-size the vehicle when larger than use requires; 4) Ensure replacement vehicle is an alternative fuel vehicle when life cycle costs are comparable to business-as-usual alternative and use allows; 5) Ensure replacement vehicle has a fuel economy equal or greater than the existing vehicle when life cycle costs are comparable and use allows; and 6) Ensure replacement vehicle has GHGs emission equal or less than the existing vehicle when and use allows.
- Require consideration of other purchasing resources outside of the Minnesota Cooperative Purchasing Venture (CPV). Other purchasing resources should be used when they present an option that: 1) Meets efficiency needs; 2) Meets alternative fuel vehicle needs; 3) Has a life cycle cost comparable to alternative purchasing option on CPV.

New Vehicle Requests

- Approve the proposed use of the replacement vehicle and that determine it is essential for city services and operations.
- Approve the intended use of the requested replacement vehicle provides a need-based justification for the size, fuel type, and weight.

Maintenance

- Ensure preventative maintenance is on a routine schedule for every vehicle.

5.3 Option #3: Revise Vehicle Use Policy

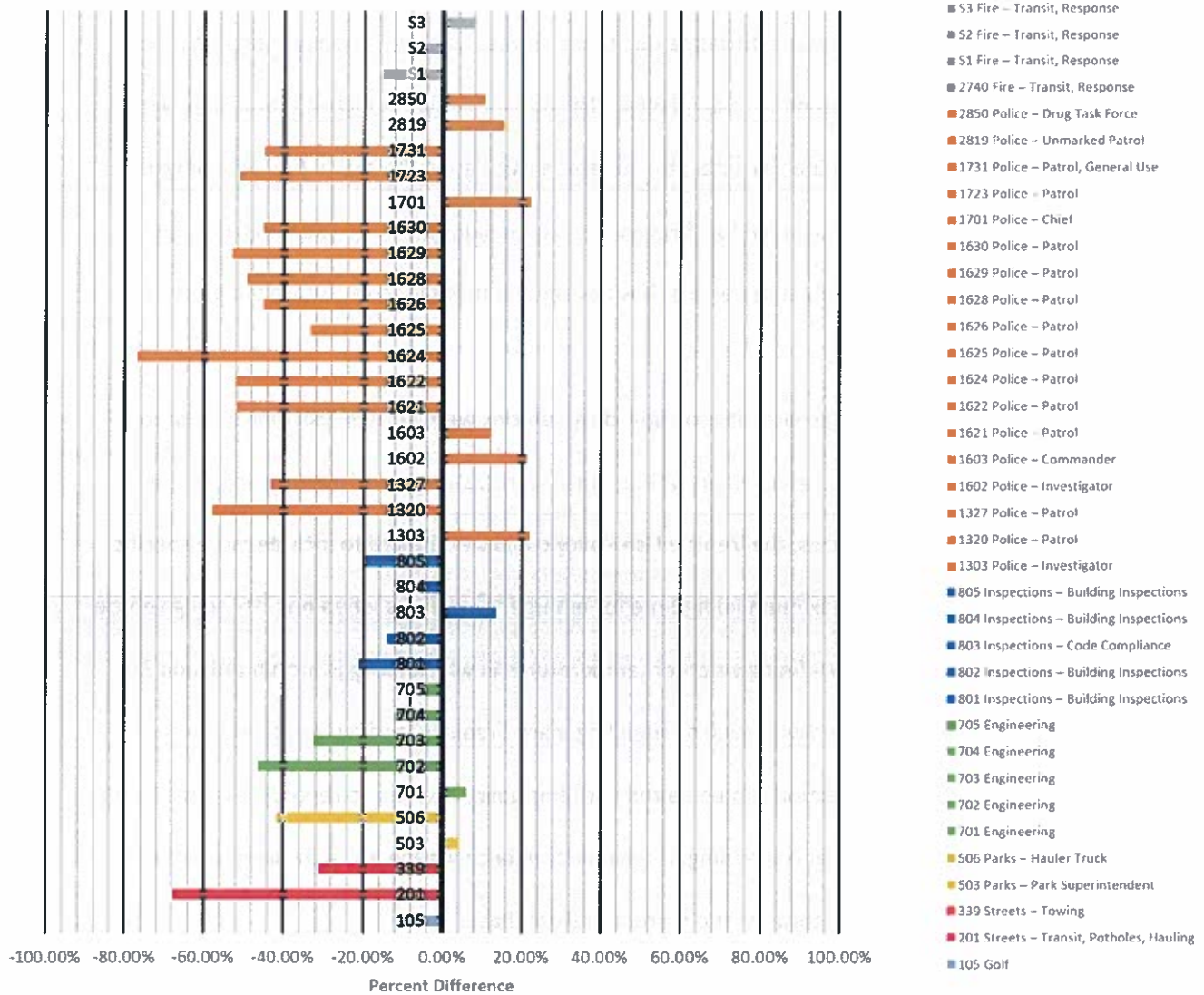
The City of Inver Grove Heights currently has a Vehicle Use Policy that was adopted in 2009 which states that, “city-owned vehicles are not to be left running when they are unattended nor shall be left idling while parked”. Although the policy has been formally adopted by the City Council, staff who operate vehicles are not informed of the policy on a regular basis. This suggests that both full-time and seasonal staff may not know the policy exists or be aware of the negative financial and environmental impacts of idling. In some cases, City vehicles are required to idle to complete their operational duty, although idling beyond these operational needs is prohibited. In other cases, idling is not required to fulfill operational duties and therefore should always be discouraged. This policy identifies exceptions to the no idling which includes: Emergency vehicles idling for readiness, traffic incidents, and preventing technology from freezing; Vehicles idling in cold weather for deicing purposes; Vehicles idling based on department head approval for safety, readiness state, and other operational needs; vehicles idling within the Public Works building and secure parking area or while worker is performing duties within sight of the vehicle.

Because the City is not collecting telematics data, the amount of time spent idling is currently unknown. Although idling data is not directly collected, the City fuel database system is able to calculate fuel efficiency of fleet vehicles based on the amount of fuel and mileage associated with the vehicle’s key card. This fuel efficiency data can be compared to the vehicle’s estimated EPA city driving fuel economy for light duty vehicles to suggest how efficiently the vehicle is being driven. A lower than expected fuel efficiency rating indicates the vehicle is burning more gasoline per mile than it would if efficient driving behaviors were practiced. Driving behaviors such as idling, speeding, hard breaking, and hard acceleration can reduce fuel efficiency of a vehicle, however, without real time data the City is unable to know which behaviors are reducing the efficiency rates. Figure 13 highlights how light-duty vehicle fuel efficiency compares to the estimated EPA City Efficiency based on 2017 vehicle usage. It

should be noted that errors may exist in this data due to employees fueling vehicles at stations other than the City fuel station that documents fuel quantity. The administrative vehicle 202 was removed from this analysis as it was an outlier based on the database calculating the actual fuel economy as 86.29 miles per gallon, which not possible for this vehicle. Additionally, although the fuel database attempts to correct for mileage data entry errors, it is possible for mileage to be entered in incorrectly by the driver.

Based on 2017 vehicle usage data, 45% of light-duty vehicles were getting less than 30% of the estimated EPA city fuel economy. This includes police patrol, parks, streets, and engineering vehicles. To increase the efficiency of vehicles, the Vehicle Use Policy could be updated to include more specific language such as: 1) Specifying maximum idling time for emergency vehicles when not attending vehicle in a non-emergency situation; 2) Defining weather temperatures in which idling is prohibited; and 3) Discouraging inefficient driving behavior such as speeding, hard breaking, and hard acceleration. Additionally, telematics data collection can be paired with this policy revision to report changes in idling, hard breaking, hard acceleration, and speeding. If telematics data collection is not available, staff can monitor changes in fuel efficiency through the current fuel database.

Figure 13: Percent Difference Between 2017 Actual Efficiency and EPA City Efficiency Estimate



5.4 Cost Benefit Analysis

The three fleet management options described above present new fleet management policies and practices that the City can implement when updating their fleet management process. In this section, each practice is associated to one of three goals defined previously defined by the City, 1) Reduce fleet costs, 2) Increase Fuel Efficiency of Fleet, and 3) Reduce greenhouse gas emissions.

The Cost Benefit Analysis includes four fleet management practices the City of Inver Grove Heights can consider implementing in the 2019 fiscal year: 1) Eliminate Vehicle; 2) Downsize Vehicle; 3)

Transition Vehicle to HEV, PHEV, or EV; and 4) Reduce Inefficient Driving Behavior. On-road vehicles up for replacement in 2018 and 2019 that have not yet been replaced have been considered in this analysis (Fig. 14; Fig. 15).

The framework of the Cost Benefit Analysis was developed based on the Alternative Vehicle Decision Tool created by the University of Minnesota (UMN) Extension (University of Minnesota Extension, 2011). This is an open source excel sheet created to assist the public in comparing the financial and economic impacts of purchasing a convention internal combustion engine vehicle (ICE), hybrid vehicle (HEV), plug-in electric vehicle (PEV), or all-electric vehicles. The original UMN Extension tool was used in this study to complete a sensitively analysis for transitioning fleet vehicles to alternative fuel. The tool was also adapted to complete a sensitivity analysis for the other three fleet management options by removing and adding additional parameters. The following inputs were used to calculate the cost-benefit of each fleet option. The City can use the same tools used in this analysis to evaluate additional fleet management options as they arise.

5.4.1 Data and Assumptions Used in Cost Benefit Analysis

The following data and assumptions were used to evaluate the fleet management options in the cost benefit analysis:

Annual Capital, Maintenance, and Insurance Costs

- If vehicle had a replacement scheduled, the capital, maintenance, fuel, and insurance costs were collected from an equivalent vehicle purchased within the last year to calculate expected costs of business-as-usual purchase.
- If maintenance costs for the proposed vehicle replacement were unavailable, Edmund's True Cost to Own calculator was used to estimate the annual maintenance costs based on the vehicle 2017 annual mileage (Edmunds, n.d.).

- If a replacement value from an equivalent vehicle purchased within the last year similar was unavailable for the proposed vehicle purchase, the replacement value was estimated from Kelly Blue Book and was subtracted from the capital cost of the replacement vehicle.
- A \$400 wall-charger for the PHEV vehicle was added to the capital cost for the PHEV vehicle.

Annual Fuel Costs

- Fuel costs were estimated based on the 2017 gasoline rated paid by the City through the Minnesota State Cooperative Purchasing Venture (\$2.37).
- The expected fuel consumption of the replacement vehicle was based on 2017 annual mileage of the existing vehicle.
- Inver Grove Heights city operations are located within Xcel Energy territory, the City would be required to pay the charging rates set by the Public Utilities Commission (PUC) and Xcel Energy. The EV Rate structure is applicable for city operations as it's structured for users who will charge on during week-nights, but have a high energy demand during the day (Xcel Energy, 2017). As of 2018, off-peak charging costs \$0.0426 per kWh all year round and an additional \$4.95 monthly charge to remain on this charging plan (Xcel Energy, 2017). The off-peak charging rate and fixed monthly charge were used in this analysis.
- The original version of the University of Minnesota's Alternative Vehicle Decision Tool was used to calculate the financial impact of transitioning to electric vehicles (University of Minnesota Extension, 2011). To calculate the cost of electricity, the following steps were followed. First, the vehicle's electricity-only mileage was multiplied by the estimated number of days the vehicle is driven per year. This value was then divided by the vehicle's miles per kilowatt-hour (kWh) of electricity, to get the amount of kWh the vehicle will charge per year. This value was then multiplied by Xcel Energy's off-peak rate, assuming the City will charge the vehicle overnight.

- The calculate the cost of gasoline, the following step were followed. The number of miles that exceeded the maximum electric-only miles for the vehicle (as calculated by the estimated EPA fuel economy) were considered to be fueled with gasoline (O. of E. E. & R. E. U.S. Department of Energy, n.d.-a). This mileage was divided by the vehicle's gasoline fuel economy and multiplied by \$2.37 to get the vehicle's annual gasoline cost.
- The vehicle's annual electricity cost and vehicle's annual gasoline cost were added together to calculate the vehicle's annual fuel cost.

Annual Benefits

- Annual savings for capital, maintenance, risk management, and fuel expenses were calculated by subtracting the estimated costs of the proposed change from the estimated business-as-usual (BAU) costs.
- The emission factor of 18.69 pounds of CO₂ per gallon of gasoline was used for this analysis. The expected emissions of the business-as-usual replacement were subtracted from the expected emissions of the downsized replacement based on 2017 annual mileage. The emission factor of 805 pounds per MWh was used for this analysis, based on Xcel Energy's Upper Midwest Grid emissions (Xcel Energy, 2016). The amount of CO₂ reduced was multiplied by the Social Cost of Carbon (SCC) measured at \$42 to incorporate the social benefits of reducing CO₂ emissions into this cost-benefit analysis. The 2020 SCC is used to monetize damages associated with an incremental increase in carbon emissions in a given year (Interagency Working Group on Social Cost of Greenhouse Gases, 2016). This estimate of SCC is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change (Interagency Working Group on Social Cost of Greenhouse Gases, 2016).
- Total Annual Benefits were calculated by adding all estimated saving for capital, maintenance, risk management, fuel expenses, and CO₂ reductions.

5.4.2 Vehicles in Cost Benefit Analysis

The following vehicles in Figures 14 and 15 are due for replacement in 2018 and 2019. The table indicates which vehicles were selected for this analysis. Vehicles were selected based on their current use and were identified as having a greater potential for changes in fleet management practices in comparison to the other vehicles up for replacement. The vehicles were selected for the analysis based on the following:

Eliminate Vehicle

- Vehicles with the lowest utilization based on 2017 fuel consumption and mileage.

Downsize Oversized Vehicle

- Vehicles with potential to be downsized.

Transition to Alternative Fuel Vehicle

- Vehicles with the highest utilization within the fleet that also have vehicle performance requirements met by alternative fuel vehicles on the market.

Reduce Inefficient Driving Behavior

- Vehicles with lowest fuel efficiency based on 2017 fuel consumption and mileage.

Figure 14: Vehicle Up for Replacement in 2018 (Not Yet Replaced)

Vehicle Make and Model	Department	In Analysis
#0850 DODGE CARAVAN	Police	Yes
#201 FORD 4X4 SUPERCAB P/U F150	Streets	No
#202 FORD TAURUS	Public Works	Yes
#339 FORD 4X4 SUPERCAB	Streets	No
#405 FORD F250 P/U	Utilities	No
#417 CHEV SILVERADO 250HD	Utilities	No
#506 FORD F150 PICKUP	Parks & Recreation	No
#705 FORD F150 SUPERCAB 4x4	Engineering	Yes
#803 2008 FORD ESCAPE	Inspections	Yes
#B13 FORD F350 GRASS TR.	Fire	No
#1523 2015 FORD INTERCEPTOR	Police	No
#1524 2015 FORD INTERCEPTOR	Police	Yes
#1526 2015 FORD POLICE INTERCEPTOR	Police	No
#1528 2015 FORD INTERCEPTOR	Police	No
#1621 2016 FORD POLICE INTERCEPTOR	Police	Yes
#1622 2016 FORD POLICE INTERCEPTOR	Police	Yes

Figure 15: Vehicle Up for Replacement in 2019		
Vehicle Make and Model	Department	In Analysis
#1626 2016 FORD POLICE INTERCEPTOR	Police	No
#1630 2016 FOR POLICE INTERCEPTOR	Police	Yes
#702 FORD F150	Engineering	Yes

5.4.3 Cost Benefit Analysis Results

The following cost benefit analysis tables include different fleet management options for the selected vehicles identified in figure 14 and 15. Each action was calculated from 2017 vehicle utilization data and was evaluated in the cost benefit analysis tables in figure 16.1 through 16.4.

Figure 16.1: Cost Benefit Analysis - Eliminate Vehicles						
	Goal: Eliminate Underutilized Vehicles					
	701 / Explorer / Engineering		803 / Escape / Inspections		705 / F150 / Engineering	
	Eliminate in 2018. Already removed from replacement schedule		Eliminate in 2018 and remove from replacement schedule. Do not replace with BAU F150.		Eliminate in 2018 and remove from replacement schedule	
Annual Costs	BAU	PROPOSED CHANGE	BAU	PROPOSED CHANGE	BAU	PROPOSED CHANGE
Capital Costs	\$ -	\$ -	\$ 29,000	\$ -	\$ 27,500	\$ -
Maintenance Costs	\$ 376	\$ -	\$ 439	\$ -	\$ 439	\$ -
Fuel Costs	\$ 219	\$ 219	\$ 398	\$ 398	\$ 396	\$ 396
Risk Management Costs	\$ 155	\$ 155	\$ 140	\$ 140	\$ 140	\$ 140
Annual Benefits	PROPOSED CHANGE		PROPOSED CHANGE		PROPOSED CHANGE	
Capital Savings	\$ -		\$ 2,900		\$ 2,750	
Maintenance Savings	\$ 376		\$ 439		\$ 439	
Risk Management Savings	\$ -		\$ -		\$ -	
Fuel Savings	\$ -		\$ -		\$ -	
CO ₂ Reduction	\$ -		\$ -		\$ -	
Total Annual Benefits	\$ 376		\$ 3,339		\$ 3,189	

Figure 16.2: Cost Benefit Analysis - Downsize Vehicles				
	Goal: Downsize oversized vehicles to increase fuel efficiency			
	2850 / Dodge Caravan / Police		803 / Escape / Inspections	
	Downsize to Chevy Equinox		Downsize to Toyota Corolla	
Annual Costs	BAU	PROPOSED CHANGE	BAU	PROPOSED CHANGE
Capital Costs	\$ 27,500	\$ 25,900	\$ 29,000	\$ 24,000
Maintenance Costs	\$ 680	\$ 633	\$ 439	\$ 805
Fuel Costs	\$ 1,248	\$ 874	\$ 398	\$ 235
Risk Management Costs	\$ 396	\$ 396	\$ 140	\$ 155
Annual Benefits	PROPOSED CHANGE		PROPOSED CHANGE	
Capital Savings	\$ 160		\$ 500	
Maintenance Savings	\$ 50		\$ (366)	
Risk Management Savings	\$ -		\$ (15)	
Fuel Savings	\$ 374		\$ 163	
CO ₂ Reduction	\$ 56		\$ 25	
Total Annual Benefits	\$ 640		\$ 307	

Figure 16.3: Cost Benefit Analysis - Convert to Electric Vehicles

	Goal: Convert to Electric Vehicles			
	2850 / Dodge Caravan / Police		1303 / Ford Taurus / Police	
	Replace with Mitsubishi Outlander PHEV		Replace with Mitsubishi Outlander PHEV	
Annual Costs	BAU	PROPOSED CHANGE	BAU	PROPOSED CHANGE
Capital Costs	\$ 27,500	\$ 31,400	\$ 30,400	\$ 31,400
Maintenance Costs	\$ 680	\$ 550	\$ 672	\$ 550
Fuel Costs	\$ 1,248	\$ 505	\$ 721	\$ 160
Risk Management Costs	\$ 396	\$ 396	\$ 140	\$ 140
Annual Benefits	PROPOSED CHANGE		PROPOSED CHANGE	
Capital Savings	\$	(390)	\$	(100)
Maintenance Savings	\$	130	\$	122
Risk Management Savings	\$	-	\$	-
Fuel Savings	\$	743	\$	561
CO ₂ Reduction	\$	84	\$	68
Total Annual Benefits	\$	567	\$	651

Figure 16.4: Cost Benefit Analysis - Reduce Inefficient Driving Behavior

	Goal: Reduce Inefficient Driving Behavior					
	1524 / Explorer / Police		1524 / Explorer / Police		1524 / Explorer / Police	
	Reduce inefficient driving behavior and increase fuel efficiency by 15% (from 7.55 mpg to 8.69 mpg)		Reduce inefficient driving behavior and increase fuel efficiency by 30% (from 7.55 mpg to 9.81 mpg)		Reduce inefficient driving behavior and increase fuel efficiency by 50% (from 7.55 mpg to 11.35 mpg)	
Annual Costs	BAU	PROPOSED CHANGE	BAU	PROPOSED CHANGE	BAU	PROPOSED CHANGE
Capital Costs	\$ 30,400	\$ 30,400	\$ 30,400	\$ 30,400	\$ 30,400	\$ 30,400
Maintenance Costs	\$ 672	\$ 672	\$ 672	\$ 672	\$ 672	\$ 672
Fuel Costs	\$ 9,870	\$ 8,450	\$ 9,870	\$ 7,490	\$ 9,870	\$ 6,473
Risk Management Costs	\$ 396	\$ 396	\$ 396	\$ 396	\$ 396	\$ 396
Annual Benefits	PROPOSED CHANGE		PROPOSED CHANGE		PROPOSED CHANGE	
Capital Savings	\$	-	\$	-	\$	-
Maintenance Savings	\$	-	\$	-	\$	-
Risk Management Savings	\$	-	\$	-	\$	-
Fuel Savings	\$	1,420	\$	2,380	\$	3,397
CO ₂ Reduction	\$	214	\$	357	\$	508
Total Annual Benefits	\$	1,634	\$	2,737	\$	3,905

6. Summary of Cost Benefit Analysis and Fleet Management Recommendations for Inver Grove Heights

Based on the Cost Benefit Analysis (Fig. 16.1 through 16.4), the City of Inver Grove Heights can take several different actions to meet their fleet management and sustainability goals to reduce fleet management costs, reduce emissions, and increase fuel efficiency; however, this analysis also indicates certain actions may be preferred over another. For example, the analysis suggests that eliminating the selected vehicles from the fleet that are currently on the replacement schedule may offer higher

financial savings in comparison to the other options (Fig. 16.1; Vehicles 803 and 705). This option, however, does not meet the goals of increasing fuel efficiency and emission reductions. Instead, the City can consider eliminating these vehicles, while also taking additional actions to meet fuel efficiency and emission reduction goals.

The greatest impact on all three goals could be achieved by reducing inefficient driving behavior (Fig. 16.4; Vehicle 1524). Like the police vehicle 1524, the other police patrol vehicles also represent the lowest rates of inefficiency within the on-road vehicle fleet with the highest utilization (Fig. 13). Because real-time vehicle use data is not collected, the cause of the low efficiency is unknown. This could be related to driving behavior speeding, hard braking, and hard acceleration. These behaviors are common for police patrol when in pursuit, however, they should be discouraged at all times when outside of a pursuit. Additionally, idling may also be attributed to the low efficiency of police vehicles.

Although a Vehicle Use Policy exists, the amount of idling within the entire fleet and level of enforcement of this policy is unknown. Idling is required to some extent by police vehicles during cold and hot temperatures, when parked outside of a garage. Currently, there is a lack of garage space for police vehicles, and therefore the police vehicles are left running outside with their equipment plugged into the vehicle's accessory for emergency response needs. Although vehicle utilization is not as high, vehicle fuel economy of other non-public safety vehicles within the Parks, Engineering, and Streets department indicate low vehicle efficiency as well. The City should have a conversation with employees who commonly utilize these vehicles to learn more about the vehicles use and why low efficiency may be present. The City can also use this as an opportunity to educate employees of the financial and environmental impacts of inefficient driving behavior. In the future it may also prove helpful to use telematics data or research vehicle use from similar government entities to determine how much of the inefficient behavior can be avoided without affecting emergency response and other operational needs.

Implementation of telematics data collection can help inform the City the true cause of low efficiency, similar to how it has informed Dakota County and Federal fleets of vehicle usage. If idling is

the main cause of low efficiency, several strategies could be considered such as provide education of efficient driving behaviors and behavior change, develop a parking garage during a future renovation of the Public Works facility, and implement idling reduction strategies such as power management systems, heat recovery systems, and battery auxiliary power units (APUs) (National Laboratory, n.d.).

Additionally, vehicles with higher utilization and therefore higher fuel costs, are likely to offer faster payback periods on electric vehicles than vehicles that aren't utilized as frequently. Given their high utilization and fuel costs, non-patrol police vehicles pose a potential opportunity to transition to alternative fuel vehicles, such as the plug-in hybrid Mitsubishi Outlander included in the Cost Benefit Analysis (Fig. 16.3; Vehicle 2850 and 1303). Non-patrol vehicles have less vehicle requirements than patrol vehicles in terms of pursuit-ratings and technology requirements, making it more feasible to find an equivalent electric vehicle to replace the existing vehicle. Although patrol vehicles represent the highest utilization, their vehicle requirements currently present large obstacles with finding an equivalent electric vehicle on the market, however this may change within the coming years. In the meantime, transitioning non-patrol vehicles can reduce fleet cost, fuel consumption, and vehicle emissions (Fig. 16.3; Vehicle 2850 and 1303).

Moving forward, the City can consider implementing these changes and initiatives beginning in 2018. Additionally, the City can use the fleet management tools used in the analysis to help inform decision making during vehicle replacement in the following years. Similar to the action plans and policies developed by City of Elk River, Dakota County, Federal government, and State of Minnesota, Inver Grove Heights can also guide this fleet management initiative through a multi-stakeholder effort, such as through the development of an Action Plan. Establishing an Action Plan with help from a committed stakeholder group will greatly assist the City of Inver Grove Heights in successfully meeting fleet management and sustainability goals within a specific timeframe.

7. Work Cited

- Alternative Fuels Data Center. (2017). Electricity Fuel Basics. Retrieved March 31, 2018, from https://www.afdc.energy.gov/fuels/electricity_basics.html
- Alternative Fuels Data Center. (2018a). Flexible Fuel Vehicles. Retrieved April 1, 2018, from https://www.afdc.energy.gov/vehicles/flexible_fuel.html
- Alternative Fuels Data Center. (2018b). Key Federal Legislation. Retrieved April 1, 2018, from https://www.afdc.energy.gov/laws/key_legislation
- Alternative Fuels Data Center: Ethanol Fuel Basics. (n.d.). Retrieved April 25, 2018, from https://www.afdc.energy.gov/fuels/ethanol_fuel_basics.html
- Amanda Bednar, A. H. (2018). Phone Interview with City of Elk River, Minnesota.
- Association of Equipment Management Professionals. (2017). AEMP Honors the 2017 Fleet Master of the Year for Medium Fleets - Dakota County. Retrieved March 15, 2018, from <http://www.aemp.org/news/335255/AEMP-Honors-the-2017-Fleet-Master-of-the-Year-for-Medium-Fleets---Dakota-County.htm>
- Bureau, U. S. C. (n.d.). American FactFinder - Results. Retrieved from <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>
- City of Elk River, M. (n.d.-a). Energy City | Elk River, MN - Official Website. Retrieved March 24, 2018, from <https://www.elkrivernm.gov/739/Energy-City>
- City of Elk River, M. (n.d.-b). GreenStep Cities. Retrieved March 25, 2018, from <https://www.elkrivernm.gov/1141/GreenStep-Cities>
- City of Elk River, M. (2017). Objective High Priority Action Tasks. Retrieved from <http://elkrivernm.gov/DocumentCenter/View/5496>
- City of Inver Grove Heights, M. (2016). Comprehensive Annual Financial Report. Retrieved from <https://www.ci.inver-grove-heights.mn.us/DocumentCenter/View/5324>
- City of Maplewood. (2013). 2013 AMERICAN PUBLIC WORKS ASSOCIATION PROFESSIONAL AWARDS SUSTAINABILITY PRACTICES AWARD. Retrieved from <https://maplewoodmn.gov/DocumentCenter/View/9287>
- CNBC. (2018). Gas prices hit three-year high and are expected to keep rising. Retrieved May 6, 2018, from <https://www.cnbc.com/2018/05/03/gas-prices-hit-three-year-high-and-are-expected-to-keep-rising.html>
- Dakota County. (2016). Vehicle Fleet Operations & Maintenance. Retrieved March 15, 2018, from <https://www.co.dakota.mn.us/Environment/Energy/CountyUse/Pages/fleet-operations.aspx>
- Dakota County. (2018). About Us. Retrieved March 15, 2018, from <https://www.co.dakota.mn.us/About>
- Dakota County, M. (2017). Environmental Legacy Fund (ELF) Budget Workshop. Retrieved from [https://www.co.dakota.mn.us/Government/BoardMeetings/Budget/WorkshopsMtgMaterials/Environmental Legacy Fund \(ELF\) Budget Workshop.pdf](https://www.co.dakota.mn.us/Government/BoardMeetings/Budget/WorkshopsMtgMaterials/Environmental%20Legacy%20Fund%20(ELF)%20Budget%20Workshop.pdf)
- Data USA. (n.d.). Inver Grove Heights, MN | Data USA. Retrieved March 18, 2018, from <https://datausa.io/profile/geo/inver-grove-heights-mn/>
- Department of Energy, O. of E. E. & R. E. (n.d.-a). Gas Mileage Tips - Keeping Your Vehicle in Shape.

- Retrieved March 11, 2018, from <https://www.fueleconomy.gov/feg/maintain.jsp>
- Department of Energy, O. of E. E. & R. E. (n.d.-b). Why Is Fuel Economy Important? Retrieved March 10, 2018, from <https://www.fueleconomy.gov/feg/why.shtml>
- Edmunds. (n.d.). True Cost to Own® (TCO®) Calculator. Retrieved May 3, 2018, from <https://www.edmunds.com/tco.html>
- Energy Management Program, F., & General Services Administration, U. (2017). Executive Order 13693: Planning for Federal Sustainability in the Next Decade. Guidance for Federal Agencies on Executive Order 13693 – Federal Fleet Management. Retrieved from https://www.energy.gov/sites/prod/files/2017/01/f34/eo_13693_federal_fleet_guidance.pdf
- Environmental Protection Agency, U. (2016). Greenhouse Gas Inventory Guidance Direct Emissions from Mobile Combustion Sources. Retrieved from https://www.epa.gov/sites/production/files/2016-03/documents/mobileemissions_3_2016.pdf
- Epa, U., of Transportation, O., Quality, A., & Division, C. (2017). Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions, 1990-2015 (EPA-420-F-17-013, July 2017). Retrieved from <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P100S7NK.pdf>
- FERC: Federal Energy Regulatory Commission. (2017). Electric Power Markets -Midcontinent (MISO). Retrieved April 24, 2018, from <https://www.ferc.gov/market-oversight/mkt-electric/midwest.asp>
- Gonder, J., Earleywine, M., & Sparks, W. (2012). Analyzing Vehicle Fuel Saving Opportunities through Intelligent Driver Feedback, 5400–53864. <https://doi.org/10.4271/2012-01-0494>
- ICLEI - Local Governments for Sustainability. (2013). U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix D: Transportation and Other Mobile Emission Activities and Sources.
- Interagency Working Group on Social Cost of Greenhouse Gases, U. S. G. (2016). Technical Support Document: -Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866. Retrieved from https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf
- Jason Hill, Liailia Tajibaeva, S. P. (2016). Climate consequences of low-carbon fuels: The United States Renewable Fuel Standard. *Energy Policy*, 97, 351–353. Retrieved from https://ac-els-cdn-com.ezp1.lib.umn.edu/S0301421516303962/1-s2.0-S0301421516303962-main.pdf?_tid=cd678195-1829-4f7d-8bae-799d2315c54d&acdnt=1526406277_8a4cb1b7f9d11e621b62b879d3b51806
- Kevin L. Schlangen. (2016). Where is My Snow Plow? Real World Uses of Fleet Telematics.
- Kevin L. Schlangen. (2017). We Have Always Done It This Way: Moving Away From Emotions in Developing a Fleet Capital Equipment Program.
- Kevin Schlangen, A. H. (2018). Phone Interview with Dakota County, Minnesota.
- Li, M., Smith, T. M., Yang, Y., & Wilson, E. J. (2017). Marginal Emission Factors Considering Renewables: A Case Study of the U.S. Midcontinent Independent System Operator (MISO) System. *Environmental Science & Technology*, 51(19), 11215–11223. <https://doi.org/10.1021/acs.est.7b00034>
- Minnesota Department of Administration: State Procurement. (2017). Cooperative Purchasing Venture. Retrieved March 25, 2018, from <http://www.mmd.admin.state.mn.us/cpv2.htm>
- Minnesota Pollution Control Agency. (n.d.-a). Frequently Asked Questions. Retrieved April 26, 2018, from

- <https://greenstep.pca.state.mn.us/faq.cfm>
- Minnesota Pollution Control Agency. (n.d.-b). Minnesota GreenStep Cities. Retrieved March 25, 2018, from <https://greenstep.pca.state.mn.us/index.cfm>
- Minnesota Pollution Control Agency. (n.d.-c). Minnesota GreenStep Cities. Retrieved April 23, 2018, from <https://greenstep.pca.state.mn.us/>
- Minnesota Pollution Control Agency. (2017). Minnesota GreenStep Cities - City of Elk River. Retrieved March 25, 2018, from https://greenstep.pca.state.mn.us/cityInfo.cfm?ctu_code=2394650
- Minnesota Pollution Control Agency. (2018). Minnesota GreenStep Cities - City of Inver Grove Heights. Retrieved March 25, 2018, from https://greenstep.pca.state.mn.us/cityInfo.cfm?ctu_code=2395429
- Minnesota State Demographic Center. (n.d.). Our Estimates. Retrieved from <https://mn.gov/admin/demography/data-by-topic/population-data/our-estimates/>
- NAFA Fleet Management Association. (2017). Current Accredited Fleets. Retrieved May 7, 2018, from <https://www.nafa.org/s/Accredited-Fleets/Current-Accredited-Fleets.aspx>
- National Laboratory, A. (n.d.). Idling Reduction for Emergency and Other Service Vehicles. Retrieved from https://www.afdc.energy.gov/uploads/publication/idling_emergency-service_vehicles.pdf
- National Research Council of The National Academies. (2011). *Renewable Fuel Standard*. Washington, D.C.: National Academies Press. <https://doi.org/10.17226/13105>
- paleBLUEdot, L. (2016). Greenhouse Gas Baseline Inventory - City of Elk River GHG Baseline Inventory. Retrieved from <https://www.elkrivernm.gov/DocumentCenter/View/3981>
- Procurement, M. D. of A. S. (2017). Cooperative Purchasing Venture (CPV) Membership Application. Retrieved from <http://www.mmd.admin.state.mn.us/pdf/CPVSubscribe2.pdf>
- Public Law 102-486, 102d Congress. (1992). Energy Policy Act of 1992. Retrieved from <https://www.afdc.energy.gov/pdfs/2527.pdf>
- Star Tribune. (2017). Twin Cities population growth lags other major U.S. cities - StarTribune.com. Retrieved March 18, 2018, from <http://www.startribune.com/twin-cities-population-growth-lags-other-major-u-s-cities/417874533/>
- State of Minnesota. (n.d.). Fleet Sustainability. Retrieved from <https://mn.gov/admin/government/vehicles/sustainability/>
- State of Minnesota, G. M. D. (2017). Executive Order 17-12: Directing State Agencies to Conserve Energy and Water, and Reduce Waste to Save Money. Retrieved from https://mn.gov/governor/assets/E.O. 17-12_tcm1055-318573.pdf
- The Office of the Revisor of Statutes. (2017a). 296A.01 - 2017 Minnesota Statutes. Retrieved April 26, 2018, from <https://www.revisor.mn.gov/statutes/?id=296A.01#stat.296A.01.5>
- The Office of The Revisor of Statutes. (2017). 239.791 - 2017 Minnesota Statutes - Oxygenated Gasoline. Retrieved March 22, 2018, from <https://www.revisor.mn.gov/statutes/?id=239.791>
- The Office of the Revisor of Statutes, S. of M. (2017b). 239.77 - 2017 Minnesota Statutes - Biodiesel Blend and Fuel. Retrieved March 31, 2018, from <https://www.revisor.mn.gov/statutes/?id=239.77>
- U.S. Census Bureau. (2017). U.S. Census Bureau QuickFacts: Dakota County, Minnesota. Retrieved March 18, 2018, from <https://www.census.gov/quickfacts/fact/table/dakotacountyminnesota,invergroveheightscityminn>

esota/PST045217

- U.S. Department of Energy. (2015). Costs Associated With Non-Residential Electric Vehicle Supply Equipment. Retrieved from https://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf
- U.S. Department of Energy; Alternative Fuels Data Center. (n.d.). Vehicle Weight Classes & Categories. Retrieved March 17, 2018, from <https://www.afdc.energy.gov/data/widgets/10380>
- U.S. Department of Energy, A. F. D. C. (n.d.). Alternative Fuels Data Center: Idle Reduction Benefits and Considerations. Retrieved March 5, 2018, from https://www.afdc.energy.gov/conserve/idle_reduction_benefits.html
- U.S. Department of Energy, A. F. D. C. (2017). Alternative Fuels Data Center: Rightsizing Your Vehicle Fleet to Conserve Fuel. Retrieved March 5, 2018, from <https://www.afdc.energy.gov/conserve/rightsizing.html>
- U.S. Department of Energy, A. N. L. (n.d.). Idling Reduction for Personal Vehicles. Retrieved from https://www.afdc.energy.gov/uploads/publication/idling_personal_vehicles.pdf
- U.S. Department of Energy, O. of E. E. & R. E. (n.d.-a). Compare Cars Side-by-Side. Retrieved May 2, 2018, from <https://www.fueleconomy.gov/feg/Find.do?action=sbsSelect&id=39259>
- U.S. Department of Energy, O. of E. E. & R. E. (n.d.-b). Standard Compliance: Guidelines to Help State and Alternative Fuel Provider Fleets Meet Their Energy Policy Act Requirements, 10 CFR Part 490, Vehicle Technologies Office (VTO). Retrieved from https://epact.energy.gov/pdfs/standard_compliance.pdf
- U.S. Department of Energy, O. of E. E. & R. E. (2018). Clean Cities Alternative Fuel Price Report, January 2018. Retrieved from https://www.afdc.energy.gov/uploads/publication/alternative_fuel_price_report_jan_2018.pdf
- U.S. Energy Information Administration. (2018). Alternative Fuels Data Center: Minnesota Transportation Data for Alternative Fuels and Vehicles. Retrieved April 25, 2018, from <https://www.afdc.energy.gov/states/mn>
- U.S. Environmental Protection Agency. (n.d.). Smog, Soot, and Other Air Pollution from Transportation. Retrieved from <https://www.epa.gov/air-pollution-transportation/smog-soot-and-local-air-pollution>
- University of Minnesota Extension. (2011). Should I buy an alternative vehicle? Retrieved April 23, 2018, from <https://www.extension.umn.edu/environment/energy/vehicle/>
- US EPA, OAR, O. (n.d.). How Mobile Source Pollution Affects Your Health. Retrieved from <https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health>
- US EPA, O. (n.d.). Greenhouse Gas Versus Smog Forming Emissions. Retrieved from <https://www.epa.gov/greenvehicles/greenhouse-gas-versus-smog-forming-emissions>
- US EPA, O. (n.d.). Sources of Greenhouse Gas Emissions. Retrieved from <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>
- Wang, M., Han, J., Dunn, J. B., Cai, H., & Elgowainy, A. (2012). Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcane and cellulosic biomass for US use. *Environmental Research Letters*, 7(4), 45905. <https://doi.org/10.1088/1748-9326/7/4/045905>
- Xcel Energy. (2016). Energy and Carbon Emissions Reporting. Retrieved from <https://www.xcelenergy.com/staticfiles/xe-responsive/Environment/Carbon/Carbon-Reduction->

2016-Energy-and-Carbon-Summary.pdf

Xcel Energy. (2017). Electric Vehicle Rate | Xcel Energy. Retrieved March 31, 2018, from https://www.xcelenergy.com/energy_portfolio/innovation/electric_vehicles/electrical_vehicle_rate

