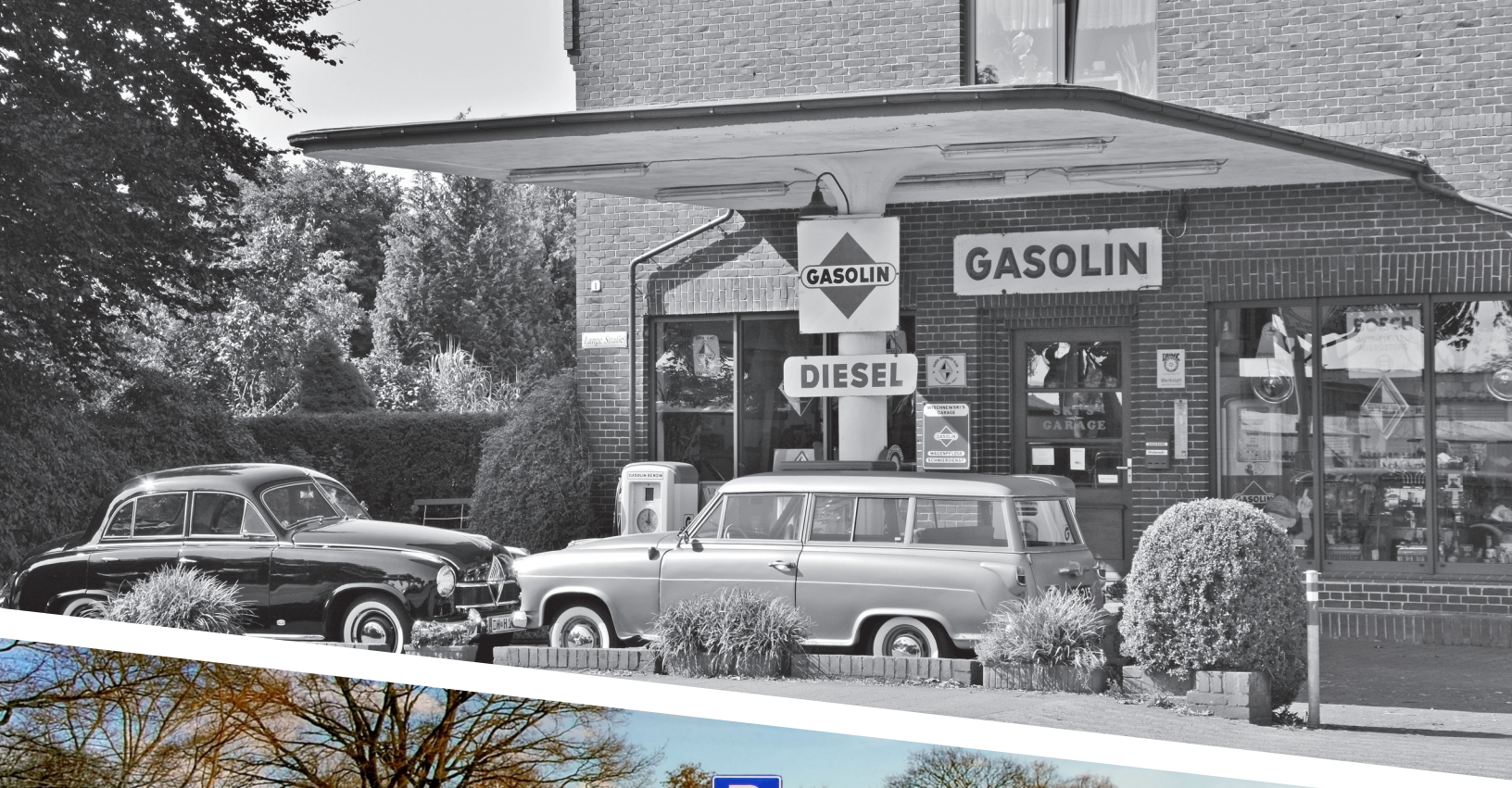


Clean Green Driving Machines

Reducing Municipal Vehicle Fuel Consumption

Green Communities Division, Mass Department of Energy Resources

Albert Good // Emily Klotz // Lily Ko

May 2018

Clean Green Driving Machines

Reducing Municipal Vehicle Fuel Consumption

Prepared for
Green Communities Division,
Massachusetts Department of Energy Resources

Written by
Albert Good // Emily Klotz // Lily Ko

UEP Field Projects
May 2018

Tufts University
GRADUATE SCHOOL OF ARTS AND SCIENCES
Urban and Environmental Policy and Planning

Acknowledgments

Massachusetts Department of Energy Resources

We would like to give a special thank you to our project partner **Joanne Bissetta**, Deputy Director of the Green Communities Division, for all of her time and support throughout the duration of this project. Thank you to the Green Communities Division Regional Coordinators, **Jim Barry**, Western Region, **Kelly Brown**, Central Region, **Neal Duffy**, Northeast Region, and **Seth Pickering**, Southeast Region. Additionally, we would like to thank **Jillian DiMedio**, Assistant Director, Leading by Example Program, **Stephen Russell**, Alternative Transportation Coordinator, and **Jane Pfister**, Grant Administrator.

Urban and Environmental Policy and Planning Field Projects Teaching Team

This project would not have been possible without the advice, guidance, and support from our teaching team, **Ann Rappaport**, Senior Lecturer and Project Advisor, and **Laura Flagg**, Teaching Assistant. Thank you to the additional Field Projects faculty, **Penn Loh** and **Beth Garver**, and Field Projects Teaching Assistants, **Christian Brandt** and **Allison Curtis**. Lastly, thank you to **Mary Davis**, Associate Professor, and **Eric Hoyt**, Visiting Scholar, for their assistance with quantitative methods.

Green Communities

Finally, a huge thank you to all of the municipal employees from Green Communities who participated in our interviews and surveys, or otherwise facilitated our connection with the right people.

Adam Jacobs, Energy Manager, Department of Environment, City of Boston
Bill McHenry, Green Communities Program Manager, Town of Mendon
Bryan Forrette, Director of Facilities, Town of Westfield
Chris Martin, Town Administrator, Town of Granby
Chester Cheng, Project Manager, Town of Tewksbury
Doreen Defazio, Sustainability Director, Town of Sutton
Gino Carlucci, Town Planner, Town of Sherborn
Greg Federspiel, Town Administrator, Town of Manchester
Gregg Cademartori, Planning Director, Town of Gloucester
Irina Sidorenko, Energy and Sustainability Analyst, Department of Public Works, City of Cambridge
Janice Kurkoski, Chair, Warwick Buildings & Energy Committee, Town of Warwick
Jennifer Rand, Town Administrator, Town of West Tisbury
Jillian Wilson-Martin, Sustainability Coordinator, Town of Natick
Justin Sultzbach, Assistant Town Administrator, Town of Tyngsborough
Ken Pruitt, Energy Manager, Town of Arlington
Larry Delaney, Highway Superintendent, Town of Warwick
Laurie Burzlaff, Executive Assistant to the Town Manager, Town of North Andover
Leonard Burnham, Deputy Superintendent, Town of Woburn
Linda Leduc, Town Planner/Economic Development Director, Town of Palmer
Martha Grover, Energy Efficiency Manager, Town of Melrose
Nathan Darling, Building Commissioner, Town of Lakeville
Oliver Sellers-Garcia, Director of Sustainability and Environment, City of Somerville
Orlando Pacheco, Town Administrator, Town of Lancaster
Ray Purington, Administrative Assistant, Town of Gill
Rebecca Slick, Town Planner, Town of Dalton
Ronald Landry, Police Chief, Town of Millville
Scott Moore, Director Central Maintenance/Energy Manager, Town of West Springfield
Stephanie Ciccarello, Sustainability Coordinator, Town of Amherst
Susan McPhee, Energy Conservation Coordinator, Town of Winchester and Woburn
Tim Kaiser, Director of Public Works, Town of Williamstown
Thomas Barasso, Director of Energy and Environmental Affairs, City of Amesbury
William Coughlin, Director of Central Fleet Management, City of Boston

Table of Contents

List of Tables and Figures 6
Executive Summary 7
Introduction 9
- The Green Communities Designation and Grant Program 10
- Challenges with Reducing Municipal Vehicle Fuel 12
- Project Overview 14
- Endnotes 15

Review of Fuel Reduction Measures 17
- Methods 18
- Findings 19
- Recommendations 25
- Endnotes 28

Status of Fuel Reduction in Green Communities 31
- Methods 32
- Findings 33
- Recommendations 55

FEV Policy Updates 57
- Methods 58
- Findings 59
- Recommendations 71
- Endnotes 72

Conclusion 73
Photo Credits 74
Works Cited 75
Appendix A: Resources for Green Communities 78
Appendix B: List of Municipalities Solicited for Interviews and Surveys 81
Appendix C: Interview and Survey Protocols 83
Appendix D: Fuel Economy Trends of Non-exempt Vehicle Classes 91

List of Tables and Figures

Table 1: Current MPG Requirements for Non-exempt Vehicles 11
Table 2: Summary of Fuel Reduction Measures 25
Table 3. Anti-idling Technology Brands Purchased by GCs 41
Table 4: 80th Percentile Fuel Economy Ratings for 2WD Passenger Cars 60
Table 5: 80th Percentile Fuel Economy Ratings for 4WD Passenger Cars 62
Table 6: 80th Percentile Fuel Economy Ratings for 2WD SUVs 63
Table 7: 80th Percentile Fuel Economy Ratings for 4WD SUVs 64
Table 8: 80th Percentile Fuel Economy Ratings for 2WD Pickup Trucks 65
Table 9: 80th Percentile Fuel Economy Ratings for 4WD Pickup Trucks 66
Table 10: 80th Percentile Fuel Economy Ratings for 2WD Minivans 67
Table 11: 80th Percentile Fuel Economy Ratings for 4WD Minivans 68
Table 12. Proposed MPG Requirements for FEV Policy 71
Table 13: Number of Vehicles Available at the 80th Percentile Fuel Economy Rating 72

Figure 1: Percent of Energy Consumption, By Category (2016) 12
Figure 2: Reductions in Energy Use, By Category (2016) 12
Figure 3: Types of Hybrid and Electric Vehicles Owned by GCs and Their Uses 34
Figure 4: CAFE Standards 69
Figure 5: 80th Percentile of 2WD Passenger Cars 69
Figure 6: CAFE Standards 70
Figure 7: 80th Percentile of 2WD SUVs 70
Figure 8: 80th Percentile of 2WD Pickup Trucks 70
Figure 9: 80th Percentile of 2WD Minivans 70

Executive Summary

In 2008, the Green Communities Act established the Green Communities Division (GCD) within the Massachusetts Department of Energy Resources (DOER), a state agency whose primary responsibility is to develop and implement policies and programs that support the transition to clean energy and reduce energy costs for the state of Massachusetts. GCD works directly with municipalities to implement clean energy projects in municipally-owned buildings and vehicle fleets through grants, technical assistance, and the support of Regional Coordinators. While GCD has been successful in helping municipalities reduce their building energy consumption, municipalities have had difficulties reducing their municipal vehicle fuel consumption.

The overarching goal of this project is to help Massachusetts Green Communities reduce their vehicle fuel consumption, energy costs, and greenhouse gas emissions by recommending updates to Criterion 4 of the Green Community program, and to encourage municipalities to purchase the most fuel efficient vehicles and technologies feasible. In order to address this goal, this project aims to expand the methods and knowledge municipalities have to reduce their vehicle fuel consumption, as well as update the miles per gallon (MPG) requirements in the Criterion 4's Fuel Efficient Vehicle (FEV) Policy.

This report is divided into three sections, each with its own set of data-driven recommendations:

1. Research on state and municipal policies and programs that aim to reduce fuel consumption in order to expand the alternative compliance tools available to GCs.
2. Investigation of successes and challenges with the fuel reduction technologies and measures that GCs have implemented.
3. Proposal for updated fuel economy standards of the eight non-exempt vehicle classes, as well as a new method for updating these standards on an ongoing basis.

To reduce vehicle fuel consumption, our recommendations include further promotion and funding of clean vehicles and fuel reduction technologies, engaging in outreach activities to share information about fuel reduction technologies and to facilitate sharing of best practices between GCs, and keeping an eye on particular emerging technologies for fuel efficient vehicles and further funding opportunities for GCs. Furthermore, we recommend that the FEV Policy's MPG requirements be increased according to the 80th percentile of fuel economy ratings on model year 2018 vehicles, at minimum. Additionally, we recommend that GCD update the MPG requirements in the FEV policy on an annual basis.

Introduction

The Massachusetts Department of Energy Resources (DOER) is a state agency that sits in the Executive Office of Energy and Environmental Affairs. DOER's primary responsibility is to develop and implement policies and programs that support the transition to clean energy throughout the state. Additionally, DOER helps municipalities, businesses, and residents in Massachusetts reduce their energy usage and costs.

In 2008, Massachusetts became one of the first states in the country to enact legislation to address the issue of climate change. MA passed not one, but two significant climate- and energy-related acts that year: the Global Warming Solutions Act (GWSA) and the Green Communities Act (GCA).[1] The primary goal of the GWSA is to reduce state greenhouse gas emissions between 10-25% below 1990 statewide levels by 2020, and 80% below 1990 statewide levels by 2050.[2] To help meet these ambitious goals, the GCA was passed to help promote renewable energy and energy efficiency projects throughout the state.

Established by the GCA, the Green Communities Division (GCD) plays an important role in DOER's work to reduce energy consumption, energy costs, and greenhouse gas emissions across the state. Through grants, technical assistance, and the support of Regional Coordinators, GCD works directly with municipalities to implement clean energy projects in municipally-owned buildings and vehicle fleets.[3] The program's most recent progress report found that, in 2016, Green Communities reduced their energy consumption by 12%, or 1.2 million MMBtus, relative to their baseline consumption.[4] This is equivalent to the amount of energy it would take to heat and power 9,000 homes in Massachusetts, and represents emissions reductions of approximately 96,000 metric tons of carbon dioxide equivalent.[5] As of December 2017, 210 municipalities - which accounts for 72% of the state's population - have voluntarily opted to become a Green Community (GC), meaning that Massachusetts will continue to see energy reductions throughout the state.[6]

The Green Communities Designation and Grant Program

The Green Communities Designation and Grant Program is the primary mechanism by which DOER funds energy efficiency and reduction projects in municipalities. In order to become eligible for funding, municipalities must be designated a Green Community. Designation is granted once a municipality has met the following criteria:[7]

Criterion 1: Passed zoning to site renewable energy facilities

Criterion 2: Adopted an expedited permitting and application process for renewable energy facilities

Criterion 3: Created a plan to reduce energy consumption by 20% in five years

Criterion 4: Adopted a policy to require the purchase of fuel efficient vehicles

Criterion 5: Adopted new building regulations to minimize life-cycle energy costs of new construction

Once designated, new Green Communities receive an initial designation grant that begins at $125,000, and is increased based on the municipality's population size and mean income. Once the projects funded by the designation grant are complete and the funds have been spent, municipalities may then apply for a competitive grant, which is capped at $250,000, to implement more projects. This program is a significant funding opportunity for Green Communities, as some municipalities have received up to $900,000 for projects since first becoming designated.

Criterion 4

While GCD has been successful in helping municipalities reduce their building and streetlight energy consumption through its grant program, municipalities have had difficulties reducing their municipal vehicle fuel consumption. Criterion 4 requires that GCs adopt a Fuel Efficient Vehicle (FEV) Policy, which requires municipalities to purchase vehicles that meet a certain fuel economy standard for that vehicle type. In other words, for each gallon of fuel consumed, each new vehicle must be able to travel a minimum number of miles (referred to as miles per gallon, or MPG). Currently, Criterion 4 dictates MPG requirements for eight different vehicle classes. As long as a vehicle weighs under 8,500 pounds, it is subject to the below requirements, and is therefore considered non-exempt from the FEV Policy. Hybrid and electric vehicles automatically meet the below requirements.

Table 1. Current MPG Requirements for Non-Exempt Vehicles[8]

Vehicle Class	MPG Requirement
2 wheel drive passenger car	29
4 wheel drive passenger car	24
2 wheel drive sport utility vehicle	21
4 wheel drive sport utility vehicle	18
2 wheel drive minivan	20
4 wheel drive minivan	18
2 wheel drive pickup truck	17
4 wheel drive pickup truck	16

Several municipal vehicles are exempt from the FEV Policy, including vehicles that weigh over 8,500 pounds, such as garbage trucks and snow plows, and emergency vehicles, such as police cruisers, ambulances, and firetrucks. Municipalities that have only exempt vehicles in their fleet are required to create an alternative compliance plan to reduce their fuel consumption. Alternative compliance plans vary between municipalities, and can include anything from incentivizing employees to bike to work to installing electric vehicle charging stations in their municipality.[9] Alternative compliance plans must be reviewed and accepted by GCD in order for Criterion 4 to be satisfied. Additionally, municipalities must commit to purchasing vehicles that meet the above fuel efficiency standards should they need to purchase a non-exempt vehicle in the future.

Challenges With Reducing Municipal Vehicle Fuel Consumption

Though all Green Communities are required to have a FEV Policy or an alternative compliance plan in place, the 2016 Green Communities Program Progress Report found that reducing vehicle fuel consumption has been difficult. As exemplified in Figures 1 and 2, though vehicles made up approximately 20% of total energy consumption among Green Communities in 2016, energy reductions from vehicles accounted for only 2% of total energy reduction. Additionally, smaller communities with populations below 5,000 used closer to 30-35% of their energy on their vehicles due to the makeup of their vehicle fleet, which has a higher ratio of larger vehicles. Energy consumption by buildings, on the other hand, made up approximately 65-70% of total energy consumption, yet Green Communities reduced their building energy consumption by approximately 13% in 2016.[10]

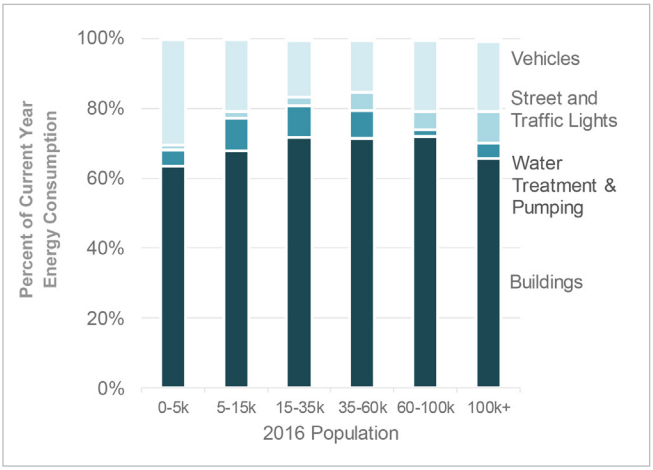


Figure 1: Percent of Energy Consumption, By Category (2016)[11]

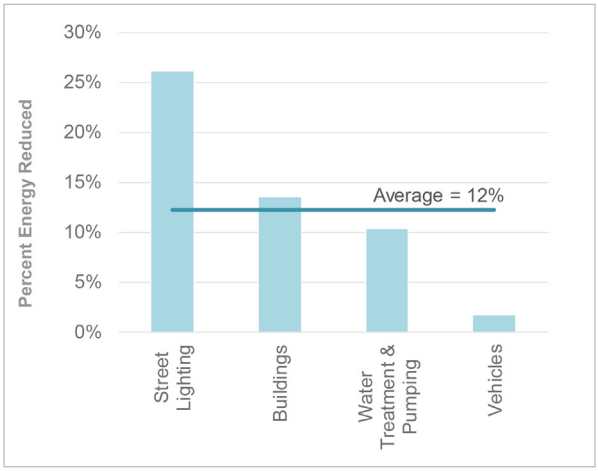


Figure 2: Reductions in Energy Use, By Category (2016)[12]

One of the largest obstacles to reducing municipal vehicle fuel consumption is the high number of exempt vehicles in municipal fleets. For most municipal fleets in the GC program, either the majority or all of the vehicles are exempt. In the 2017 GCD vehicle inventory, non-exempt vehicles made up only a quarter (25.6%) of the inventory. Two-thirds (67.9%) of the vehicles reported by Green Communities in the 2017 GCD vehicle inventory were exempt from the FEV Policy.

Two-thirds (67.9%) of the vehicles reported by Green Communities in the 2017 GCD vehicle inventory were exempt from the FEV Policy.

The remainder (6.5%) were not classified as either exempt or non-exempt. Of the vehicles marked as exempt, at least 15% were police vehicles, 9.5% were public works vehicles, 8.8% were buses, and 1.7% were plows.[13]

These vehicles are problematic for several reasons. First, as previously noted, exempt vehicles include all vehicles exceeding 8,500 pounds in weight, and heavy vehicles, such as public works vehicles, tend to have lower fuel efficiency.[14] Second, though police cruisers tend to be light-duty vehicles, the fact that they make up a large percentage of fleets and are not subject to the MPG standards makes reducing overall fuel consumption difficult. Lastly, school buses are difficult to deal with because most municipalities lease their buses from a third party and most smaller towns share their buses regionally. These buses are therefore not subject to regulation by municipalities.

Several other problems prevent municipalities from reducing their vehicle energy use as well. There is an overall lack of more fuel efficient alternatives, including electric and hybrid options, for larger vehicles on the market. For example, few hybrid and electric options are available for trucks. Additionally, many municipalities have certain operational requirements for vehicles that are hard to meet with more fuel efficient options, like the ability to attach a plow onto a vehicle. Municipalities also tend to hold on to older, inefficient vehicles for as long as possible because they lack the resources to purchase new vehicles on a regular basis. For example, out of commission police cruisers are often transferred to other departments to perform other roles—a common practice known as vehicle "recycling." This may be perceived as a more environmentally friendly alternative to purchasing a new vehicle, even if it is more fuel efficient, but in most cases these recycled vehicles do not comply with the FEV Policy and result in inefficient vehicles remaining on the road for a longer period of time.

Moreover, some fleet managers are not aware of new technologies and alternatives that are available to reduce vehicle emissions. There is also indication from some regions in the state that changing mindsets may be difficult to accomplish, especially given that MA is a home rule state and, therefore, municipalities within MA are used to having autonomy and setting their own direction. On top of it all, the Green Communities program is largely voluntary. While GCs that violate their FEV Policy are required to describe how and why a non-compliant vehicle was acquired and what measures were implemented to prevent it from happening again, the Green Communities Division has not yet penalized communities for non-compliance, such as disqualifying them from future grants. Instead, DOER wants to encourage communities to adopt change through friendly tactics, as opposed to disincentivizing communities from participating at all due to potential consequences from non-compliance. In most cases, FEV policy violations only occur once in a Green Community, and issues are addressed through corrective action plans.

Lastly, Green Communities have been potentially missing an opportunity to bring down vehicle energy use because the MPG requirements in the current FEV Policy have not been updated since 2012, the same year that the Obama Administration set new Corporate Average Fuel Economy (CAFE) standards that require auto manufacturers to produce increasingly efficient cars and light trucks each year.[15]

Project Overview

In order to address the vehicle fuel reduction challenges faced by Green Communities and encourage them to take advantage of the more fuel efficient vehicles on the market, this project aims to expand the methods and knowledge municipalities have to reduce their vehicle fuel consumption, as well as update the FEV Policy in Criterion 4.

This project is divided into three main deliverables. The first and second deliverables increase the knowledge base of municipalities through two forms of research. First, we researched state and municipal policies and programs, both inside and outside of Massachusetts, aimed at reducing fuel consumption in order to expand the alternative compliance methods available to GCs. Second, we conducted interviews and surveys with GC municipal employees to learn about their successes and challenges with implementing the fuel reduction technologies that they have acquired with their GC grants, as well as any other fuel reduction measures they have implemented. The last deliverable analyzed trends in fuel economies for the eight nonexempt vehicle classes available on the market to set new MPG requirements for the outdated FEV Policy.

The overarching goal of this project is to help municipalities reduce their vehicle fuel consumption, energy costs, and greenhouse gas emissions by recommending updates to Criterion 4 of the GC program, and to encourage municipalities to purchase the most fuel efficient vehicles and technologies feasible.

Endnotes

1 "Global Warming Solutions Act Background," Mass.gov, https://www.mass.gov/service-details/global-warming-solutions-act-background. Accessed 10 March 2018.

2 Ibid.

3 "Green Communities Division," Mass.gov, https://www.mass.gov/orgs/green-communities-division. Accessed 10 March 2018.

4 Massachusetts Green Communities Program 2016 Progress Report. Massachusetts Department of Energy Resources, December 2017, www.mass.gov/files/documents/2018/03/12/gc-2016-progress-report.pdf.

5 Ibid.

6 "Maps, Reports, and Publications," Mass.gov, https://www.mass.gov/lists/maps-reports-and-publications. Accessed 16 March 2018.

7 "Becoming a Designated Green Community." Mass.gov, https://www.mass.gov/guides/becoming-a-designated-green-community. Accessed 10 March 2018.

8 "Criterion 4 Guidance." Mass.gov, https://www.mass.gov/files/documents/2016/08/pp/criterion-4-guidance.pdf. Accessed 22 January 2018.

9 "Criterion 4 Guidance."

10 Massachusetts Green Communities Program 2016 Progress Report

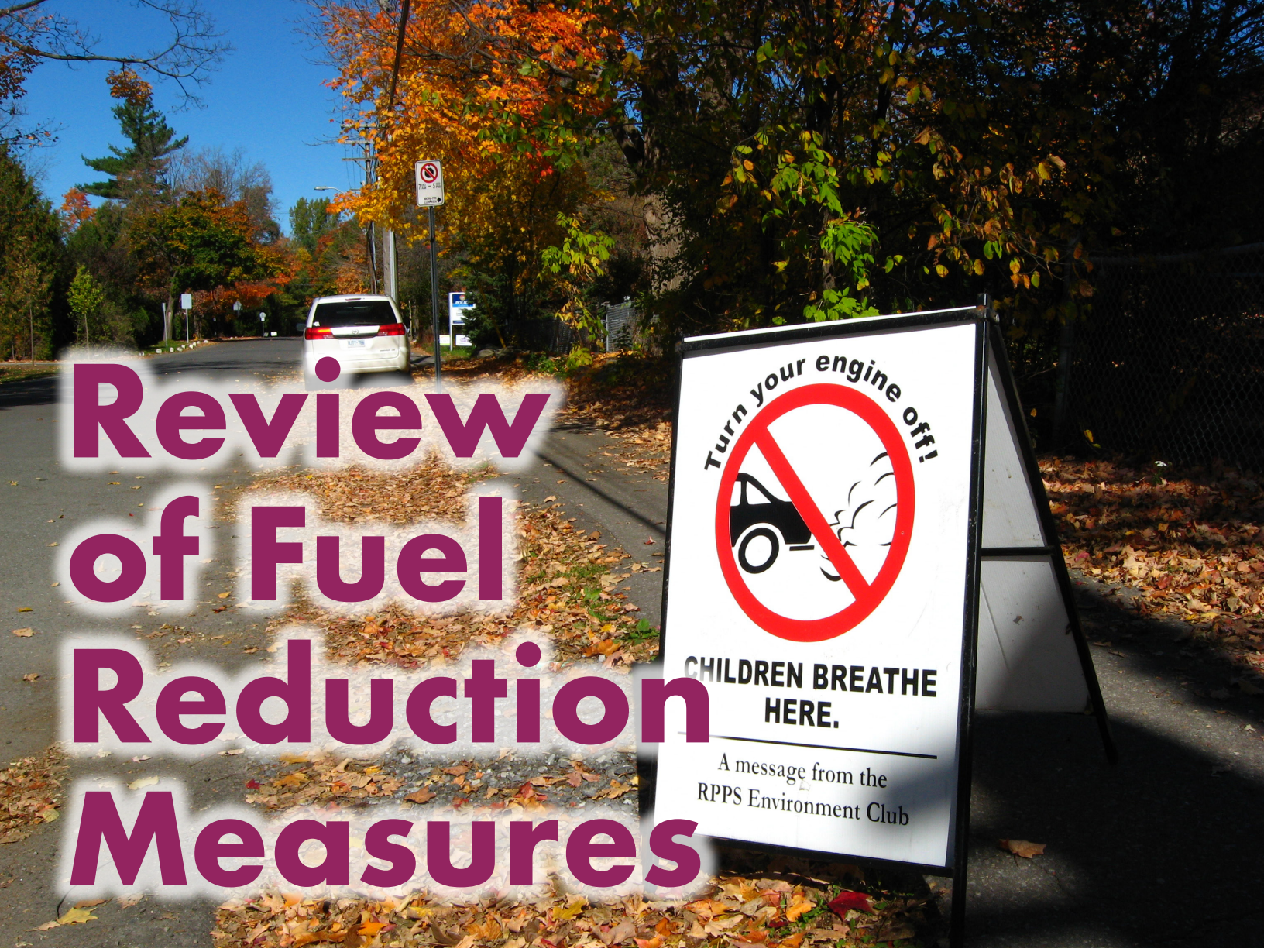
11 Ibid.

12 Ibid.

13 Vehicles were inconsistently self-reported by the municipalities. The 15% being police vehicles is the result of a search under "Vehicle Function" for any match in the cell containing "police," and exact matches of the cell for "cruiser," "PD cruiser," or "patrol." The 8.8% being buses is a result of a search under "Vehicle Function" for any match in the cell containing "bus." The 1.7% being plows is a result of a search under "Vehicle Function" for any match in the cell containing "plow." Public works vehicles were found by searching for cells containing "public works" and "DPW." Percentages may actually be higher as these types of vehicle functions may be reported with other names.

14 "Corporate Average Fuel Economy." National Highway Traffic Safety Administration, www.nhtsa.gov/laws-regulations/corporate-average-fuel-economy#corporate-average-fuel-economy-cafe. Accessed 24 April 2018.

15 "Massachusetts Electric Vehicle Incentive Program (MassEVIP) Fleets Questions & Answers," Mass.gov, https://www.mass.gov/files/documents/2017/11/08/massevipfaq_11.pdf. Accessed 13 March 2018.



Review of Fuel Reduction Measures

As a division that provides technical assistance to Massachusetts communities, the Green Communities Division would like to expand the fuel reduction measures they have available to share with municipalities. As previously mentioned, most Green Communities have a largely exempt municipal fleet, and electric or hybrid options are not widely available for the specific types of exempt vehicles that they need, making it difficult to replace old vehicles with more fuel efficient vehicles. Therefore, municipalities have a need for fuel reduction measures that can be applied to their existing, larger vehicles in order to reduce fuel consumption.

Methods

Our research on fuel reduction measures was compiled through online research with secondary, qualitative and quantitative, case-specific data. Through online research, we primarily reviewed federal, state, and municipal government websites to collect information on programs, policies, and tools that currently exist. We also reviewed studies published in peer-reviewed journals on fuel reduction measures, as well as reports published by states and municipalities on their fuel reduction pilot programs. Additionally, DOER previously conducted research on other states' fuel reduction policies for the MA state fleet fuel efficiency standards they enacted in 2016, so we reviewed the policies that helped to inform the state fleet policy, as well as the state fleet policy itself for additional guidance.

From our preliminary research, we established three overarching categories in which fuel reduction measures fall, and used these categories to help organize and prioritize our search. The categories are as follows:

1. Promote the purchase of new alternative fuel vehicles
2. Improve the fuel efficiency of existing vehicles through aftermarket technologies
3. Change fleet management practices and driving habits

The first category includes incentives, programs, and regulations that encourage or require the purchase of electric vehicles, hybrid vehicles, and/or alternative fuel vehicles (e.g., those that run on ethanol or compressed natural gas). The second category includes programs that encourage the purchase and installation of aftermarket technologies on existing vehicles so as to reduce fuel consumption and harmful vehicle emissions. These programs include the installation of anti-idling technology, vehicle conversions or retrofits to install hybrid engines, and the installation of GPS technology that optimizes driving routes and reduces vehicle miles traveled. The final category includes incentives, programs, and regulations that focus on changing fleet management practices and the driving habits of municipal employees. These include carpool and bike to work incentives, preferred workplace parking for electric or hybrid vehicles, anti-idling policies, vehicle right-sizing, vehicle sharing among municipal departments, and early retirement programs for old, inefficient vehicles.

While our research spanned all three categories, we focused our attention on the aftermarket technology and behavior change categories. The assumption was made that purchasing electric or hybrid vehicles is the best option for reducing fuel use for Green Communities, so we pulled together key funding programs currently available in MA to ensure that GCs are aware of these opportunities. However, given that there are limited electric or hybrid alternatives on the market for exempt vehicles and the need to expand the alternative compliance options available to municipalities with exempt fleets, we concluded that policies and programs that fall in the second and third categories will be of the most use to GCs, and therefore highlighted common and effective methods in these categories.

Findings

Massachusetts Hybrid and Electric Vehicle Incentive Programs

The Massachusetts Department of Environmental Protection (DEP) used to administer the Massachusetts Electric Vehicle Incentive Program (MassEVIP). MassEVIP provided funding to municipalities to purchase or lease electric and hybrid vehicles and install vehicle charging stations. The program offered between $3,000 and $5,000 for plug-in hybrids, between $5,000 and $7,500 for battery electric vehicles, and between $5,000 and $10,000 for charging stations dependent upon the number of vehicles that a municipality purchases.[1] A municipality could purchase up to 25 vehicles through this program, and several Green Communities took advantage of this program.[2] Of the 77 electric or hybrid vehicles that have been purchased by municipalities with grant money, 69 were supplemented with EVIP funding. Unfortunately, the funding for this program has been exhausted and has not been renewed as of the completion of this report.

The Metropolitan Area Planning Council (MAPC) administers the Green Mobility Group Purchasing Program, which is part of the US Department of Energy's (DOE) Fleets for the Future initiative.[3] The Green Mobility Program helps municipalities purchase electric vehicles, charging stations, and aftermarket technologies by helping municipalities navigate the purchasing process, aggregating purchase requests from multiple municipalities, and searching for the best quotes by buying in bulk.[4] Additionally, the Green Mobility Program offers technical and fleet planning assistance to municipalities.[5]

Lastly, the MA DEP has been designated a trustee for the funds that the State of Massachusetts will receive from the Volkswagen Settlement, which totals $75 million. The DEP has held several public meetings over the past few months to share their plans for how the settlement funds could potentially be used. Proposed funding projects include replacing current engines with new diesel engines, alternate fuel (i.e. compressed natural gas, propane, or hybrid), or electric engines, and replacing current vehicles with new diesel-powered, alternate fuel, or electric vehicles.[6] Government-owned vehicles are eligible to have up to 100% of their project funded by the settlement, including the cost of the equipment and installation.[7]

Alternative Fuels

In addition to electric vehicles, several other low-carbon alternative fuels currently exist on the market. Prominent alternative fuels include biodiesel, ethanol, hydrogen, natural gas, and propane, some of which are already widely used in vehicle fuel, such as ethanol and propane.[8] Though use of alternative fuels does not necessarily reduce fuel consumption, these fuels are known to produce less vehicle emissions—both greenhouse gas emissions and other emissions harmful to human health and the environment—than more conventional fuels, such as gasoline and diesel. While some alternative fuels can be used in conventional engines, some fuels require existing vehicles to be retrofitted with a new engine, or the purchase of a new vehicle altogether. Additionally, new fueling infrastructure and suppliers may be required for alternative fuels.

San Francisco, CA

In 2015, San Francisco began using renewable diesel as a replacement for petroleum diesel. Renewable diesel is similar to biodiesel in that it is not fossil fuel-based, and instead is derived from renewable resources such as animal fats, vegetable oils, and greases. However, due to the way it is processed, renewable diesel does not run into the same issues as biodiesel during freezing temperatures and does not need to be blended.[9] San Francisco replaced petroleum diesel with renewable diesel in all of the 53 fueling stations throughout the City, affecting 1,966 diesel-powered vehicles. The project was cost-neutral to the City due to state and federal support for renewable diesel, but was expected to reduce vehicle emissions by 50% in one year, from 100,000 metric tons of greenhouse gases to 50,000 metric tons.[10] Because renewable diesel can be used in any diesel engine and burns much cleaner than both biodiesel and petroleum diesel, switching to renewable diesel can result in cost savings for municipalities. The fleet manager of the Eugene Water and Electric Board in Oregon estimated a savings of $5,000 a year in vehicle maintenance costs by switching his 75 trucks to renewable diesel.[11] Though renewable diesel is a more environmentally-friendly alternative to biodiesel and petroleum diesel and does not require the purchase of a new vehicle or new technology for an existing vehicle, renewable diesel is produced and largely incentivized on the West Coast. Therefore, transporting renewable diesel to the East Coast coupled with the lack of state incentives in Massachusetts for renewable diesel may make the alternative too expensive of an option for Green Communities.[12]

Smithtown, NY

In 2007, Smithtown, NY, required that its garbage collection contractor use compressed natural gas (CNG) in place of diesel. The contractor replaced its 30 diesel-powered garbage trucks with 22 CNG models. The reduction in vehicles and the switch to CNG was estimated to reduce vehicle emissions of nitrogen oxides by 265 tons and particulate matter by 15 tons over a five year period, improving air quality and reducing overall emissions.[13] Additionally, vehicles powered by CNG are estimated to produce 25% less greenhouse gas emissions than diesel-powered vehicles.[14] Though CNG vehicles were more expensive than diesel-powered trucks at the time, the contractor was able to

take advantage of the Federal Alternative Motor Vehicle Credit to fund up to 80% of the increased cost. The town also had to contract with a natural gas supplier in order to establish the necessary fueling infrastructure. Since New York State was trying to increase the use of natural gas at the time of the project, the partnership with the natural gas supplier brought an additional $0.05 per gasoline gallon equivalent of CNG of revenue to the state.[15] Additionally, the negotiated price of CNG between Smithtown and their supplier was lower than the average cost of diesel, resulting in fuel cost savings for the town.[16] This project was considered an overall success, but also exemplifies how significant investment and incentives are needed to make projects like these successful. While Massachusetts' incentive program for alternative fuel vehicles and infrastructure includes natural gas, CNG has a similar fuel economy to conventional fuel vehicles, and thus does not necessarily help to reduce fuel consumption.[17]

Anti-idling Technology

Engine idling wastes fuel and money, wears out an engine, and releases unnecessary, harmful emissions into the air.[18] However, several municipal vehicles, such as police vehicles or school buses, need to idle in order to operate equipment on board or to keep passengers warm during the winter. Anti-idling technology therefore has the potential to have a big impact on reducing fuel consumption. Additionally, anti-idling technology can be installed in heavy-duty vehicles which, as previously mentioned, does not have many fuel efficient alternatives on the market. Several different types of anti-idling technology exists today for heavy-, medium-, and light-duty vehicles and school buses, including auxiliary power systems, coolant heaters, and automatic engine stop-start controls.[19] Though these technologies function differently, they all essentially aim to reduce the use of the engine when the vehicle needs to be operated in some capacity, but is not actually being driven.

Canyon County, ID

In 2011, Canyon County, ID, installed anti-idling equipment on almost its entire police fleet, which consisted of over 60 vehicles. The County saved 36 miles worth of fuel per vehicle per day and reduced their carbon emissions by 100 pounds per vehicle per day. Overall, the County fleet manager estimated an increase in fuel economy of 4 to 6 MPG, and a reduction of 1.4 million pounds of carbon dioxide emissions per year.[20]

St. Louis, MO

Also in 2011, a Special School District in St. Louis, MO, installed Espar fuel-operated heaters on 116 of its school buses, almost the entire fleet, to heat the buses without idling. Each heater cost $1,364 and saved at least three gallons of diesel per bus per day.[21] The total project cost approximately $158,224, but saved approximately 127,020 gallons of diesel per year, or approximately $489,027 per year based on the average cost of diesel in 2011.[22]

Telematics and Route Optimization

Telematics is the use of software to monitor the use of a vehicle through GPS tracking as well as vehicle diagnostics, such as speed, fuel use, idle time, and maintenance requirements.[23, 24] A benefit of telematics is that it can help to plan efficient and optimal routes that reduce vehicle miles traveled, which can be particularly useful for snow plow, waste collection, and school bus routes that have to make several stops. Route optimization can be achieved through different methods, including using mapping software to plan out efficient routes, and installing telematics devices directly onto vehicles that provide turn-by-turn directions. Telematics devices can also provide drivers with real time feedback about their vehicle's fuel economy based on their driving, which can increase driver awareness about fuel saving driving habits, which has proven to be an effective fuel reduction method.[25]

University of Vermont Study

A study completed by the University of Vermont in 2016 reviewed route optimization projects in nine different states (see summary on page 25) and found that snow plow routes were reduced in length by 5-10% after projects were completed.[26] These projects predominantly used mapping software, such as ArcGIS, Fleet Route, and TransCAD, to plan the most efficient snow plow routes, though telematics devices were used as well in some cases. Most projects using mapping software required the expertise of outside consultants in some cases, resulting in project costs ranging from $30,000 to $120,000.[27] This is more than the cost of purchasing a fuel efficient vehicle in some cases, and perhaps not the best use of GC grant money. However, these projects could be completed in house by individual municipalities, or by Urban or Environmental Policy and Planning students. Additionally, the report emphasized the importance of local knowledge and hands on experience when it comes to route planning. Therefore current snow plow operators can and should play key roles in efficient route planning projects, which may further reduce the need for outside consultants.

Baltimore County, MD

Additionally, telematics devices can help to optimize vehicle routes, while providing other benefits as well. In 2012, Baltimore County, MD, installed telematics devices on 850 of its vehicles, including dump trucks and snow plows, in an effort to help with route planning, reducing fuel consumption and miles traveled, and reducing carbon emissions. The County reported a decrease of 817,327 miles driven in a one year period relative to the previous year, which is equivalent to 99,311 gallons of fuel and $300,000 in fuel costs. In addition to these reductions, the County reported improved driver behavior, reduced idle time, and increased customer satisfaction. The overall cost of the project totaled $320,000, or about $376 per vehicle, but the project almost paid for itself in one year. The County also saw a reduction in monthly average fuel consumption of 8,300 gallons, meaning that cost savings would continue to accrue.[28]

Rightsizing Requirements

Rightsizing can refer to each individual vehicle, as well as an entire fleet. Vehicle rightsizing ensures that vehicle size matches the intended function and purpose of the vehicle, and therefore ensures that larger, less efficient vehicles are only acquired and used where absolutely necessary. This can be applied to new vehicle purchases, as well as existing vehicles through an inventory review. Fleet rightsizing ensures that the number and composition of vehicles in a fleet matches the operational needs of a municipality. By conducting a review of vehicle inventory and assessing if there are underutilized vehicles, fleet managers can remove those vehicles from its fleet, saving fuel and maintenance costs. Telematics devices and fleet management software can serve as useful rightsizing tools since they can track vehicle miles traveled and help determine whether vehicles are underutilized and unnecessary.

Burlington, VT

In 2008, Burlington, VT, began requiring new vehicles to be rightsized, and developed a needs assessment tool that had to be completed by departments before purchasing a new vehicle. The tool, along with the Roads and Parks Department fleet manager, helped departments to evaluate the operational needs of their vehicle, and then chose the smallest vehicle that met their needs. One assessment resulted in the replacement of a cube van with a Sprinter van that had a 40% higher fuel efficiency.[29]

Detroit, MI

In 2012, Detroit, MI, partnered with the Clean Energy Coalition, a nonprofit that promotes clean energy technologies, to identify vehicles in their fleet that could be eliminated.[30] By selling the identified vehicles, the city generated $1 million and was expected to save thousands of dollars in fuel and maintenance costs.[31]

Vehicle Sharing Among Municipal Employees

An important tool that can be used to help rightsize a fleet is to implement a vehicle sharing program for municipal employees. This would entail setting aside a portion of a municipality's fleet, such as passenger cars, into a pool that municipal employees can use for business-related travel, while also encouraging carpooling. Vehicle pools reduce the overall number of cars that are needed for individual employees and have been found to reduce vehicle miles traveled. Several cities, including Boston and Washington, D.C., have partnered with Zipcar, a car sharing service, to help establish and maintain a municipal vehicle pool.

New York, NY

In 2011, New York City implemented a car-sharing pilot program for its employees in lower Manhattan and found that vehicle miles traveled decreased by 11% over the six-month pilot period while maintaining adequate access to vehicles when needed.[32]

Eco-driving Training and Education

Driving behavior is known to have a large impact on the fuel efficiency of a vehicle. Several states, including the MA Department of Transportation, and municipalities have required their employees to go through "smart" or "eco" driving training in order to teach driving practices that reduce fuel consumption. Examples of eco-driving include reducing idling, promoting slow acceleration and braking, and avoiding speeds above 60 miles per hour. If conducting a training is not feasible, educational campaigns on eco-driving best practices is an alternate option, and several resources are available on the internet to compile these best practices (see Appendix A for some of these resources).

Examples

North Carolina's Department of Transportation promotes eco-driving through the state's Drive Green, Save Green educational program, which has posters available for download and videos available for viewing. Additionally, some small Green Communities with a high percentage of vehicle fuel consumption, such as West Boylston, Charlton, and New Braintree, have incorporated eco-driving behaviors into their municipal energy reduction plans by implementing "general vehicle-fuel conservation measures" across all departments. This includes avoiding aggressive driving, which has been shown to improve gas mileage by up to 30% on the highway and up to 40% in stop-and-go traffic, and removing excess weight from vehicles, which has been shown to improve gas mileage by 1% per 100 pounds of weight removed., Additionally, several small GCs, as well as municipalities outside of MA, including Burlington, VT, and San Jose, CA, have instituted an anti-idling policy that aim to prevent vehicles from idling for longer than five minutes at a time. These measures can be achieved at no additional cost, and therefore present low-hanging fruit.

Proactive Vehicle Maintenance

We found that several communities both inside and outside of Massachusetts have implemented measures to proactively keep their vehicles well maintained. For example, keeping tires properly inflated have been shown to improve gas mileage by up to 6%, and keeping engines properly tuned has been shown to improve gas mileage by 4% on average.

Cummington, MA

In order to help track when vehicle repairs are needed or when preventative maintenance will be beneficial, Cummington, MA, another Green Community, plans to implement a fleet management system. As previously discussed, telematics systems can be useful in tracking vehicle diagnostics and maintenance schedules, which enable fleet managers to proactively maintain their vehicles and can raise drivers' awareness about their driving habits, thus resulting in reduced fuel consumption.

Recommendations

Table 2: Summary of Fuel Reduction Measures

Fuel Reduction Measure	Applicable Vehicles	Cost of Implementation and Maintenance*	Fuel Savings*	Fuel Cost Savings*
Alternative Fuels	All, but more useful for heavy-duty vehicles	Varies	Varies	Varies
Anti-idling Technology	All, but particularly useful for police vehicles and heavy-duty vehicles	Varies	Varies	Varies
Route Optimization Projects	All, but particularly useful for vehicles on fixed routes	$30,000 - $120,000 for implementation	5-10% reduction in route length	Varies
Telematics Devices	All, but particularly useful for vehicles on fixed routes	Avg. $350/vehicle for implementation Monthly subscription fee	Avg. 117 gallons/ vehicle/year	$60 - $350/ vehicle/year
Rightsizing Requirements	All	Administrative costs to create requirements and review vehicle inventory on an ongoing basis	Depends on the size and make up of the fleet and which vehicles are eliminated	Depends on the size and make up of the fleet and which vehicles are eliminated
Vehicle Sharing Programs	Passenger cars Particularly useful for larger cities or nonexempt fleets	N/A	N/A	N/A
Eco-driving Training and Education	All	Administrative costs for educational campaign and/or creation of measures Training course: $29/ person	30% - 40% reduction in fuel use	N/A
Proactive Vehicle Maintenance	All	Administrative costs related to tracking vehicle maintenance schedules	4-6% increase in MPG per vehicle	N/A

*Note: This data only reflects numbers from the case studies cited in this report and is not a complete representation of fuel reduction measures.

Examples of states and municipalities that have implemented the above fuel reduction measures can be found in Appendix A.

Several of the fuel reduction measures discussed above are relatively easy and low-cost to implement, such as encouraging eco-driving, implementing an anti-idling policy, requiring rightsizing, and proactively maintaining vehicles. Therefore, these measures should be written into the FEV Policy as a requirement, as opposed to presented as a measure that can be incorporated into an alternative compliance plan. If this is seen as too imposing, then these measures should be included in the policy as best practices, and GCs should be strongly encouraged to adopt these measures if they are not already doing so. Given the ease and low cost of implementation, these measures could be particularly beneficial to smaller municipalities with limited budgets and staff as exemplified by some the smaller GCs that have already written these measures into their energy reduction plans. However, it is worth noting that these measures may be difficult to enforce, which could affect how effective these measures are.

Telematics devices or fleet management software are useful tools for fleet managers to monitor and enforce these strategies, while also enabling fleet managers and drivers to plan efficient routes in order to reduce vehicle miles traveled. The multiple uses and benefits of telematic devices and their customization makes them an appealing technology to fund. In order to work around the privacy concerns associated with telematics that DOER has shared with us (i.e. that employees feel as if their employers are monitoring them too closely), perhaps GCs who purchase telematics devices could reward their employees for eco-driving habits, as opposed to reprimanding them for using large amounts of fuel, or institute friendly competition between departments to reduce fuel usage in the vehicles with telematics devices. Ultimately the framing around why telematic devices are being purchased and how they are being used will be important for GCs to clearly communicate to their municipal employees so as to facilitate acceptance and implementation of the technology.

An alternative option to telematics devices is route optimization projects. While hiring outside consultants can be more than the cost of purchasing a fuel efficient vehicle in some cases, these projects could be completed in-house by individual municipalities, or by graduate students, such as another Field Projects course. Additionally, the report emphasized the importance of local knowledge and hands on experience when it comes to route planning. Therefore current snow plow operators should play key roles in efficient route planning projects, which may further reduce the need for outside consultants.

Anti-idling technologies also present a great opportunity for alternative compliance plans given that they can be installed on heavy-duty vehicles that have limited fuel efficient alternatives available. The Environmental Protection Agency's SmartWay Program includes a list of verified idle-reduction technologies for trucks and school buses that can serve as a useful tool for municipalities when deciding between available technologies (see Appendix A). Anti-idling technology can range significantly in cost, but are expected to have short pay-back periods, as well as result in substantial reductions in wasted fuel use and avoidable vehicle emissions.

Municipal vehicle share programs can help to both reduce fleet size and vehicle miles traveled, yet are likely to only be useful for large fleets with several non-exempt vehicles that are used for employee travel only. Although these programs lend themselves to

larger municipalities, smaller towns can implement comparable programs even without car share software, by requiring vehicle sharing or employee carpooling for business-related travel where feasible.

Of all the fuel reduction methods reviewed, switching to alternative fuels would be our last choice, with the exception of electricity. If alternative fuels do not require significant investment in new vehicles and infrastructure, then we believe it is worth pursuing due to the associated decrease in harmful emissions. However, we see alternative fuels as an interim solution until more electric vehicles that meet municipal operational requirements are produced and made affordable. Though alternative fuels reduce greenhouse gas emissions, they do not necessarily reduce fuel consumption. Electric vehicles, on the other hand, accomplish DOER's goals of both drastically reducing fuel consumption and greenhouse gas emissions. Therefore, significant investment in electric vehicles and related infrastructure could have a larger overall benefit than significant investment in other alternative fuels. For example, if a municipality were to invest in new CNG-powered garbage trucks, and electric-powered garbage trucks became more widely available and affordable shortly after, that municipality will be stuck with CNG-powered garbage trucks for an entire vehicle life-cycle. Though not yet widely produced and used in the US, there are electric-powered heavy-duty vehicles available that meet municipal operational requirements, and their market share is expected to continually grow. Ultimately, we recommend that municipalities complete a cost-benefit analyses before switching to an alternative fuel, as well as keep an eye on the electric vehicle market before making any significant investment decisions.

To help fund electric and hybrid vehicles, as well as related infrastructure, GCs should keep an eye on the various funding programs available in MA. Though funding for EVIP has run out, GCs should continue to take advantage of this program if funding eventually becomes renewed. Since the MAPC Green Mobility Program is relatively new and has had trouble with promotion, GCD should be sure to share this program with GCs. Finally, the funds from the Volkswagen Settlement pose potential funding options for Green Communities in the future, especially for heavy-duty vehicles in their fleets.

Based on the case studies that we reviewed, we recommend the following measures be added to Criterion 4's options for alternative compliance measures:

- Require use of anti-idling technology on police cruisers and medium- to heavy-duty vehicles
- Require use of telematics devices to plan routes and monitor idling and driving habits
- Require route optimization projects for vehicles on fixed routes
- Implement rightsizing requirements for new vehicles by creating a needs assessment tool
- Require annual reviews of municipal fleet inventory to ensure that fleets are rightsized
- Incentivize vehicle sharing programs for business-related travel
- Encourage eco-driving through trainings for municipal employees and educational campaigns
- Encourage and educate employees on proactive vehicle maintenance
- Keep an eye on electric and hybrid vehicle funding opportunities, and let GCs know when they become available

Endnotes

1 "Massachusetts Electric Vehicle Incentive Program (MassEVIP) Fleets Questions & Answers," Mass.gov, https://www.mass.gov/files/documents/2017/11/08/massevipfaq_11.pdf. Accessed 13 March 2018.

2 Ibid.

3 "Clean Vehicle Projects," Metropolitan Area Planning Council, https://www.mapc.org/our-work/expertise/clean-energy/clean-vehicle-projects/. Accessed 13 March 2018.

4 Ibid.

5 Ibid.

6 "Appendix D-2: Eligible Mitigation Actions and Mitigation Action Expenditures," Volkswagen Settlement, https://www.vwcourtsettlement.com/wp-content/uploads/documents/DOJ/Approved%20Appendix%20D-2.pdf. Accessed 4 April 2018.

7 Ibid.

8"Alternative Fuels and Advanced Fuels." Alternative Fuels Data Center, https://www.afdc.energy.gov/fuels/. Accessed 24 April 2018.

9 Ernst, Shelley. "What You Need to Know About Renewable Diesel." Government Fleet, March 2016, http://www.government-fleet.com/channel/green-fleet/article/story/2016/03/what-you-need-to-know-about-renewable-diesel.aspx. Accessed 24 April 2018.

10 "San Francisco's Renewable Diesel Halves Diesel Emissions." Government Fleet, 14 December 2015, https://www.government-fleet.com/channel/green-fleet/news/story/2015/12/san-francisco-reduces-diesel-emissions-by-50-with-renewable-diesel.aspx. Accessed 24 April 2018.

11 Boada, Mark. "Managers of Work Truck Fleets: Is Renewable Diesel in Your Future?" Fleet Management Weekly, http://www.fleetmanagementweekly.com/managers-work-truck-fleets-renewable-diesel-future/. Accessed 24 April 2018.

12 Ernst, "What You Need to Know."

13 "Smithtown Selects CNG to Cut Refuse Collection Costs." Alternative Fuels Data Center, 7 April 2011, https://www.afdc.energy.gov/case/1047. Accessed 24 April 2018.

14 Gallucci, Maria. "More U.S. Towns Are Requiring Natural Gas Garbage Fleets, in Boon to Truck Makers." Inside Climate News, 21 October 2011, https://insideclimatenews.org/news/20111021/compressed-natural-gas-vehicles-garbage-trucks-clean-fuels-electric-cars-smithtown-new-york-fracking. Accessed 24 April 2018.

15 "Smithtown Selects CNG."

16 Gallucci, "More U.S. Towns."

17 "Natural Gas Fuel Basics." Alternative Fuels Data Center, https://www.afdc.energy.gov/fuels/natural_gas_basics.html. Accessed 24 April 2018.

18 "Idle Reduction," Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/idle_reduction_onboard.html. Accessed 17 April 2017

19"Onboard Idle Reduction Equipment for Heavy-Duty Trucks," Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/idle_reduction_onboard.html. Accessed 17 April 2018.

20 "County Fleet Goes Big on Idle Reduction, Ethanol Use, Fuel Efficiency," Alternative Fuels Data Center, 7 April 2011, https://www.afdc.energy.gov/case/1046. Accessed 17, April 2018.

21 "The Heat Is On in St. Louis Buses," Alternative Fuels Data Center, 24 May 2013, https://www.afdc.energy.gov/case/1429. Accessed 17 April 2018.

22 "Petroleum & Other Liquids." U.S. Energy Information Administration, https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M. Accessed 24 April 2018.

23 "What is telematics?" Geotab, https://www.geotab.com/blog/what-is-telematics/. Accessed 5 April 2018.

24 "Vehicle Parts and Equipment to Conserve Fuel," Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/equipment.html. Accessed 5 April 2018.

25 Ibid.

26 Dowds, Jonathan, et al. Identifying Best Practices for Snowplow Route Optimization. Saint Paul, MN: Transportation Research Center, University of Vermont, 2016. Accessed 2 April 2018.

27 Ibid.

28 Mika, Shelley. "Telematics by the Numbers," Government Fleet, January 2014, http://www.government-fleet.com/channel/gps-telematics/article/story/2014/01/telematics-by-the-numbers.aspx. Accessed 19 April 2019.

29 "Greening the Corporate Fleet: Transition Strategy." City of Burlington. May 2008. https://www.burlington.ca/en/live-and-play/resources/Environment/Green_Fleet_Strategy.pdf. Accessed 4 April 2018.

30 "Detroit Working to Right-size & Green its Fleet," Government Fleet, 4 May 2012, http://www.government-fleet.com/channel/green-fleet/news/story/2012/05/detroit-working-to-right-size-green-fleet.aspx. Accessed 4 April 2018.

31 Ibid.

32 "Car Sharing," NYC.gov, http://www.nyc.gov/html/dot/downloads/pdf/ssi11-car-sharing.pdf. Accessed 4 April 2018.

33 Jessen, Clark. "MassDOT GreenDOT: Eco-Driving Training," MassDOT Blog, 9 August 2015, https://blog.mass.gov/transportation/uncategorized/massdot-greendot-eco-driving-training/. Accessed 4 April 2018.

34 Killian, Ronald. "Ecodriving: The Science and Art of Smarter Driving." TR News, July-August 2012, pp. 34-39.

35 "Driving More Efficiently." Www.fueleconomy.gov, https://www.fueleconomy.gov/feg/driveHabits.jsp. Accessed 24 April 2018.

36 "Vehicle Maintenance to Conserve Fuel." Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/vehicle_maintenance.html. Accessed 24 April 2018.

37 Town of Cummington, Massachusetts Energy Reduction Plan. Town of Cummington, November 2017.

38 Ayre, James. "Electric Semi Trucks & Heavy-Duty Trucks – Available Models & Planned Models (In-Depth List)." CleanTechnica, 16 December 2017, https://cleantechnica.com/2017/12/16/electric-semi-trucks-heavy-duty-trucks-available-models-planned-models/. Accessed 9 May 2018.

Status of Fuel Reduction in Green Communities

Through the GC Designation and Grant Program, GCD has provided funding to several GCs to acquire the following fuel reduction technologies: hybrid and electric vehicles and electric vehicle charging stations, anti-idling technology, and hybrid vehicle conversions on medium- and heavy-duty vehicles. Appendix B includes a list of Green Communities and the technologies they have purchased, as well as two additional municipalities that we learned had taken other fuel reduction measures.

In order to better understand the impact that these technologies have had on reducing fuel use, we conducted interviews and surveys with GCs to learn about the benefits they have received from and the challenges they have encountered with these technologies. Additionally, we wanted to learn about any alternative compliance measures that these communities have implemented. Lessons learned from these interviews and surveys will help to raise awareness among municipal fleet managers about the different fuel reduction technologies that are available, and will help DOER to promote these technologies to Green Communities.

Methods

We gathered data through semi-structured interviews and online surveys. Broadly, we asked municipal fleet managers about the benefits of adopting the above mentioned technologies, and about any implementation challenges they came across. We also asked about the pros and cons of alternative compliance measures that municipalities may have adopted, and requested overall lessons learned to share with other Green Communities. As our aim was to get an open range of qualitative answers, rather than try to quantify anything in particular, our survey mirrored our interview. The survey enabled us to capture a larger sample that would not have been possible with solely interviews. Our interview and survey protocols can be found in Appendix C.

We obtained information from GCD on Green Communities that received grants to purchase hybrid and electric vehicles, charging stations, and anti-idling technology, or to perform hybrid vehicle conversions on medium- and heavy-duty vehicles. This included contact information, as well as information provided by the municipality about their project, such as costs, fuel savings in gallons and dollar terms, and other grants that helped to fund the project. There were a total of 57 municipalities that adopted one or more of the technologies. From this list, we selected 13 municipalities to interview, and added two more municipalities based on their high adoption of fuel reduction policies or measures. Our selection criteria ensured that our interview sample included:

- GCs from every region in MA (as GCD has divided MA into four regions);
- Urban, suburban, and rural municipalities; and
- Diversity of technologies adopted.

We sent the remaining 44 municipalities our survey. Joanne Bissetta, Deputy Director of the Green Communities Division, contacted individual municipalities to encourage their participation in our interviews and surveys. We then followed up with our own requests for the interviews. Interviews were conducted between the end of March and mid-April 2018. They were conducted over the phone and lasted between 20 and 45 minutes. Some interviews were recorded, for note-checking purposes only. The survey was created in Tufts Qualtrics, and was sent out to Green Communities on April 5 and remained open until April 19. All interview and survey participants were offered the option to remain unnamed in this report to GCD.

Findings

Thirty-two municipalities were interviewed or responded to the survey. Nine municipalities were interviewed over the phone, 23 municipalities completed the survey online, and one municipality completed the survey online and spoke with us on the phone. Our list of participants included a diverse range of municipal representatives, such as: a police chief, sustainability consultants, town administrators, energy efficiency managers, fleet managers, building commissioners, town planners, and a Green Communities Program Manager.

Our findings are divided into four main sections:

1. hybrid and electric vehicles
2. anti-idling technologies
3. hybrid vehicle conversions
4. alternative fuel reduction measures

We also included other key findings that came up during the interviews or in the surveys that we believed would be important for GCD, but fell outside of the four main themes. The additional themes include: police vehicles, school buses, large vehicles, challenges of limited resources, and use of incentive funding sources. Although municipalities were asked specifically about the products they acquired with a GC grant, many reported on other technology they had related to our themes.

Hybrid and Electric Vehicles

Twenty-four municipalities reported acquiring a hybrid or electric vehicle.

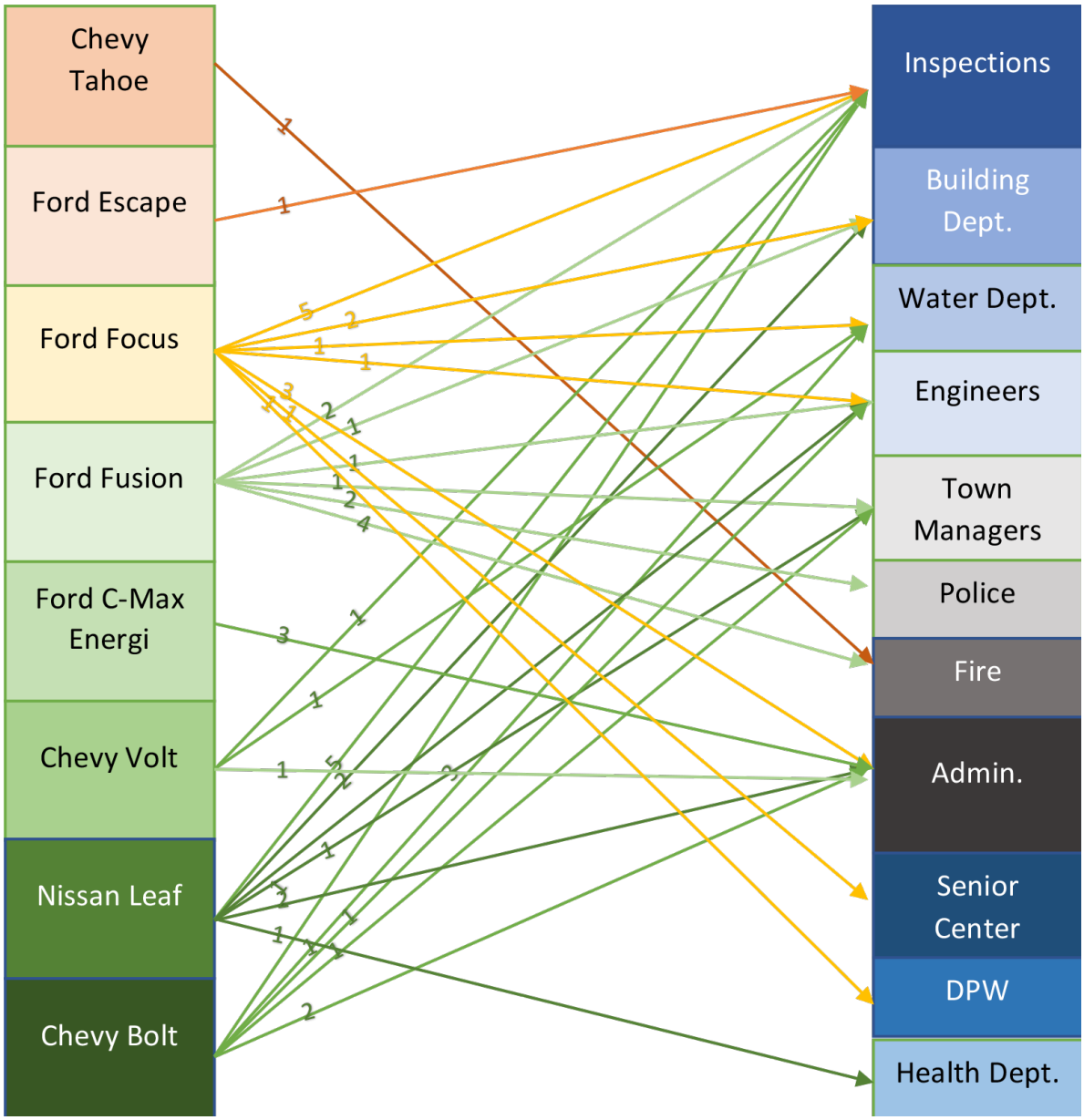


Figure 3: Types of Hybrid and Electric Vehicles Owned by GCs and Their Uses

Figure 3 shows certain vehicles are heavily favored among certain municipal departments. For instance, the Ford Fusion Hybrid is heavily favored by the Fire and Police Departments, whereas the Nissan Leaf and Ford Focus are favored among the Inspections Department. This graphic could help GCs decide on their vehicle acquisitions for specific departments.

Uses

Some municipalities (Amherst, Gloucester, Lancaster) noted that the reason they purchased electric or hybrid vehicles was due to the availability of grants. The acquired hybrid and electric vehicles served as either additions to a fleet or replacements for outdated vehicles. A few municipalities stated that vehicles were acquired to alleviate personal vehicle use for municipal functions. A wide range of uses were reported for municipal hybrid and electric vehicles, from administrative to emergency purposes. The majority of cities and towns reported administrative uses. Thirteen municipalities (Amesbury, Amherst, Arlington, Gloucester, Lancaster, Melrose, Natick, North Andover, Palmer, Tyngsborough, Westfield, Winchester, Woburn) reported that the vehicles were either for general department use or particular departments, including: fire, building, IT, engineering, senior center, water, and inspections. Use for the building department, water department, and inspections were the most common. Three towns (Amherst, Arlington, Woburn) also reported acquiring hybrid and electric vehicles for head honchos, like the Mayor, Town Manager, Building Commissioner, Facilities Director, and the Police and Fire Captains.

Somerville and Millville used their vehicles for the police department. Several towns said they were interested in the use of hybrid or electric vehicles for police needs (see Police Department Needs section below).

Four municipalities (Boston, Melrose, Mendon, Tewksbury) shared their vehicles across departments, as well as among employees for business-related travel.

Zip-A-Dee-Doo-Dah

The City of Boston incoporated their electric vehicles into their shared municipal vehicle fleet, which has close to 50 vehicles. Adam Jacobs, Energy Manager for the Department of Environment, and William (Bill) Coughlin, Director of Central Fleet Management, described how this system works. For this general motor pool–which is accessible to any city employee–a key, reservation, and tracking system is maintained through an agreement with Zipcar (the City provides the vehicle). The vehicles are utilized by employees mostly for getting around the City for meetings, site visits, audits, and meeting contractors–which is useful because there are parts of the City of Boston that are not within a quarter mile of a public transit stop, and sometimes it is not practical to spend an hour or more getting to a location. In the system, there are vans and pickup trucks as well as hybrid and electric vehicles. While the gas-powered vehicles do not cut down on vehicle emissions, Adam explained that having a central fleet system works like car sharing in general–reducing the overall size of the fleet they would otherwise need to maintain and helping them right-size their fleet. Bill said they have about 500 reservations a month through the system.

“Reliable” (Gloucester)

“Fun to drive” (Tewksbury)

“[R]uns smoothly and is roomier than expected.”
(North Andover)

“Loves driving the Bolts” (Arlington)

“Great to drive” (Melrose)

“Drivers of the full electric love it”
(Woburn)

“Easy to drive” (Palmer)

“Health inspector and water treatment love their vehicles.”
(Winchester)

Benefits

Nearly all municipalities reported reduced fuel consumption and fuel savings from using hybrid or electric vehicles. Many cities and towns discussed the environmental benefits from the vehicles through reductions in greenhouse gas emissions. Several municipalities (Melrose, Natick, Westfield, Williamstown, Woburn) stated additional economic savings through a reduction in operating and maintenance costs. Three towns (Mendon, Palmer, West Tisbury) who were using personal vehicles for municipal functions said that having the hybrid and electric vehicles allowed for elimination of the use of personal vehicles, and thus less wear and tear on their personal vehicles. This also benefited the towns by reducing staff liability risk (West Tisbury), and no longer having to manage mileage reimbursements (Palmer).

Leadership, public perception, and public interest were also additional benefits reported by several municipalities (Amesbury, Arlington, Boston, Granby, Mendon, Palmer, Sutton). Multiple towns viewed themselves as leaders through adoption of hybrid and electric vehicles. They felt they were able to promote the discussion of sustainable technologies, showcase the benefits of electric vehicles to town employees and the general public, change mindsets on electric vehicles, and generally lead by example. For example, Melrose commented that hybrid and electric vehicles were a great way to introduce skeptical staff to alternative fuel vehicles. Amesbury said their Ford Focus is highly visible to the public and the community, and helped to display the efficiency projects being undertaken by the city. The City explained that most energy efficiency measures are not visible to the public so the community is not aware of them. However, their water meter vehicle runs all over town, and is therefore highly visible.

There were a few comments on the convenience and economic benefits of charging stations, however, this appears to vary by municipality. For example, Arlington said that it was more convenient to plug in a vehicle rather than to bring it down to their charging station. Amesbury commented on how the location of their downtown charging station, which is “highly popular” and “very visible to the community” has resulted in a lot of use, helping to attract people to the downtown area and contribute to economic development. They would love another grant for public charging stations in another part of town that is also close to other amenities, such as banks and City Hall.

Barriers

Challenges mentioned by municipalities included issues around vehicle charge, price, space and performance for public safety, car maintenance, car lifespan, and attitudes toward hybrid and electric vehicles. Nine municipalities (Amesbury, Arlington, Boston, Dalton, Gloucester, Lancaster, Mendon, Somerville, Woburn) brought up issues around vehicle charge, including electric vehicle range anxiety (worry that the battery will run out before the trip is complete), employees forgetting to charge, not having dedicated or enough charging spaces, having to compete with the public for charging spaces (since Green Communities are required to share their charging stations with the public if acquired through grant support), and unfamiliarity with charging away from the home station. Discussion of issues around charge time were mixed—and would reasonably vary depending on the season and length of trip. Palmer had reported that their Chevy Bolts allowed for over 200 miles and numerous trips between charging. Meanwhile, Gloucester found that longer trips in winter driving conditions were not feasible for them with their Nissan Leafs. Amesbury found solutions by building in buffer time for charging, and augmenting their electric vehicle with a gasoline vehicle in the coldest winter months. Winchester also experienced charging issues as their Ford Focus vehicles would not charge completely, however, that was resolved through the dealership and the vehicles are now functioning smoothly. Regarding the charging station issues, Arlington chose to purchase their charging stations with municipal funds instead of a GC grant to avoid competing with the public for charge time. At the same time, Somerville struggles with the implementation costs of charging stations, which they explained can run up to $20,000 for them—depending on the location—when the costs from tearing up and rebuilding the street infrastructure are taken into account for the entire installation.

No municipality reported the cost of electricity at the public charging stations as an issue. However, Amesbury stated that they are attempting to get sponsorship from local businesses to help pay for electricity at their public charging stations. In exchange, the town would put the name of business sponsors on the charging station or promote discounts for the business. No businesses responded to their offer, but the town will try to market this again.

Some municipalities also reported performance concerns with particular tasks. For instance, Tewksbury explained that their Chevy Bolts worked well with tasks on pavement, but found them to be less reliable off road since the vehicles are so low to the ground. Amesbury admitted that their Ford Focus does not carry enough tools and they did not find it as user friendly as a pick up truck, however, they resolved their problem by removing the back seat to make more room for tools when needed. Both Cambridge and Natick cautioned that other municipalities should look at specific departmental needs to determine whether their needs can be met with electric vehicle technology, as different circumstances and operational needs should be considered. Natick has a growing concern that their electric vehicles would not last as long as gasoline-powered vehicles. Additionally, both Tewksbury and Natick reported that the lack of electric vehicle maintenance and repair expertise from current employees was an issue.

A couple of towns reported that their hybrid or electric vehicles “caused some complaints at the beginning” or “took some getting used to,” but Woburn reported that “everyone seems to like them now.”

Money money money money, MONEY

Natick was appreciative of the grants they were given to purchase electric vehicles, and they believe electric vehicles are the direction the state should be moving in. However, they also felt that the state has overlooked the undertaking required for the technology switch, beyond the purchase of the vehicles themselves. Ken Fisher, Equipment Maintenance Supervisor, wanted to ensure GCD was aware of the costs associated with electric vehicles after they were acquired. He reported that electric vehicles accrued significant additional costs over purchasing a typical gas-powered vehicle due to two reasons: 1) the need to train technicians on how to handle the equipment properly, and 2) ancillary equipment purchases required with electric vehicles.

Ken spoke about how new electric vehicle technology is, and that many technicians have not had proper training on how to maintain and repair electric vehicles. To increase skills, the technicians needed to attend training courses on how to safely handle and maintain electric vehicles. It is not the time commitment for the training that poses an issue, but rather the cost of the class itself. In the last few years, the cost of electric vehicle training courses has skyrocketed, according to Ken. This has made training his staff very costly.

Additionally, Ken spoke about how the equipment purchased to safely handle electric vehicles is expensive. While an exact estimate was not given, Ken mentioned that it is a rising cost for his facilities. He explained that electric vehicles, unlike gas-powered vehicles, require new tools. For example, because of the constant electric current the battery gives out, he purchased a tool that is used to safely disengage employees who are getting shocked (this was a precaution and the scenario has not actually occurred). This is one of the many tools that maintenance operators must purchase to ensure safety.

Future Acquisition Plans

The vast majority of cities and towns (Amherst, Boston, Gloucester, Mendon, Lancaster, Manchester, Melrose, North Andover, Somerville, Tyngsborough, Williamstown, Winchester, Woburn) expressed that they are interested in purchasing more hybrid or electric vehicles in the future. Somerville has other departments requesting electric vehicles, and Winchester already has plans to purchase two additional Chevy Bolts this year. However, Lancaster noted that they had a limited number of vehicles that they could replace with hybrid or electric options due to "limitations to perform job functions." A few towns advised ensuring that new electric vehicles are able to accomplish the task they are being purchased for. For example, Amesbury suggested using a function evaluation to compare available electric vehicle.

While interest in purchasing more hybrid and electric vehicles is high, several towns (Amesbury, Arlington, Natick, Palmer, Tyngsborough) said that funding would be necessary for future acquisitions of hybrid or electric vehicles. Similarly, North Andover expressed that it would definitely consider adding another electric vehicle to its fleet if grant funding were available. The town also expressed a desire to acquire electric vehicles for its entire Community Development Department, but wanted to see how it goes with their current ones, which they have only had for a year, to ensure no major mechanical or reliability issue occurs. Natick expressed that it would be helpful for GCD to support hybrid and electric vehicles with additional grants to fund the additional tools and training required.

"Incentive funding is critical to affordability, at least for now. EVs still generally cost municipalities, which can't take advantage of federal tax breaks, more than internal combustion vehicles." (Arlington)

Anti-idling Technology

Six municipalities reported acquiring anti-idling technology. The types of technologies acquired are listed in Table 3.

Table 3. Anti-idling Technology Brands Purchased By GCs

Brand / Technology	Description
Havis Idleright 2	Allows vehicles to run light bars for extended periods of time while vehicle is parked. Monitors vehicle's battery condition and automatically idles vehicle only when necessary. Promoted for vehicles that must keep their emergency lights flashing: police cars, fire trucks, ambulances, highway construction vehicles, public works trucks and more. http://www.havis.com/catalog/Idle_Management-924-1.html
Energy Xtreme	Provides energy for a vehicle's ancillary electrical tools and equipment load; including lights, cameras, computers, power tools and hydraulic systems, without engaging the vehicle's engine. Connects to vehicle's alternator to draw energy during normal operation. Promoted for police vehicles. Ideal for fleets in law enforcement, military, transportation, public works, telecom, utilities, oil and gas and work truck centric organizations. https://www.linkedin.com/company/energy-xtreme
Stealth Power	Enables full operation of onboard electrical systems – including air, heat, lights, camera, laptops, radio, refrigerator, chargers and power-load stretchers – for hours without engaging the engine. Recharges either from the vehicle's alternator while it's driving, or from shore (plug-in) power. Promoted for emergency response vehicles. Promoted for fire & rescue, law enforcement, service vehicles, and long-haul trucking. https://www.idlereduction.com/idle-reduction-technology/

Uses

The acquired anti-idling technologies were installed in police vehicles (Gill, Gloucester, Lakeville, Millville, Sherborn).

There are two other types of technologies that municipalities are using that are unlike the standard anti-idling technology listed above. Cambridge is updating their police cruisers this year to install solar-powered LED light bars, which will improve battery life and efficiency, as a pilot program. West Springfield is using Networkfleet, a fleet management system that notifies administration when a vehicle is idling too long.

Benefits

Similar to hybrid and electric vehicles, some municipalities reported economic and environmental benefits from lower fuel consumption, and reduced air pollution from less particulate matter and reduced greenhouse gas emissions. For example, Millville reported that their vehicle equipped with the anti-idling technology could run the heat for eight hours without turning on the engine. However, one town stated that the technology resulted in minimal fuel reduction.

Sherborn noted that police vehicles are the best candidates for anti-idling technology due to the amount of time they spend idling in order to use their onboard communications equipment. Both Millville and Sherborn reported being able to extend the life of their vehicles with anti-idling technology due to reduced wear and tear and being able to install the technology on older vehicles instead of having to buy new ones.

Barriers

Municipalities are very interested in anti-idling technology, but some are encountering feasibility challenges. Gill and another town found installation of the anti-idling technology to be difficult because there were no local mechanics nearby who could install the technology. Ultimately, because of the time and fuel costs associated with traveling for installation, the town is uncertain whether the savings from the anti-idling technology were worth it. Similarly and not surprisingly, Mendon reported that they considered anti-idling devices for their police vehicles, but was advised against this from police departments from other towns who said it was not worth the installation costs. Millville had the opposite experience as Gill, however, as their installation took only two hours by a local mechanic. However, Millville and Gill used different technologies.

One town suggested that GCD initiate a stand-alone program offering contractors who are able to work with and travel to municipalities who want to install anti-idling technology on their vehicles.

> **"If you have a fleet of vehicles, you're not going to want to invest your man power in going to another town to get anti-idling installed. A program where a few vetted vendors go around making installations for anti-idling, hybrid retrofits, or any other small installations? Would really help the small towns. May not be feasible for every type of installation, but would be great if it could be looked into." (Unnamed municipality)**

Future Acquisition Plans

Most towns either said they would acquire anti-idling technology again or that it was not necessary given they have been acquiring new police vehicles with anti-idling already built in. Lakeville reported that their current anti-idling devices cannot be reinstalled in new police vehicles due to technology changes, and said they will need to acquire new devices for the new vehicles. Gill highly favors and recommends acquiring new vehicles with equipment built in, due to their aforementioned experience with high installation costs. Natick wants to invest in anti-idling technology on their loaders and large trucks.

Millville wants to acquire more anti-idling devices, but finds the cost prohibitive. The cost of their current anti-idling device was alleviated through their GC grant, but they have 10-20 police cruisers that idle for eight hours a day and do not have devices installed yet. Another town said that purchasing the anti-idling devices would become more feasible if GCD could support the incremental cost of acquiring police vehicles with anti-idling technology, since they are more expensive than police vehicles without it.

Hybrid Vehicle Conversions

Four municipalities reported performing hybrid vehicle conversions. The vehicles converted include a Chevy Cargo Van, two Ford Transit Vans, a Ford 450 Shuttle Bus, and a garbage truck. Three municipalities used XL Hybrid technology.

Uses

Uses for the converted vehicles were similar to uses for hybrid and electric vehicles reported above, including traveling between municipal buildings, departmental trips and activities, water meter reading, and senior shuttling. Additionally, Cambridge performed a hydraulic retrofit on one of their garbage trucks (see Large Vehicles section).

Benefits

Two towns (Cambridge, Melrose) reported a 20-25% reduction in fuel usage from their hybrid conversions. Cambridge additionally reported an expected 50-95% reduction of emissions from their hydraulic retrofit. While they have not been able to conduct a full economic benefit analysis yet, they did report that they will be able to save over 800 gallons in fuel annually.

Natick has not had a chance to measure any potential savings in fuel reduction yet as they have only had their XL Hybrid for a couple of months. However, XL Hybrid reports a potential 25-50% increase in MPG. The town also received very positive feedback from drivers who found the vehicles very quiet.

Cambridge reported that the regenerative braking from their retrofits reduces wear and tear on vehicles, and actually made drivers more aware and present while driving because of the difference in feeling from the gas and brake pedals.

Barriers

One performance barrier brought up by Cambridge was that the retrofitted vehicles can be quiet and therefore throw off drivers, who can find it “a little shocking” at first. They realized that they should have test drives and informal drivers education to get drivers comfortable with the new hybrid system. The City is also interested in retrofitting more of their vehicles, but noted that not all of their vehicles can be retrofitted. They are eager to do more conversions and expand this technology into different departments, but are aware that each department has its own unique operational needs, which causes issues for further expansion. Lastly, Natick reported that XL Hybrid conversions posed a challenge because they were limited to XL Hybrid locations only for the conversions.

Future Vehicle Conversion Plans

Both Cambridge and Melrose said they would perform a vehicle conversion again. In fact, Cambridge has already applied for funds to retrofit another nine vehicles. They are seeking grants, including GC grants, for more conversions.

Alternative Fuel Reduction Measures

In an effort to reduce fuel consumption beyond the above mentioned technologies, several towns have methods for tracking fuel consumption, which aims to influence driving habits by creating employee accountability. Most of these municipalities (Arlington, Boston, Lancaster, Millville, Natick, West Springfield, Williamstown, Woburn) use software to track vehicle fuel consumption, provide tips to drivers to increase vehicle efficiency, and/or help municipalities prevent excessive fuel use. West Springfield plans to have their fleet management system on all of their vehicles townwide by the end of 2018.

Big Data

"For the last year, the [Arlington] DPW has piloted a new Fleet Maintenance Program capitalizing on information automatically obtained when town owned vehicles fill up with gasoline at the DPW owned pump. The system records miles driven, idle times, and any vehicle codes for maintenance each time a vehicle is fueled. Over time, Arlington hopes to use the system to reduce vehicle idle times, and to improve vehicle performance (including gas mileage) by optimizing maintenance. Over the last year, the system was piloted with a limited number of DPW vehicles. In 2018, DPW plans to expand the program to include Police Department vehicles. Arlington will report on this program as it expands over time." (Arlington)

Cambridge reported using a biodiesel blend for most of their diesel vehicles due the associated environmental benefits of reduced harmful emissions.

Three towns (Manchester, North Andover, Williamstown) reported having an anti-idling policy in place, however, two towns were unsure whether the policy was effective at reducing fuel consumption. North Andover posted signs at their schools indicating that they were idle-free zones. Amesbury reported that while they issued a policy paper on an anti-idling policy to their DPW staff, there has not been much follow up on it. They explained that it is a hard policy to enforce.

Warwick has also been able to reduce the idling time of their snow plows through an informal anti-idling policy over the past couple of years. In the past, they were in the

practice of plowing the roads, then waiting for the snow to build up again with the snow plow engines left running. The plowing staff were resistant at first, as they were convinced their practice was more productive than turning off their engines. They found it more convenient to leave their engines on to avoid start-up times and having to clean off their windows again. Over the years, however, they have been eliminating the practice, and the staff is now generally cooperative and finds that it only takes a few minutes to get the plow ready to go out again, which is much more efficient compared to idling for over an hour.

A few municipalities reported measures to change employee commute modes. Boston offers teleconference options for meetings and a discount for the city's bikeshare membership. They have also installed bike racks around municipal buildings. Amherst has installed five electric assist bike stations, and will be holding a launch event as a part of a broader public outreach campaign for bikeshare programs. They plan to track bikeshare ridership with data supplied by their vendor. Gloucester is looking into shifting commute modes by encouraging carpooling and biking, and Williamstown is in the design stage of installing a bike path through town. Three towns (Sutton, Tyngsborough, West Tisbury) reported that they did not have alternative compliance measures because they were small or rural towns that either were not able to promote alternative commute modes like transit, biking, or walking—or did not need additional measures.

Four municipalities referred to their own vehicle policies or clean vehicle studies they were doing outside of the Green Communities program as additional fuel reduction measures they were undertaking. In some cases, the municipal FEV policy was made stricter than what was required by GCD. For example, Cambridge's policy dictates that a new vehicle can only be purchased to replace an old vehicle, and that the new vehicle must be more efficient and smaller than the vehicle being replaced, if possible. They also acquire fuel saving add-ons that are available at the time of purchasing a new vehicle (e.g., automatic engine shut off).

Police Department Vehicles

As previously mentioned, police vehicles are exempt from the FEV Policy, and therefore pose a challenge for municipalities. However, two municipalities (Somerville, Millville) have attempted to tackle this issue by purchasing some hybrid and electric police vehicles, and several municipalities (Amesbury, Gill, Manchester, Mendon) have expressed interest in using hybrid or electric vehicles for their police department fleet. However, they are currently facing some barriers to adoption.

Amesbury expressed difficulty in switching to hybrid and electric police vehicles as they have been acquiring more SUVs as opposed to smaller sedan-size vehicles, largely due to the amount of gear and equipment that police officers need to carry with them that fit better in SUVs. Similarly, Manchester is having difficulty finding a hybrid or electric SUV that is able to handle all the capabilities required for emergency vehicles, such as electronics (e.g., laptops, radio, sirens), range, and acceleration. Because of this and the fear of performance issues, there is staff push-back against hybrid or electric vehicles. So far, the most promising vehicle for them to replace the Ford Explorer Police Edition is the Volvo plug-in hybrid SUV—but they are interested in teaming up with a dealer who would be willing to work with them to ensure that all police vehicle needs are met for whatever vehicle they acquire. When Gill was considering Ford Fusions for its police department, the police officers did a demonstration getting in and out of the cars with their equipment on, which ultimately helped them to decide that the Fusions were not practical for police department use.

While some Police Chiefs are open to changes, some are still cautious about how new hybrid and electric vehicles are. Natick reported that their Police Chief would like to wait ten years before pursuing them.

One municipality suggested that GCD offer an incentive program specifically for hybrid police vehicles, and expressed it was something they would be interested in participating in.

School Buses

Both Amesbury and Boston said that electric school buses are not yet feasible. Amesbury said that, while it would be great to switch to electric school buses, especially because there could be a lot of savings, that would require a whole different infrastructure for the buses. They also stated it is not feasible yet because their buses are handled by a private company, so it is out of their control. For Boston, the issue has been revisited multiple times by the fleet manager. The switch to electric for them is not yet feasible not only due to the lack of charging infrastructure along the route of the school buses, but mainly because of the long run-time that school buses are needed for. There is no time to stop and charge, and with the need to charge comes the concern of getting kids to school on time. They would make the switch if it were feasible economically and logistically.

King of the Propane

The City of Boston has been replacing their old mid-sized diesel buses with propane buses. Adam Jacobs, Energy Manager for the Department of Environment, said there has been good feedback on the propane buses and the City has been able to achieve a substantial reduction in their greenhouse gas emissions through these replacements. Propane is not a silver bullet, but it does save money and reduce emissions. There were a lot of particulate matter (PM) emissions from the diesel vehicles, which was especially an issue for students in wheelchairs who sit at the tailpipe level, whom the buses were picking up. The emissions are somewhat less of an issue with propane. The propane buses have also used half the fuel per mile traveled compared to the diesel buses.

Large Vehicles

Three municipalities (Boston, Cambridge, Warwick) have been tackling fuel reduction with their larger vehicles as well.

Boston ensures that all the new vehicles they acquire are as fuel efficient as possible. Bill Coughlin, Boston's Director of Central Fleet Management, said they have a certified propane bi-fuel installer and 30 pickup trucks that are bi-fuel vehicles. The system starts on gasoline, warms up, then moves to propane. This has reduced vehicle emissions, and has also been extremely economical. On a gasoline-only system, they would need to fill-up on gas once a week, but now they only do it once every two weeks—so it has been a 100% savings on gasoline costs. The rest of their trucks are diesel-powered, and Bill will also be looking into XL Hybrid technology for their pickup trucks. For Boston's large earth-loading equipment, they have hybrid loaders that are diesel over electric. There are reduced emissions from the loaders because the diesel runs just a little above idle and charges the electric motor. Bill reported that John Deere is the only company that make such a product, though there are other companies testing similar products. He also said the hybrid loaders are not much more expensive than regular ones.

Cambridge performed a hybrid retrofit through National Van Builders for one of their garbage collection trucks, a M2 106 freightliner. Because the truck was over 50,000 pounds in gross weight, they had to do a hydraulic, rather than an electric, hybrid retrofit. The City wanted to choose vehicles that could benefit the most from hybrid conversions, which were vehicles that idle the most and have the lowest fuel efficiency, so it was great news that they could convert a garbage truck. The conversion came with a telematics device to track the converted garbage truck's fuel use. The City also placed a telematics device on a different garbage truck so they can compare fuel usage between the two trucks and get an accurate estimate of fuel reduction.

Warwick was able to acquire a front end loader and backhoe with pre-installed anti-idling equipment, where the machine shuts off after a given amount of time. They mentioned that John Deere offers options for anti-idling technology without additional cost, but that all the brands they tried for the backhoe appeared to have idle-reduction technology already installed in them.

Winchester expressed interest in technologies to reduce truck fuel consumption since the majority of their vehicles are heavy duty vehicles, as well as programs that would address the issue of culture change around the use of heavy duty vehicles. Amesbury expressed a need for funding in order to acquire hybrid truck options though. They said that Ford pickup hybrids are available and would be great to have, however, "it's a matter of what funding is available."

Why So Salty, Plow?

Warwick was able to reduce fuel consumption of their plows by reducing the amount of time the plows spent traveling salting roads for snow storms. They accomplished this through use of salt-only—rather than a sand/salt—solution. With the salt-only solution, they were able to travel approximately three times the length before having to double back for a solution refill, applying the salt solution at the rate recommended by the Department of Transportation (DOT). Doubling back results in traveling over roads that are already treated. They were able to save 5-7 miles each time that the plow did not have to double back. This year, they had 47 weather events that required salting. So, there were some significant potential economic savings in terms of fuel and solution costs. Warwick saw about a 25% reduction in the amount of salt used this year compared to last year, which had about the same number of events requiring salting. However, they only made the solution transition in the middle of the winter, so they believe the savings potential are actually much higher. Additionally, they explained that many towns still use salt/sand mixes, but it actually makes sense not to put down too much sand with salt—as sand acts as insulation, stopping the salt from preventing snow from sticking to the roads.

Challenges of Limited Resources

Tyngsborough stated that the partnership with the Green Communities Division has been great, especially for small towns with few resources. However, multiple towns (Amesbury, Amherst, Arlington, Gill, Gloucester, Millville, Natick, Palmer, Sherborn, Tyngsborough) still reported that they are limited due to low resources or capital to focus on vehicle energy reduction measures, or acquire more vehicle energy saving technology. Some towns said they chose to focus their limited energy reduction efforts on buildings and lights rather than on vehicles, and one town said they acquire larger vehicles that are able to accomplish particular needs, but then do not have resources to acquire a smaller vehicle for their other needs. For instance, while they could use a small pickup truck for light duty work, they only have medium and large pickup trucks in their fleet. Three towns (Amesbury, Arlington, Natick) explicitly stated that additional incentives are necessary to purchase and maintain hybrid and electric vehicles.

GCD's Policy on VEHICLE RECYCLING

Recycling of vehicles – i.e., moving a previously purchased and used vehicle from one municipal department to another municipal department in need of a vehicle - is only allowed if the vehicle being recycled to a new department meets the fuel efficient criteria listed above. Please be advised that a recycled Ford Crown Victoria does not meet the MPG rating and therefore would not meet fuel efficient vehicle requirements. When a city or town is ready to retire a Crown Victoria police vehicle, fleet disposal companies can provide an attractive option.

Good Policies Gone Bad

In the past, Gill has recycled their older, retired police vehicles for use by the Highway Department. The vehicles were used to drive around town, check potholes, and run errands. It was more efficient using the retired police vehicles than the Highway Department's 1.5-ton pickup truck or the department staff's personal pickup trucks. However, since the Green Communities policy does not allow for vehicle recycling unless the vehicle's fuel economy rating meets the policy's MPG standards, Gill has had to use their large pickup trucks for the things that they could have a smaller, albeit inefficient, vehicle for.

"More than likely, it's going to be the larger towns with larger budgets that you will probably see a larger hybrid fleet. But the smaller communities, they have to be a little more particular about their line items. I don't want to say hybrids are a luxury, but they are." (Tyngsborough)

"Many vehicles used in Arlington's municipal fleet need to be larger: SUVs, pickup trucks and cargo vans. We have not found suitable EVs and plug-in hybrids for these functions. The XL Hybrid model doesn't seem to make sense for us - the [return on investment] only works for vehicles with high annual mileage (e.g., 25,000 miles), which is a much longer distance than our vehicles typically drive (except police cruisers, which is a different story). We hope offerings and incentives make it feasible for us to adopt larger vehicles that are EVs or plug-in hybrids in the future." (Arlington)

Use of Incentive Funding Sources

Beside mentioning the use of MassEVIP funding, a few other incentive funding sources were brought up by a few municipalities. Melrose received incentive funding from National Grid to install the XL Hybrid system on their Chevy Cargo Van, and Cambridge said they took advantage of the MAPC Green Mobility Group Purchasing Program, allowing them to get significant discounts on their hybrid retrofits since they were bought in bulk.

GCD Communication and Outreach

A few towns suggested increased communication and outreach from the Green Communities Division. Gill requested demonstrations of clean vehicle technology in Western Massachusetts, as Worcester takes too much time to travel to. Another town suggested press releases to keep towns abreast of new technologies, expressing the importance of knowing about new technologies before vehicle acquisitions take place. When we mentioned the new Ford police vehicle coming out in 2019, the town representative said, "[That] would be BIG… [we] might hold off on purchase decision knowing that something like that is coming soon."

Recommendations

Overall, our interviews and surveys with Green Communities revealed that, while there is general enthusiasm for reducing fuel consumption, the capacity of municipalities may be limited by their size. For example, whereas a large city like Boston has several hybrid and electric vehicles already in its fleet, smaller towns like Tyngsborough have both limited resources to purchase a hybrid or electric vehicle, as well as less of a need given their overall fleet size is much smaller. Additionally, smaller towns, both in terms of physical size, population size, and therefore budget, have less vehicles in their fleets. There are therefore less options available for them to reduce their fuel consumption given the lack of alternatives available that meet their specific operational requirements when they require a new vehicle or need to replace an old vehicle. Though there are several ways to reduce the fuel consumption of these vehicles, limited resources are again an issue. As previously discussed, those limited resources often go towards energy reduction projects that are able to accomplish more with less resources, such as replacing street lights with LED bulbs.

Based on these themes and what we learned from Green Communities about their experiences with hybrid and electric vehicles, anti-idling technology, vehicle retrofits, and the additional fuel reduction measures they are undertaking for their exempt vehicles, we have the following recommendations. Some of our recommendations are based off of suggestions we heard from Green Communities during our interviews.

Provide grant funding:

- For more hybrid and electric vehicles, to alleviate the limited resource challenges of towns with smaller budgets
- Provide separate incentives for hybrid police vehicles and hybrid trucks
- For more electric charging stations and to support the implementation and installation costs of the stations
- To cover startup costs for switching from gasoline-powered vehicles to electric vehicles, including for costs related to new equipment and mechanic training courses
- To cover the difference in costs between vehicles without anti-idling technology and vehicles with built-in anti-idling technology
- To cover the difference in costs between non-hybrid loaders and hybrid loaders
- For fleet maintenance programs or telematics devices that provides information on amount of fuel consumption and idling, among other things that help reduce fuel usage

Changes and Additions to Policy:

- Research Green Communities' vehicle policies (formal and informal), and require adoption of best practices
- Require anti-idling policies for any school buses idling within municipal boundaries, including buses from services leased by the municipality
- Require Green Communities to use fleet maintenance programs or fuel tracking software, and that reports are shared with municipal employees on a regular basis

- Require fleet right-sizing
- Adjust policy on vehicle recycling to allow recycling of vehicles that do not meet the MPG requirement, if the only alternative would be to use a vehicle with an even worse fuel economy rating than the vehicle that could be recycled

Programs:

- Provide contractors that are willing to travel to municipalities to install anti-idling devices and other clean vehicle technologies

Communication and Outreach:

- Aggregate best practices from Green Communities on charging electric vehicles and reducing range anxiety
- Create a tip sheet on alternative fuel reduction measures, or use the "Review of Fuel Reduction Measures" section of this report
- Create an evaluation sheet for picking the right vehicle for any given municipal department need - checklist of factors that municipalities can use to determine the right car?
- Publicize clean vehicle technology, funding ideas, and local leadership.
- Send an e-newsletter once a month, and post the newsletter on the DOER website. Include a shout out to highlight municipalities that recently purchased new vehicle technology or demonstrated clean vehicle leadership.
- Organize an annual symposium to keep GC members connected, communicating, and sharing best practices.
- Provide demonstrations or showcases regionally, so people don't have to spend too much time traveling and have multiple options to attend in terms of location and time.
- Publicize anti-idling technology, especially for police vehicles and large vehicles, which are often exempt
- Publicize the 2019 Ford Police Responder Hybrid Sedan
- Publicize John Deere hybrid loaders
- Publicize alternative fuel vehicle options, but with caution, since they are cleaner but still producing greenhouse gas emissions.
- Educate municipal employees on fuel reduction measures, especially for workers who use large vehicles. Offer programs in all four GC regions to increase attendance.
- Publicize state funding incentives for clean vehicle technology, as the incentives become available, and regularly in list form through an e-newsletter and the DOER website
- Share tips among municipalities on ways to fund clean vehicle technology

Keep an eye on:

- 2019 Ford Police Responder Hybrid Sedan
- Electric school bus technology
- Anti-idling equipment
- Cleaner large vehicle technology

FEV Policy Updates

At the core of the FEV Policy in Criterion 4 is the requirement to purchase fuel efficient vehicles whenever a municipality needs a new vehicle. As previously noted, the policy's MPG requirements have not been updated since 2012, and have become outdated. In order to update these requirements, we analyzed trends in gas mileage for the eight nonexempt vehicle classes in the FEV Policy to recommend new standards that more accurately reflect what is available on the market. Our recommendation aims to be fair, yet competitive, in order to enable GCs to further reduce their fuel consumption. Additionally, we offer guidance for updating these requirements on an ongoing basis.

Methods

The new MPG requirements for the FEV policy were determined by finding the 80th percentile of fuel economy ratings on model year 2018 vehicles for each nonexempt vehicle class.

First, we analyzed data from the Department of Energy and the Environmental Protection Agency's fuel economy website (www.fueleconomy.gov),[1] which provides fuel economy data in the form of an Excel spreadsheet for each vehicle sold in the U.S. every year dating back to 1978. This provided the fuel economy rating for each vehicle on the market, and enabled us to easily sort the information by vehicle class, model and make, drivetrain, and transmission. Because the current FEV Policy is set to ensure that at least five automatic transmission models for each vehicle class are available on the market from affordable brands, we had to limit the vehicles in the list to those that met these specifications. Thus, we only included vehicles that had automatic (as opposed to manual) transmissions and were from affordable (as opposed to luxury) brands. The luxury makes we excluded were: Alfa Romeo, Aston-Martin, Audi, Bentley, BMW, Bugatti, Cadillac, Ferrari, Genesis, Infiniti, Jaguar, Koenigsegg, Lamborghini, Land Rover, Lexus, Lincoln, Maserati, Mercedes-Benz, Pagani, Porsche, Rolls-Royce. The luxury models we excluded were: 124 Spider, 370Z, Beetle Convertible, Camero, Challenger, Charger, Corvette, Ford GT, Mustang, and Shelby. Hybrid and electric vehicles were also excluded since the FEV policy states that all hybrid and electric vehicles meet the criteria.

Once these filters were applied to the data, we created lists of remaining vehicles and their fuel economy rating for each vehicle class. Then, we established a minimum cutoff for the new MPG requirements, which we set at the 80th percentile of fuel economy ratings on model year 2018 vehicles for each nonexempt vehicle class. In other words, only vehicles that had a fuel economy rating at or above the 80th percentile vehicle were included in our cutoff (see Appendix D). We found that Connecticut requires any new vehicle purchased for the state fleet to be in the top third of fuel economies in its vehicle class, which further supported our general method of requiring the purchase of the most fuel efficient vehicles in their classes.[2]

We chose the 80th percentile for several reasons. First, we wanted to ensure that we were able to recommend new MPG standards that were strict enough to make a meaningful impact on fuel consumption, while also allowing a range of vehicle makes and models to be available to meet the needs of the GCs. The 80th percentile ensured that at least five different vehicles were available for each class (with the exception of minivans), and that American-made brands, such as Ford and Chevrolet, were an option within our requirements for pickup trucks. GCD coordinators noted that having American-made brands available for pickup trucks was important to many GCs.

Additionally, we compared fuel economy trends for each vehicle class with the federal CAFE standards to determine if we could establish a trend by which fuel economies were increasing each year so that GCD could update their MPG requirements regularly and reliably, barring any significant technological advancements. Therefore, we found and graphed the 80th percentile of each vehicle class for every year from 1998 to 2018 in order to see how the 80th percentile MPG for each of the eight non-exempt vehicle classes changed from 1998-2018. These graphs can be found in Appendix D. We used data beginning in 1998 because 20 years worth of data is a sufficient length of time to determine trends over time. Ultimately, we looked for trends in the graphs to help form a recommendation that could be used to determine future increases in the MPG minimum for the FEV policy.

Findings

80th Percentile Fuel Economy Ratings

Tables 5 through 12 include all the vehicles that fall above the 80th percentile of fuel economy ratings within each non-exempt vehicle class. Some vehicle classes, such as passenger cars, include more vehicles than vehicle classes, such as minivans, simply because there are more models available on the market. All vehicles that had a fuel economy rating that matched the fuel economy rating of the vehicle at the 80th percentile were also included in our charts. Table 4 serves as an example of this. Additionally, the 85th, 90th, and 95th percentile have been marked, as applicable, in each table to exemplify the options that would be available to GCs if stricter requirements were adopted.

Table 4. 80th Percentile Fuel Economy Ratings for 2WD Passenger Cars

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)	Percentile
1	General Motors	Chevrolet	MALIBU	46	
2	Mitsubishi Motors Co	Mitsubishi Motors Corporation	MIRAGE	39	
3	General Motors	Chevrolet	CRUZE	37	
4	Mitsubishi Motors Co	Mitsubishi Motors Corporation	MIRAGE G4	37	
5	Honda	Honda	CIVIC 4Dr	36	
6	Honda	Honda	FIT	36	95th
7	Toyota	TOYOTA	YARIS iA	35	
8	Honda	Honda	CIVIC 2Dr	35	
9	MAZDA	MAZDA	MAZDA2	35	
10	General Motors	Chevrolet	CRUZE HATCHBACK	35	
11	Honda	Honda	CIVIC 2Dr	34	
12	Nissan	NISSAN	VERSA	34	90th
13	Honda	Honda	CIVIC 4Dr	34	
14	Toyota	TOYOTA	CAMRY	34	
15	Toyota	TOYOTA	COROLLA LE ECO	34	
16	Honda	Honda	CIVIC 5Dr	34	
17	General Motors	Chevrolet	SPARK	33	
18	General Motors	Chevrolet	SPARK ACTIV	33	85th
19	General Motors	Chevrolet	CRUZE	33	
20	General Motors	Chevrolet	CRUZE PREMIER	33	
21	Toyota	TOYOTA	COROLLA LE ECO	33	

22	Honda	Honda	ACCORD	33	
23	Honda	Honda	FIT	33	
24	Kia	KIA MOTORS CORPORATION	Rio	32	
25	Toyota	TOYOTA	YARIS	32	80th
26	Volkswagen Group of	Volkswagen	Jetta	32	
27	General Motors	Chevrolet	CRUZE HATCHBACK	32	
28	Kia	KIA MOTORS CORPORATION	Forte	32	
29	MAZDA	MAZDA	MAZDA3 5-Door	32	
30	Nissan	NISSAN	SENTRA	32	
31	Toyota	TOYOTA	CAMRY LE/SE	32	
32	Toyota	TOYOTA	CAMRY XLE/ XSE	32	
33	Toyota	TOYOTA	COROLLA	32	
34	Honda	Honda	CIVIC 5Dr	32	

Table 5. 80th Percentile Fuel Economy Rating for 4WD Passenger Cars

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)	Percentile
1	Subaru	Subaru	IMPREZA 4-Door	32	95th
2	Subaru	Subaru	IMPREZA 5-Door	31	
3	Subaru	Subaru	IMPREZA SPORT 4-Door	30	90th
4	Subaru	Subaru	IMPREZA SPORT 5-Door	30	
5	MAZDA	MAZDA	CX-3 4WD	29	85th
6	Subaru	Subaru	LEGACY	29	
7	Honda	Honda	HR-V AWD	29	80th
8	Honda	Honda	HR-V AWD	29	

Table 6. 80th Percentile Fuel Economy Rating for 2WD SUV

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)	Percentile
1	General Motors	Chevrolet	EQUINOX FWD	32	
2	General Motors	GMC	TERRAIN FWD	32	
3	General Motors	Buick	ENCORE	30	
4	Honda	Honda	CR-V FWD	30	95th
5	Hyundai	HYUNDAI MOTOR COMPANY	Kona FWD	30	
6	Nissan	NISSAN	ROGUE FWD	29	
7	General Motors	Buick	ENCORE	28	
8	General Motors	Chevrolet	EQUINOX FWD	28	
9	General Motors	Chevrolet	TRAX	28	90th
10	Ford Motor Company	Ford	ECOSPORT FWD	28	
11	General Motors	GMC	TERRAIN FWD	28	
12	Honda	Honda	CR-V FWD	28	
13	MAZDA	MAZDA	CX-5 2WD	28	85th
14	Mitsubishi Motors Co	Mitsubishi Motors Corporation	OUTLANDER 2WD	27	
15	Mitsubishi Motors Co	Mitsubishi Motors Corporation	OUTLANDER SPORT 2WD	27	
16	Ford Motor Company	Ford	ESCAPE FWD	26	
17	Hyundai	HYUNDAI MOTOR COMPANY	Tucson FWD	26	
18	Kia	KIA MOTORS CORPORATION	Sportage FE FWD	26	80th
19	Toyota	TOYOTA	RAV4 LE/XLE	26	

Table 7. 80th Percentile Fuel Economy Rating for 4WD SUV

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)	Percentile
1	General Motors	Chevrolet	EQUINOX AWD	32	
2	General Motors	GMC	TERRAIN AWD	32	
3	Toyota	TOYOTA	RAV4 HYBRID AWD	32	
4	Honda	Honda	CR-V AWD	29	
5	Subaru	Subaru	CROSSTREK	29	95th
6	General Motors	Buick	ENCORE AWD	28	
7	Subaru	Subaru	FORESTER	28	
8	Subaru	Subaru	OUTBACK	28	
9	General Motors	Buick	ENCORE AWD	27	
10	General Motors	Chevrolet	TRAX AWD	27	
11	Honda	Honda	CR-V AWD	27	90th
12	Hyundai	HYUNDAI MOTOR COMPANY	Kona AWD	27	
13	Nissan	NISSAN	ROGUE AWD	27	
14	General Motors	Chevrolet	EQUINOX AWD	26	
15	General Motors	GMC	TERRAIN AWD	26	
16	MAZDA	MAZDA	CX-5 4WD	26	
17	Mitsubishi Motors Co	Mitsubishi Motors Corporation	OUTLANDER 4WD	26	85th
18	Mitsubishi Motors Co	Mitsubishi Motors Corporation	OUTLANDER SPORT 4WD	26	
19	Ford Motor Company	Ford	ECOSPORT AWD	25	
20	FCA US LLC	Jeep	Compass 4X4	25	
21	Mitsubishi Motors Co	Mitsubishi Motors Corporation	OUTLANDER SPORT 4WD	25	
22	Subaru	Subaru	FORESTER	25	
23	Toyota	TOYOTA	RAV4 AWD	25	80th

Table 8. 80th Percentile Fuel Economy Rating for 2WD Pickup Truck

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)	Percentile
1	General Motors	Chevrolet	COLORADO 2WD	25	
2	General Motors	GMC	CANYON 2WD	25	95th
3	FCA US LLC	RAM	1500 4X2	23	
4	General Motors	Chevrolet	COLORADO 2WD	22	90th
5	General Motors	GMC	CANYON 2WD	22	
6	Honda	Honda	RIDGELINE FWD	22	85th
7	Ford Motor Company	Ford	F150 2WD BASE PAYLOAD LT TIRE	22	
8	Ford Motor Company	Ford	F150 PICKUP 2WD	22	
9	Ford Motor Company	Ford	F150 PICKUP 2WD	22	80th
10	Ford Motor Company	Ford	F150 PICKUP 2WD FFV	22	

Table 9. 80th Percentile Fuel Economy Rating for 4WD Pickup Truck

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)	Percentile
1	General Motors	Chevrolet	COLORADO 4WD	23	
2	General Motors	GMC	CANYON 4WD	23	95th
3	FCA US LLC	RAM	1500 4X4	22	
4	General Motors	Chevrolet	COLORADO 4WD	21	
5	General Motors	GMC	CANYON 4WD	21	90th
6	Ford Motor Company	Ford	F150 2.7L 4WD GVWR>6799 LBS	21	
7	Ford Motor Company	Ford	F150 PICKUP 4WD	21	85th
8	Honda	Honda	RIDGELINE AWD	21	
9	General Motors	Chevrolet	COLORADO ZR2 4WD	20	
10	Toyota	TOYOTA	TACOMA 4WD	20	80th
11	Toyota	TOYOTA	TACOMA 4WD	20	
12	Ford Motor Company	Ford	F150 4WD BASE PAYLOAD LT TIRE	20	
13	Ford Motor Company	Ford	F150 PICKUP 4WD	20	
14	Ford Motor Company	Ford	F150 PICKUP 4WD FFV	20	

Table 10. 80th Percentile Fuel Economy Rating for 2WD Minivan

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)
1	FCA US LLC	Chrysler	Pacifica	22
2	FCA US LLC	Chrysler	Pacifica	22
3	Honda	Honda	ODYSSEY FWD	22
4	Honda	Honda	ODYSSEY FWD	22
5	Toyota	TOYOTA	SIENNA	22

Note: Only 2WD minivans available after filtering for affordable vehicles.

Table 11. 80th Percentile Fuel Economy Rating for 4WD Minivan

	Manufacturer Name	Division	Carline	Combined Fuel Economy (MPG)
1	Toyota	TOYOTA	SIENNA AWD	20

Note: Only 4WD minivan vehicle available on market.

Future MPG Requirements

When comparing the trends in fuel economies for each vehicle class, we originally assumed that fuel economies would have increased at a relatively steady pace largely due to improvements in technology and energy efficiency over time. Instead, we found that between 1998 and 2007, MPGs remained relatively stagnant, while a more steady increase began in 2008 and continued through the present.

Below is a comparison of our graph of the trend in MPG for 2WD passenger cars from 1998 to 2018, and a graph of the CAFE standards for light-duty vehicles from 1978 to 2018 and projected through 2025. Though the CAFE standards set average MPG requirements for passenger cars and light vehicles, and our graph shows the change in the 80th percentile of MPGs for one vehicle class, this does not pose an issue for our analysis because we are looking at general trends over time as opposed to comparing actual MPGs.

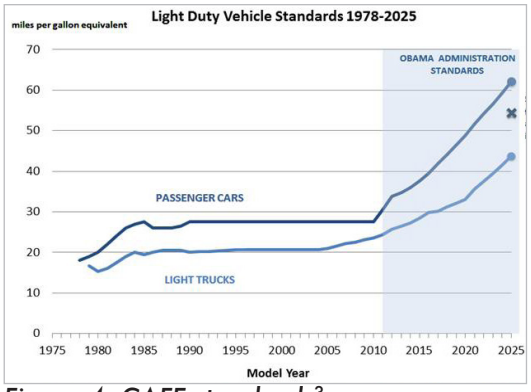


Figure 4: CAFE standards[3]

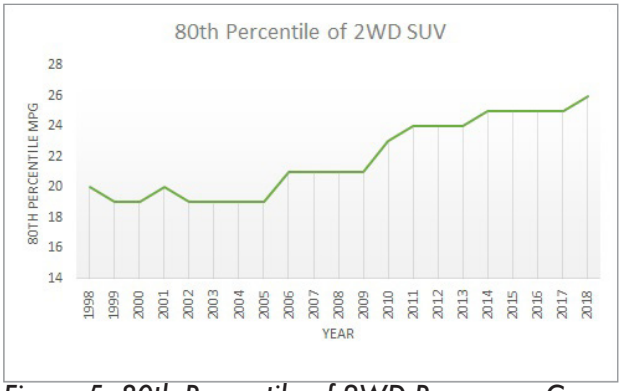


Figure 5: 80th Percentile of 2WD Passenger Cars

A similar trend is present in both graphs, and reveals a step function. In 2007, the CAFE standards were updated for the first time since they were implemented in 1978, which helps to explain the steady increase in MPG for 2WD passenger vehicles in 2008 that we see in our graph. Ultimately, when the CAFE standards are strengthened, the MPG for individual vehicle classes increases, whereas when the CAFE standards remain unchanged, the MPG for individual vehicle classes flatlines.

The CAFE standard also includes a separate standard from passenger cars for light-duty trucks, which includes pickup trucks, vans, and SUVs.[4] The additional vehicles included within the light-duty truck class makes the CAFE standard substantially different from the FEV Policy's MPG requirement. The FEV Policy sets MPG requirements for pickup trucks, vans, and SUVs independent of each other, while the CAFE standard groups them together. Therefore the CAFE standard may not accurately represent the actual MPG on the market within the pickup truck, van, and SUV vehicle classes. Minivans and pickup trucks bring the average down, wheres the SUVs bring the average up. The CAFE standard for light trucks may therefore not be an accurate representation of where each individual vehicle class should be by the year 2021. Regardless, Figure 5 reveals that the MPG trends in the 80th percentile still follow the CAFE standard trends for the three vehicle classes. This similar trends further support our finding that MPG is mainly driven by the CAFE standard, though the CAFE standard may not directly dictate the actual MPG of each vehicle.

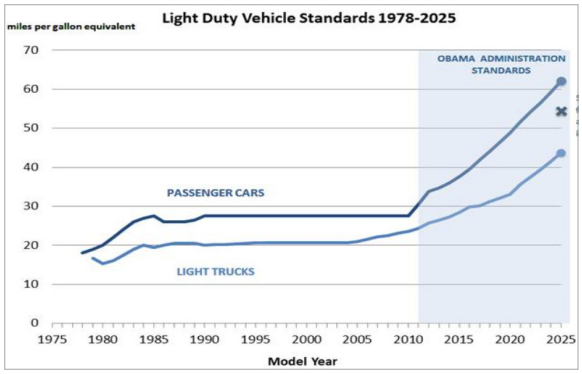


Figure 6: CAFE Standards[5]

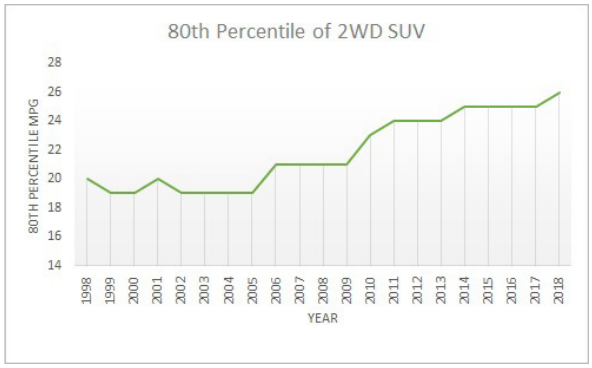


Figure7: 80th Percentile of 2WD SUVs

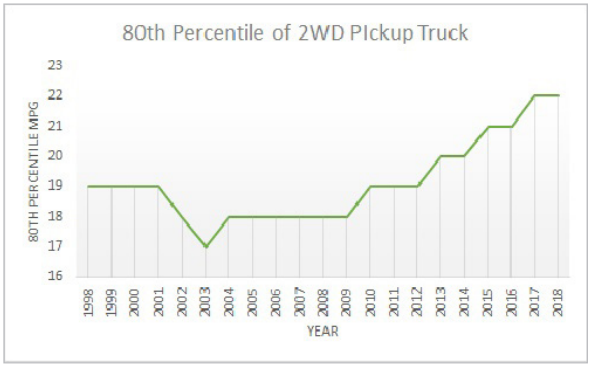


Figure 8: 80th Percentile of 2WD Pickup Trucks

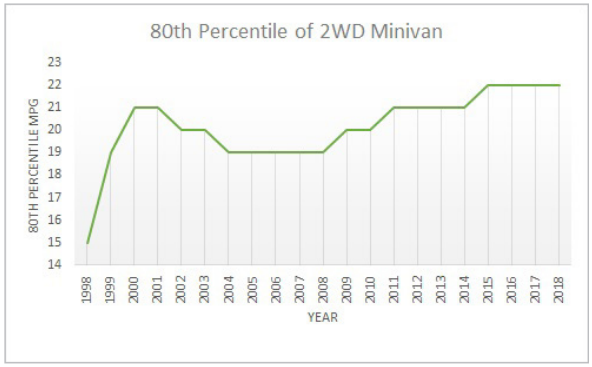


Figure 9: 80th Percentile of 2WD Minivans

When comparing the 2WD options from the three vehicle classes to the light truck CAFE standard, a strong trend between the three vehicle classes can be seen. Depending on the vehicle class, there is little difference in MPG between years 1998 to 2006/9, and then a steady incremental increase following 2009, much like the passenger car trend. This trend further supports our finding that MPG is mainly driven by the CAFE standard. Again, we are not looking at the actual MPG data points and instead looking at the trends in the data.

Recommendations

The below table shows the 80th percentile of fuel economy ratings on model year 2018 vehicles for each nonexempt vehicle class and is our recommendation for the FEV Policy's new MPG requirements. These recommendations result in an increased fuel economy of potentially up to 38.9% for each new municipal vehicle purchased, depending on the vehicle class.

Table 12. Proposed MPG Requirements for FEV Policy

Vehicle Class	2012 MPG Requirement	2018 MPG Proposal	Percent Change (2012 to 2018)
2WD Passenger Car	29	32	10.3
4WD Passenger Car	24	29	20.8
2WD SUV	21	26	23.8
4WD SUV	18	25	38.9
2WD Minivan	20	22	10.0
4WD Minivan	18	20	11.1
2WD Pickup Truck	17	22	29.4
4WD Pickup Truck	16	20	25.0

This recommendation meets all of the FEV Policy requirements set by GCD (vehicles that are affordable, automatic transmission, American made; and minimum of 5 for each vehicle class), except for 4WD minivans due to the of the lack of 4WD models available on the market. The new MPG requirements include a range of vehicles municipalities can choose from. By setting our MPG proposal to these parameters, municipalities will continue to work towards a cleaner future while also closing the gap between conventional gas powered cars and hybrids. We hope the increase in the minimum MPG requirements will help drive municipalities towards hybrids and EVs.

For future use, GCD should take, at minimum, the 80th percentile of each vehicle class for the given year, and adjust it according to the CAFE standard. However, there are four vehicle classes (2WD passenger cars, 2WD SUV, 4WD SUV, and 4WD pickup trucks) with over ten vehicle options available at the 80th percentile, as shown in Table 13. Thus, GCD should consider setting their MPG requirement higher than the 80th percentile for those four vehicle classes to encourage the purchase of even more fuel efficient vehicles (see Tables 4, 6, 7, 9). This could be accomplished while still having a diverse set of vehicle options available and while meeting GCD's specification that five vehicles from affordable brands be available to purchase in each class.

Table 13. Number of Vehicles Available at the 80th Percentile Fuel Economy Rating

Vehicle Class	Number of vehicles included at 80th percentile
2WD Passenger Car	34
4WD Passenger Car	8
2WD SUV	19
4WD SUV	23
2WD Pickup Truck	10
4WD Pickup Truck	14
2WD Minivan	5
4WD Minivan	1

The trends comparing the CAFE standard to the 80th percentile indicates that DOER should seek stricter MPG requirements when stricter CAFE standards are set, as they were under both the Bush and Obama Administrations. This will provide the opportunity to place more fuel efficient vehicles in municipality fleets. However, when CAFE standards remain constant or are rolled back, DOER has less of an opportunity to increase its MPG requirements. Though Massachusetts follows California's stricter vehicle emissions standards allowed by the Clean Air Act, the impacts of the current administration's proposed roll back of Obama-era CAFE standards on this are uncertain. GCD should increase its MPG requirements to the maximum extent feasible between now and 2021, as the standards for 2022-2025, which were originally supposed to drastically increase fuel economy as shown in Figure 4, have been reopened with the intent to roll them back.

Endnotes

1 "Download Fuel Economy Data." Www.fueleconomy.gov, www.fueleconomy.gov/feg/download.shtml. Accessed 24 April 2018.

2 DiMedio, Jillian. Fuel Efficiency Standards for State Fleets. Mass Department of Energy Resources.

3 Plumer, Brad. "What Are the CAFE Standards for Cars and Trucks?" Vox, 28 March 2014, www.vox.com/cards/obama-climate-plan/what-are-u-s-fuel-efficiency-standards-for-cars-and-trucks.

4 CAFE Final Rule. Department of Transportation, 15 Oct. 2012.

5 Plumer, Brad. "What Are the CAFE Standards for Cars and Trucks?" Vox, 28 March 2014, www.vox.com/cards/obama-climate-plan/what-are-u-s-fuel-efficiency-standards-for-cars-and-trucks.

Conclusion

Through grant funding, technical assistance, and regional support, GCD is clearly effective in helping municipalities across Massachusetts reduce their energy consumption. Additionally, the Green Community program is well-received by GCs, and GCs are eager to take part in energy efficiency projects. While reducing vehicle fuel consumption remains a challenge, there are certainly opportunities for GCs to tackle this issue, and several initiatives being undertaken by GCs that can serve as guidance for others.

To reduce both non-exempt and exempt vehicle fuel consumption, GCD should further promote and fund clean vehicles and fuel reduction technologies, and incorporate low cost best practices from our research and other Green Communities into Criterion 4, including anti-idling policies, fleet maintenance and tracking initiatives, eco-driving training and educational campaigns, and right-sizing requirements. GCD should also keep an eye on particular emerging technologies for fuel efficient vehicles (i.e. for police cruisers, heavy-duty and public works vehicles, and school buses), further funding opportunities for GCs and the state to help alleviate the costs associated with clean vehicle technology, and changes in federal regulations related to CAFE standards.

While GCD has strong relationships with GCs, there is potential to further strengthen those partnerships, especially between existing and future Green Communities. GCD should engage in outreach and communication activities to share information about current and future fuel reduction technologies. Additionally, GCD should facilitate connection among GCs to allow for sharing of best practices. To assist with this, we recommend that GCD share this report with Green Communities as soon as possible, as some towns said that they plan to acquire new vehicles this summer. The information presented in this report may be able to offer guidance in their decision-making process.

Lastly, as highlighted in Criterion 4, the primary method in which GCs can reduce their fuel consumption is by purchasing fuel efficient vehicles. Based on the fuel economies of the non-exempt vehicles that are currently available on the market, we recommend that the FEV Policy's MPG requirements be increased according to the 80th percentile of fuel economy ratings for each vehicle class within model year 2018. Given that a new vehicle will remain in a municipal fleet for several years, GCD should update its FEV policy on MPG requirements annually. This will ensure that the requirements are keeping up to date with what is available on the market and further push GCs to reduce their fuel consumption.

Beyond reducing fuel consumption, this report provides the Green Communities Division and its communities with the resources to continue to take the lead in implementing progressive climate commitments in the U.S.

Photo Credits

Page 1 Gasolin station: No author listed (CC0 Public Domain)
https://pxhere.com/en/photo/493570
Page 1 Electric vehicles: Joenomias (CC0)
https://pixabay.com/en/electric-car-hybrid-car-charging-2783573/
Page 9: Sass Peress, Renewz Sustainable Solutions Inc. (CC-BY-SA-3.0)
https://commons.wikimedia.org/wiki/File:Baka-charging-station_cropped.jpg
Page 17: Peter Blanchard (CC BY-SA 2.0)
https://www.flickr.com/photos/peterblanchard/5080950783
Page 31: Trish Benoit-Rudden, Town of Millville
Page 42: Trish Benoit-Rudden, Town of Millville
Page 47: Louis Oliveira (CC-BY-SA-2.0)
https://commons.wikimedia.org/wiki/File:Hubway_bikes_at_rack.jpg
Page 48: BMRR (CC-BY-SA-3.0)
https://commons.wikimedia.org/wiki/File:Girardin-mb-ii-boston.jpg
Page 52: Erik Gudmundson, U.S. Air Force (Public Domain)
https://commons.wikimedia.org/wiki/File:John_Deere_loader.jpg
Page 57: Kārlis Dambrāns (CC-BY-2.0)
https://commons.wikimedia.org/wiki/File:BMW_i3_charging_port.jpg
Page 73: Jon Sullivan (Public Domain)
https://en.wikipedia.org/wiki/File:Leaf_1_web.jpg

Works Cited

"Alternative Fuels and Advanced Fuels." Alternative Fuels Data Center, https://www.afdc.energy.gov/fuels/. Accessed 24 April 2018.

"Appendix D-2: Eligible Mitigation Actions and Mitigation Action Expenditures," Volkswagen Settlement, https://www.vwcourtsettlement.com/wp-content/uploads/documents/DOJ/Approved%20Appendix%20D-2.pdf. Accessed 4 April 2018.

Ayre, James. "Electric Semi Trucks & Heavy-Duty Trucks – Available Models & Planned Models (In-Depth List)." CleanTechnica, 16 December 2017, https://cleantechnica.com/2017/12/16/electric-semi-trucks-heavy-duty-trucks-available-models-planned-models/. Accessed 9 May 2018.

"Becoming a Designated Green Community." Mass.gov, https://www.mass.gov/guides/becoming-a-designated-green-community. Accessed 10 March 2018.

Boada, Mark. "Managers of Work Truck Fleets: Is Renewable Diesel in Your Future?" Fleet Management Weekly, http://www.fleetmanagementweekly.com/managers-work-truck-fleets-renewable-diesel-future/. Accessed 24 April 2018.

CAFE Final Rule. Department of Transportation, 15 October 2012, file:///C:/Users/alber/Downloads/2017-25_CAFE_Final_Rule.pdf. Accessed 25 April 2018.

"Car Sharing," NYC.gov, http://www.nyc.gov/html/dot/downloads/pdf/ssi11-car-sharing.pdf. Accessed 4 April 2018.

"Clean Vehicle Projects," Metropolitan Area Planning Council, https://www.mapc.org/our-work/expertise/clean-energy/clean-vehicle-projects/. Accessed 13 March 2018.

"Corporate Average Fuel Economy." National Highway Traffic Safety Administration, www.nhtsa.gov/laws-regulations/corporate-average-fuel-economy#corporate-average-fuel-economy-cafe. Accessed 24 April 2018.

"County Fleet Goes Big on Idle Reduction, Ethanol Use, Fuel Efficiency," Alternative Fuels Data Center, 7 April 2011, https://www.afdc.energy.gov/case/1046. Accessed 17, April 2018.

"Criterion 4 Guidance." Mass.gov, https://www.mass.gov/files/documents/2016/08/pp/criterion-4-guidance.pdf. Accessed 22 January 2018.

Davenport, Coral, and Hiroko Tabuchi. "E.P.A. Prepares to Roll Back Rules Requiring Cars to Be Cleaner and More Efficient." The New York Times, 29 March 2018, www.nytimes.com/2018/03/29/climate/epa-cafe-auto-pollution-rollback.html. Accessed 24 April 2018.

DiMedio, Jillian. Fuel Efficiency Standards for State Fleets. Mass Department of Energy Resources.

"Detroit Working to Right-size & Green its Fleet," Government Fleet, 4 May 2012, http://www.government-fleet.com/channel/green-fleet/news/story/2012/05/detroit-working-to-right-size-green-fleet.aspx. Accessed 4 April 2018.

Dowds, Jonathan, et al. Identifying Best Practices for Snowplow Route Optimization. Saint Paul, MN: Transportation Research Center, University of Vermont, 2016. Accessed 2 April 2018.

"Download Fuel Economy Data." Www.fueleconomy.gov, www.fueleconomy.gov/feg/download.shtml. Accessed 24 April 2018.

"Driving More Efficiently." Www.fueleconomy.gov, https://www.fueleconomy.gov/feg/driveHabits.jsp. Accessed 24 April 2018.

Ernst, Shelley. "What You Need to Know About Renewable Diesel." Government Fleet, March 2016, http://www.government-fleet.com/channel/green-fleet/article/story/2016/03/what-you-need-to-know-about-renewable-diesel.aspx. Accessed 24 April 2018.

Gallucci, Maria. "More U.S. Towns Are Requiring Natural Gas Garbage Fleets, in Boon to Truck Makers." Inside Climate News, 21 October 2011, https://insideclimatenews.org/news/20111021/compressed-natural-gas-vehicles-garbage-trucks-clean-fuels-electric-cars-smithtown-new-york-fracking. Accessed 24 April 2018.

"Global Warming Solutions Act Background," Mass.gov, https://www.mass.gov/service-details/global-warming-solutions-act-background. Accessed 10 March 2018.

"Green Communities Division," Mass.gov, https://www.mass.gov/orgs/green-communities-division. Accessed 10 March 2018.

"Greening the Corporate Fleet: Transition Strategy," City of Burlington, May 2008. https://www.burlington.ca/en/live-and-play/resources/Environment/Green_Fleet_Strategy.pdf. Accessed 4 April 2018.

"Idle Reduction," Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/idle_reduction_onboard.html. Accessed 17 April 2018.

Jessen, Clark. "MassDOT GreenDOT: Eco-Driving Training," MassDOT Blog, 9 August 2015, https://blog.mass.gov/transportation/uncategorized/massdot-greendot-eco-driving-training/.

Killian, Ronald. "Ecodriving: The Science and Art of Smarter Driving." TR News, July-August 2012, pp. 34-39.

"Maps, Reports, and Publications," Mass.gov, https://www.mass.gov/lists/maps-reports-and-publications. Accessed 16 March 2018.

"Massachusetts Electric Vehicle Incentive Program (MassEVIP) Fleets Questions & Answers," Mass.gov, https://www.mass.gov/files/documents/2017/11/08/massevipfaq_11.pdf. Accessed 13 March 2018.

Massachusetts Green Communities Program 2016 Progress Report. Mass. Department of Energy Resources, 2017, www.mass.gov/files/documents/2018/03/12/gc-2016-progress-report.pdf.

Mika, Shelley. "Telematics by the Numbers," Government Fleet, January 2014, http://www.government-fleet.com/channel/gps-telematics/article/story/2014/01/telematics-by-the-numbers.aspx. Accessed 19 April 2019.

"Natural Gas Fuel Basics." Alternative Fuels Data Center. https://www.afdc.energy.gov/fuels/natural_gas_basics.html. Accessed 24 April 2018.

"Onboard Idle Reduction Equipment for Heavy-Duty Trucks," Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/idle_reduction_onboard.html. Accessed 17 April 2018.

"Petroleum & Other Liquids." U.S. Energy Information Administration, https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2D_PTE_NUS_DPG&f=M. Accessed 24 April 2018.

"San Francisco's Renewable Diesel Halves Diesel Emissions." Government Fleet, 14 December 2015, https://www.government-fleet.com/channel/green-fleet/news/

story/2015/12/san-francisco-reduces-diesel-emissions-by-50-with-renewable-diesel.aspx. Accessed 24 April 2018.

"Smithtown Selects CNG to Cut Refuse Collection Costs." Alternative Fuels Data Center, 7 April 2011, https://www.afdc.energy.gov/case/1047. Accessed 24 April 2018.

"The Heat Is On in St. Louis Buses," Alternative Fuels Data Center, 24 May 2013, https://www.afdc.energy.gov/case/1429. Accessed 17 April 2018.

Town of Charlton, Massachusetts Energy Reduction Plan. Town of Charlton, November 2016.

Town of Cummington, Massachusetts Energy Reduction Plan. Town of Cummington, November 2017.

Town of New Braintree, Massachusetts Energy Reduction Plan. Town of New Braintree, October 2017.

Town of West Boylston, Massachusetts Energy Reduction Plan. Town of West Boylston, October 2017. "Vehicle Maintenance to Conserve Fuel." Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/vehicle_maintenance.html. Accessed 24 April 2018.

"Vehicle Parts and Equipment to Conserve Fuel," Alternative Fuels Data Center, https://www.afdc.energy.gov/conserve/equipment.html. Accessed 5 April 2018.

"What is telematics?" Geotab, https://www.geotab.com/blog/what-is-telematics/. Accessed 5 April 2018.

Appendix A: Resources for Green Communities

Hybrid and Electric Vehicle Incentive Programs in MA

- MA EVIP Program Details: https://www.mass.gov/how-to/massevip-fleets
- MAPC Green Mobility Program Details: https://www.mapc.org/our-work/expertise/clean-energy/clean-vehicle-projects/
- MA DEP Volkswagen Settlement Beneficiary Mitigation Plan: https://www.mass.gov/files/documents/2018/02/09/vw-shpres.pdf; https://www.vwcourtsettlement.com/wp-content/uploads/documents/DOJ/Approved%20Appendix%20D-2.pdf

Alternative Fuels Examples

- Renewable Diesel Info: http://www.fleetmanagementweekly.com/managers-work-truck-fleets-renewable-diesel-future/
- Renewable Diesel Info; Oakland, CA; San Fransico, CA; Oregon: http://www.government-fleet.com/channel/green-fleet/article/story/2016/03/what-you-need-to-know-about-renewable-diesel.aspx
- San Francisco, CA: https://www.government-fleet.com/channel/green-fleet/news/story/2015/12/san-francisco-reduces-diesel-emissions-by-50-with-renewable-diesel.aspx
- Smithtown, NY: https://www.afdc.energy.gov/case/1047

Anti-idling Technology Examples

- SmartWay Verified List of Idling Reduction Technologies for Trucks and School Buses: https://www.epa.gov/verified-diesel-tech/smartway-verified-list-idling-reduction-technologies-irts-trucks-and-school
- Anti-Idling Technologies, Alternative Fuels Data Center, US Department of Energy: https://www.afdc.energy.gov/conserve/idle_reduction_onboard.html
- Canyon County, ID: https://www.afdc.energy.gov/case/1046
- St. Louis, MO: https://www.afdc.energy.gov/case/1429

Telematics Examples

- Telematics Systems, Alternative Fuels Data Center, US Department of Energy: https://www.afdc.energy.gov/conserve/equipment.html
- Snowplow route optimization study: http://clearroads.org/wp-content/uploads/dlm_uploads/FR_CR.14-07_Final.pdf
- Worcester, MA; Napa, CA; Washington County, FL; Baltimore County, MD: http://www.government-fleet.com/channel/gps-telematics/article/story/2014/01/telematics-by-the-numbers.aspx
- Eastern Municipal Water District, Riverside County, CA: http://www.government-fleet.com/channel/gps-telematics/article/story/2013/12/telematics-case-study-reducing-operating-costs.aspx

Rightsizing Examples

- Vehicle Rightsizing Tips, Alternative Fuels Data Center, US Department of Energy: https://www.afdc.energy.gov/conserve/rightsizing.html
- Minneapolis, MN: http://www.minneapolismn.gov/www/groups/public/@council/documents/webcontent/convert_259214.pdf
- Burlington, VT: https://www.burlington.ca/en/live-and-play/resources/Environment/Green_Fleet_Strategy.pdf
- New York, NY: http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
- San Jose, CA: http://www.sanjoseca.gov/index.aspx?NID=2953
- State of Massachusetts: https://www.mass.gov/doc/fuel-efficiency-standard-for-state-fleet

Vehicle Sharing Examples

- Boston, MA: http://boston.fastfleet.net/help/about; https://www.zipcar.com/press/releases/zipcar-launches-new-boston-fleethub-program
- New York, NY: http://www.nyc.gov/html/dot/downloads/pdf/ssi11-car-sharing.pdf
- Washington, DC: https://www.fastfleet.net/case_study

Eco-driver Training Examples

- Eco-driving Tips, Alternative Fuels Data Center, US Department of Energy: https://www.afdc.energy.gov/conserve/driving_behavior.html
- Driving Behavior Tips for Medium-and Heavy-duty Vehicles (page 174): https://www.nap.edu/read/12845/chapter/9#174
- The University of Vermont's Certification for Sustainable Transportation Program (used by MassDOT): http://www.erating.org/transportation-company-education/courses
- Burlington, VT: https://www.burlington.ca/en/live-and-play/resources/Environment/Green_Fleet_Strategy.pdf
- New York, NY: http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
- North Carolina: https://www.ncdot.gov/travel/drivegreen/
- Massachusetts: https://blog.mass.gov/transportation/uncategorized/massdot-greendot-eco-driving-training/; http://onlinepubs.trb.org/onlinepubs/trnews/trnews281ecodriving.pdf

Vehicle Maintenance Examples

- Vehicle Maintenance Tips, Alternative Fuels Data Center, US Department of Energy: https://www.afdc.energy.gov/conserve/vehicle_maintenance.html
- See Energy Reduction Plans from DOER for West Boylston, Charlton, New Braintree, and Cummington examples

Appendix B: List of Municipalities Solicited for Interviews and Surveys

Municipality	Region	Hybrid or Electric Vehicle	Anti-Idling	Hybrid Vehicle Conversion	Just Alternative Compliance
Barnstable	Southeast	3			
Boston	Northeast	5			
Cambridge	Northeast	1	1		
Gill	Western		1		
Hardwick	Western	2	1		
Hatfield	Western	1			
Millbury	Central	1			
Millville	Central		1		
Natick	Northeast	4		1	
Revere	Northeast	1			
Truro	Southeast		1		
Tyngsborough	Northeast	2			
Wayland	Northeast	2		1	
Somerville	Northeast				x
Warwick	Western				x
Lakeville	Southeast		1		
Mendon	Central	1			
Northampton	Western	2			
Sherborn	Northeast		1		
Sutton	Central	1			
Woburn	Northeast	1			
Amesbury	Northeast	2			
Amherst	Western	1	1		
Arlington	Northeast	2			
Bourne	Southeast	1	1		
Braintree	Southeast	3			

Chelmsford	Northeast	1	1		
Dalton	Western	2			
Dudley	Central		1		
Gloucester	Northeast		1		
Granby	Western	1			
Hanover	Southeast	1			
Holliston	Central	1			
Hopkinton	Central	1			
Lancaster	Central	2			
Lincoln	Northeast	1			
Manchester	Northeast	1			
Marlborough	Central	1			
Maynard	Central	1			
Melrose	Northeast	1			
Monson	Western	1			
Newburyport	Northeast	1			
Newton	Northeast	1			
North Andover	Northeast	1			
Palmer	Western	1			
Saugus	Northeast	1			
Scituate	Southeast	1			
Shirley	Central		1		
Sudbury	Northeast	1			
Tewksbury	Northeast	1			
Townsend	Central	1	1		
Upton	Central		1		
West Springfield	Western	1			
West Tisbury	Southeast		1		
Westfield	Western	2			
Williamstown	Western	1			
Winchester	Northeast	2			

Appendix C: Interview and Survey Protocols

Introduction

Thank you so much for taking the time to talk with us. I mentioned this in my email, but I just wanted to reiterate: [name] and I are urban and environmental policy and planning students at Tufts. As part of a class, we are working on a project with the Massachusetts Department of Energy Resources to help them evaluate their Green Communities Program. Specifically, we are evaluating and providing updates to the fuel efficient vehicle policy, so we're interested in learning more about:

- the hybrid or electric vehicle(s) that [municipality] acquired in XXXX (Year).
- the anti-idling technology that [municipality] acquired in XXX (year) and installed on (type of vehicle if known).
- the vehicle upfit/retrofit that [municipality] recently installed on XXX (type of vehicle)

Broadly, we would like to learn about any benefits from the technology and challenges you have encountered when implementing the technology or with the technology itself. We will use your answers in aggregate form in a report that we will share with DOER, as well as highlight particular municipalities in outreach materials for other municipalities. At the end of the interview, you will have an opportunity to select to remain anonymous in our report to DOER, in which case identifying information about you and your municipality (e.g., region, population size) will not be reported with your interview data.

This interview should take 30 (to 45) minutes. You may skip an interview question, or end the interview at any time. There will be no negative consequence for these actions.

Do you have any questions for me before we begin?

[If given permission to record beforehand] You had provided me permission to record the interview for note-checking purposes only. Again, the recordings will be saved onto a private folder at Tufts and deleted immediately after we finalize the notes from this interview. They won't be shared with DOER or anyone outside of the project team and our advisor. If you have changed your mind about the recording, there will not be any negative consequences. Is it okay for me to begin recording?

Questions

Hybrids/EVs

1. I see that [name of municipality] purchased XXX (vehicle name(s)). What vehicle(s) were replaced with the hybrid/EV purchase?
2. What are the new vehicle(s) used for?
3. Why did [name of municipality] decide to acquire the hybrid/EV?
4. What do you find to be the benefits of the hybrid/Evs? '

5. Did you come across or have any challenges with the new vehicles? If so, what were they?
   (Prompt: Financial? Employee pushback? Technological?) How did you overcome those challenges?
6. Would you purchase additional hybrid or electric vehicles? Why or why not?
   Prompt: Implementation barriers due to operational requirements (e.g., towing, attaching plow) Cost?
7. Would you recommend that other municipalities buy hybrid/electric vehicles? Why or why not?

Anti-idling technology

1. (If information not already available) I see that [name of municipality] installed anti-idling technology on some of [name of municipality]'s municipal vehicles. What anti-idling technology was installed? (i.e. what company/brand was used? Can you briefly describe how the anti-idling technology works?)
2. How many vehicles were equipped with this technology?
3. What vehicles was this technology installed this on, and what are those vehicles used for?
4. Why did [name of municipality] choose to undertake this project over other fuel reduction projects?
5. What do you find to be the benefits of the anti-idling technology?
6. Did you come across or have any challenges with getting the technology installed? If so, what were they? (Prompt: Financial? Employee pushback? Technological?) How did you overcome those challenges?
7. Would [name of municipality] purchase further anti-idling technology for its municipal vehicles? Why or why not?
8. Would you recommend this technology to other municipalities? Why or why not?

Vehicle conversions

1. I see that [name of municipality] completed a hybrid conversion project for your municipal fleet. What vehicles were converted?
2. How many vehicles were converted?
3. What are those vehicles used for?
4. Why did [name of municipality] choose to undertake this project over other fuel reduction projects?
   Prompt: Did [name of municipality] consider purchasing new vehicles instead?
5. What do you find to be the benefits of the conversions?
6. Did you come across or have any challenges with the conversions? If so, what were they? (Prompt: Financial? Employee pushback? Technological?) How did you overcome those challenges?
7. Would [name of municipality] fund further hybrid conversion projects for its municipal vehicles? Why or why not?
8. Prompt: is cost an issue? Would you only do it if grants are available for it?
9. Would you recommend that other municipalities convert their vehicles? Why or why not?

Alternative compliance measures

1. Does [name of municipality] have any other programs, measures, or tools aimed at reducing vehicle fuel consumption outside of purchasing fuel efficient vehicles, installing anti-idling equipment, or converting its vehicles (include technologies as applicable)?
   Prompt: This could include promoting biking to work, carpooling, requiring the use of biodiesel, policies around anti-idling, etc.
   If yes: What are they? (then move to question 2)
   If no: Is this something that [name of municipality] has considered doing or would like to do in the future? If so: what ideas have you considered? If not: why not?
2. Does [name of municipality] promote these programs or measures? If so: How?
3. (as applicable) Do you offer incentives for participating in these programs? If so: What incentives do you offer?
4. Do you find these programs/measures to be effective in reducing fuel consumption?
5. Do you track the impact of these programs/measures? If so, how?
   Prompt: For example, through measures of reduced driving to work, surveying whether people carpool, etc.
6. Do you encounter any challenges with these programs/measures?
7. Would you recommend any of your current programs/measures to other municipalities?

Final questions

1. (switching gears) For your general vehicle purchases, what types of additional features have you needed to add onto the base vehicle models?
2. Do you have anything else you want to share regarding the technology your community adopted?
3. Do you have any lessons learned you would like to share with other municipalities?
4. If you would like to remain anonymous in our report to DOER, meaning identifying information about you and your town would not be reported with your survey data, please let me know.

Survey Protocol

Introduction

This is a Tufts University Urban and Environmental Policy and Planning student project with the Massachusetts Department of Energy Resources (DOER). We are helping DOER evaluate Criteria 4 (fuel efficient vehicle purchasing and fuel reduction measures) of the Green Communities Program, and are interested in learning more about:

- the hybrid or electric vehicle(s) that your municipality acquired.
- the anti-idling technology that your municipality acquired and installed.
- the vehicle upfit/retrofit that your municipality recently installed.

Broadly, we would like to learn more about any benefits from the technology and/or challenges encountered when implementing the technology or with the technology itself. We will use your answers in aggregate form in a report that we will share with DOER, as well as highlight particular municipalities in outreach materials for other cities and towns. At the end of the survey, you will have an opportunity to select to remain anonymous in our report to DOER, in which case identifying information about you and your municipality (e.g., region, population size) will not be reported with your survey data.

This survey consists of a set of open-ended questions about your experience because we're interested in the range of possible answers, rather than quantifying any particular answer, for our questions. It is supplementing our outreach to other communities through interviews. This survey should take about 15-30 minutes to complete. You may skip a question or skip to the end at any time. There will be no negative consequence for these actions.

If you have any questions or concerns, please contact project member Lily Ko (Lily.Ko@tufts.edu), project advisor Ann Rappaport (Ann.Rappaport@tufts.edu) or Tufts University Social, Behavioral and Educational Research IRB Operations Manager Lara Sloboda (Lara.Sloboda@tufts.edu).

By moving onto the next page, you agree to have your survey responses evaluated and shared in a report with DOER.

If you do NOT agree, you may exit the survey.

Survey questions

Municipality:
Name:
Your Role:

Hybrids/EVs

Did your municipality acquire a hybrid or electric vehicle? YES / NO (If YES, move onto questions from this section. If NO, skip to next section.)

Please list the type of hybrid/EVs purchased, the type of vehicles it replaced, the vehicle function, and whether the municipality received grant funds to help cover the cost.

Purchased hybrid/EV vehicle	Vehicle replaced (Make & Model)	Vehicle function	Grant Support? YES / NO
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

1. Why did your municipality decide to acquire the hybrid/EV(s)?
2. What do you find to be the benefits of the hybrid/Evs?
3. Did you come across or have any challenges with the new vehicle(s)? YES / NO
4. If so, what are or were the challenges? How did you overcome them?
5. Would you purchase additional hybrid or electric vehicles? YES/ NO
6. Why or why not?
7. Do you have anything else you want to share regarding the hybrid/ electric vehicle(s)?

Anti-idling technology

Did your municipality install anti-idling technology on a vehicle in your fleet? YES / NO
(If YES, move onto questions from this section. If NO, skip to next section.)

1. Please list the type of anti-idling technology installed on its municipal vehicles, the company/brands of technology installed, and the types of vehicles equipped with the technology and its function.

Brand of anti-idling technology	Quick description of how anti-idling technology works	Type of vehicles equipped and vehicle function	Grant support? YES / NO
1.			
2.			
3.			
4.			
5.			

1. Why did your municipality choose to undertake this project over other fuel reduction projects?
2. What do you find to be the benefits of the anti-idling technology?
3. Did you come across or have any challenges with getting the technology installed? YES / NO
4. If so, what are or were the challenges? How did you overcome them?
5. Would your municipality purchase further anti-idling technology for its municipal vehicles? YES/ NO
6. Why or why not?
7. Do you have anything else you want to share regarding the technology?

Vehicle conversions

Did your municipality perform a vehicle upfit or retrofit? YES / NO (If YES, move onto questions from this section. If NO, skip to next section.)

Please list the type of hybrid vehicle conversions, the vehicle converted, vehicle function, and and whether the municipality received grant funds to help cover the cost

Type of vehicle conversion	Vehicle converted (Make & Model)	Vehicle function	Grant Support? YES / NO
1.			
2.			
3.			
4.			
5.			

1. Why did your municipality choose to undertake this project over other fuel reduction projects, or purchasing a new vehicle?
2. What do you find to be the benefits of the conversions?
3. Did you come across or have any challenges with the conversions? YES / NO
4. If so, what are or were the challenges? How did you overcome them?
5. Would your municipality fund further hybrid conversion projects for its municipal vehicles? YES/ NO
6. Why or why not?
7. Do you have anything else you want to share regarding the vehicle conversions?
8. Do you have any lessons learned you would like to share with cities and towns?

Alternative compliance measures

Does your municipality have any other programs, measures, or tools aimed at reducing vehicle fuel consumption outside of purchasing fuel efficient vehicles, installing anti-idling equipment, or converting its vehicles? (e.g., promoting biking to work, carpooling, requiring the use of biodiesel, policies around anti-idling, etc.)
YES / NO (If YES, move onto questions from this section. If NO, skip to question 6.)

If you answered "Yes" for the first question:

1. What are the programs, measures or tools your municipality has implemented to reduce vehicle fuel consumption?
2. How does your municipality implement these programs? Please include details about promotion and incentives, if any.
3. Do you find these programs/measures to be effective in reducing fuel consumption?
4. Does your municipality track the impact of these programs/measures? (e.g., through measures of reduced driving to work, surveying whether people carpool, etc.) YES / NO
5. How does your municipality track the impact of the programs/ measures?

If you answered "No" for the first question:

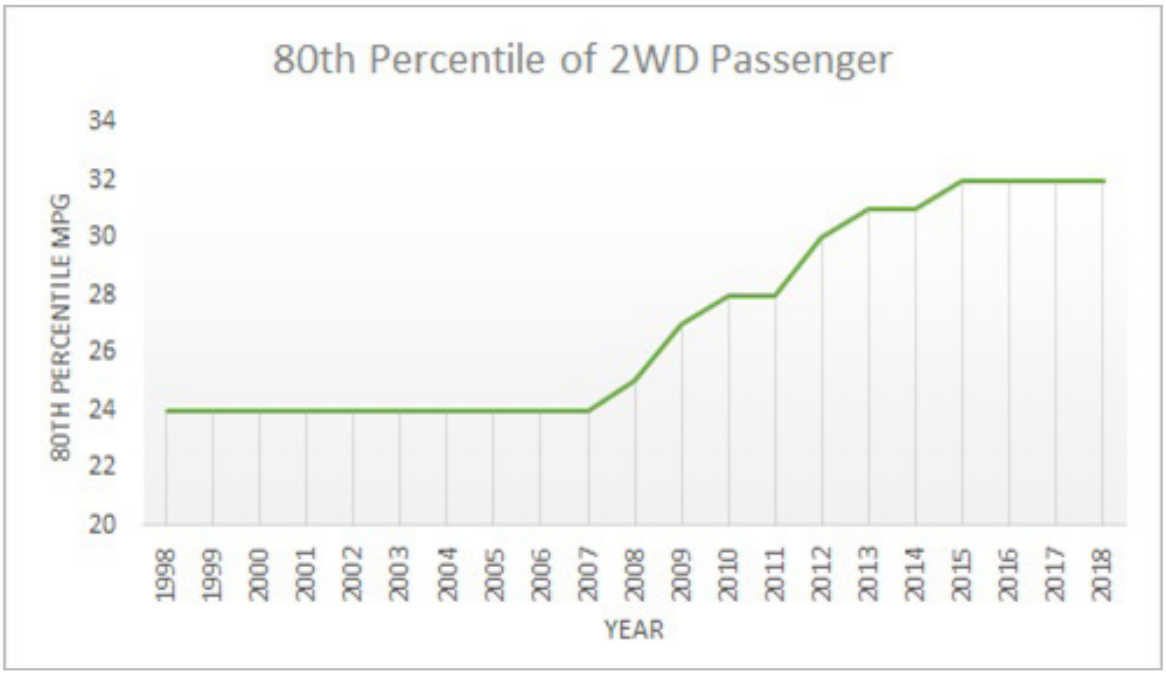
1. Has your municipality considered implementing any programs, measure or tools to reduce vehicle fuel consumption outside of purchasing fuel efficient vehicles? If so, what ideas have you considered? YES / NO
2. If your municipality has considered implementing any programs, measures or tools to reduce vehicle fuel consumption (beside purchasing fuel efficient vehicles, installing anti-idling equipment or converting its vehicles), what ideas have been considered?
3. If your municipality has not considered implementing any programs, measures or tools to reduce vehicle fuel consumption (beside purchasing fuel efficient vehicles, installing anti-idling equipment or converting its vehicles), why not?

Final questions

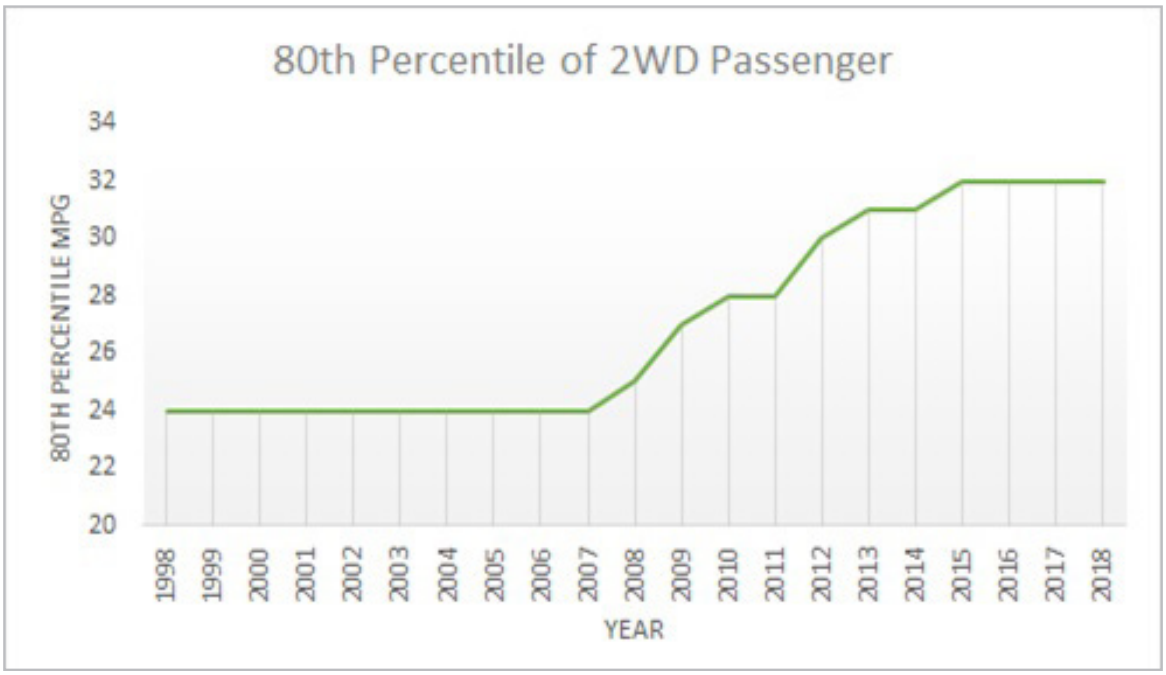
1. Do you have anything else you want to share regarding the technology you adopted?
2. Please select the box below if you wish to remain anonymous in our report to DOER. (Identifying information about you and your town would not be reported with your survey data.)

Appendix D: Fuel Economy Trends of Non-exempt Vehicle Classes

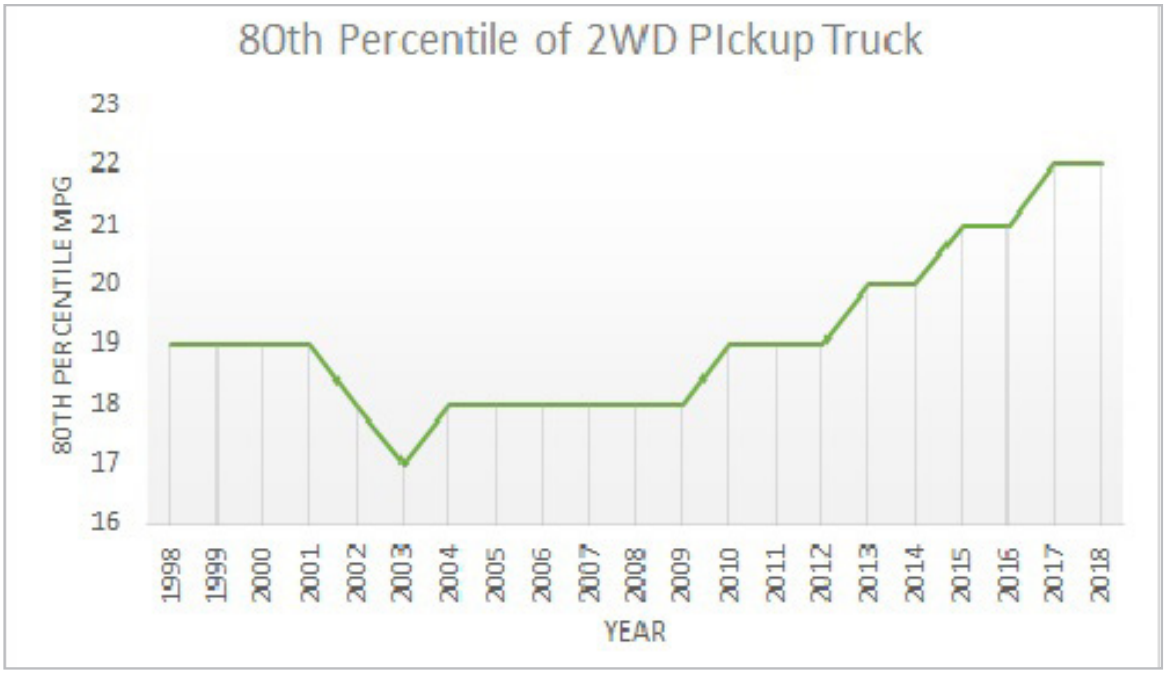
2WD Passenger Cars



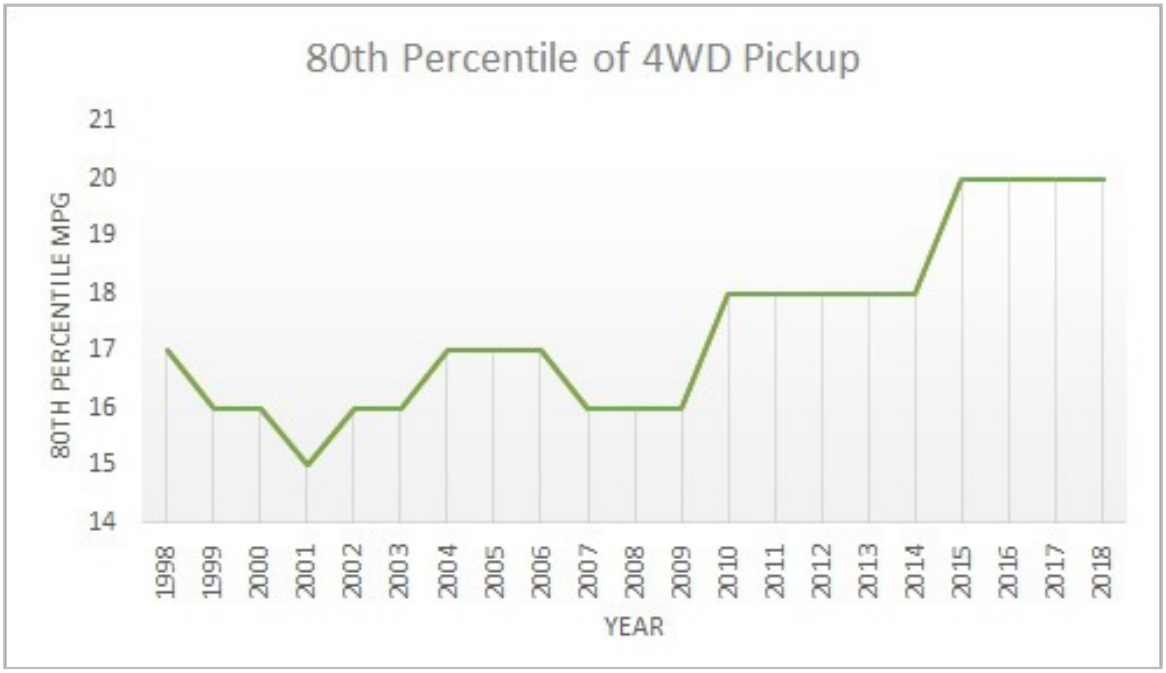
4WD Passenger Cars



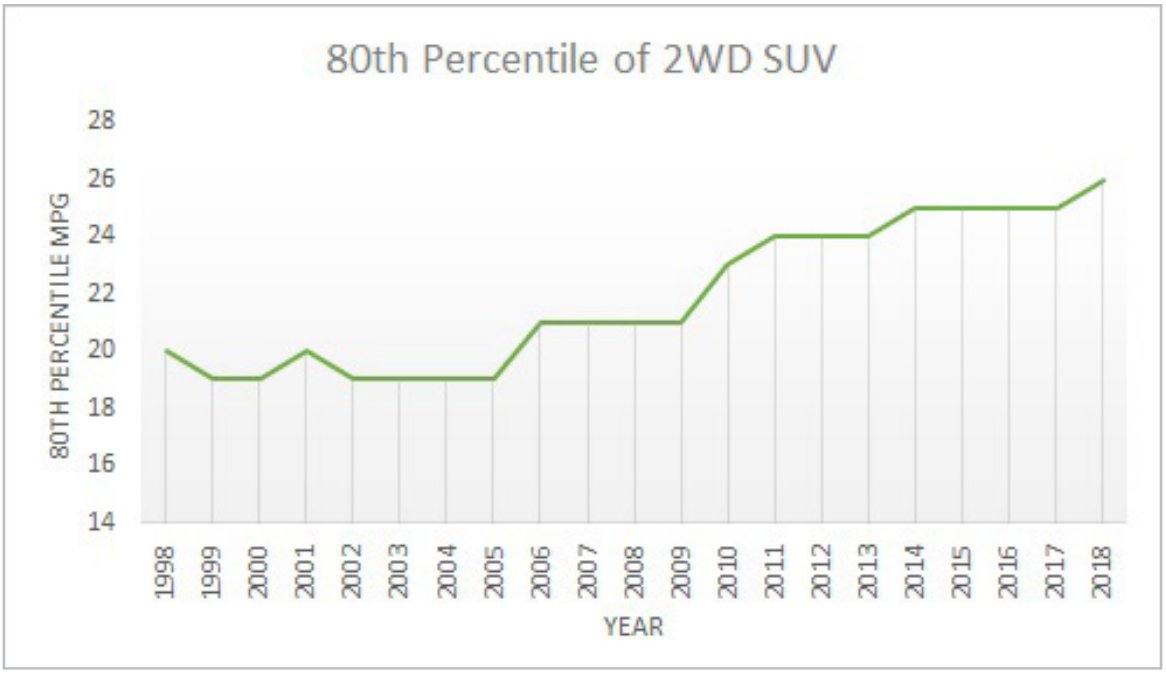
2WD Pickup Trucks



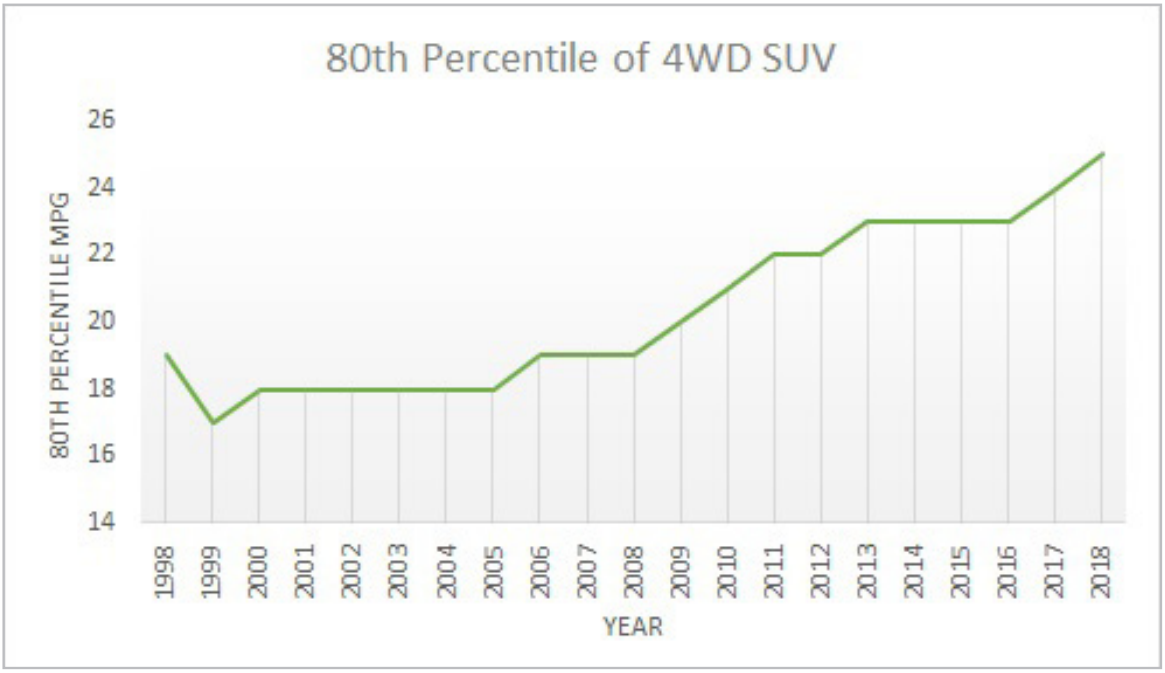
4WD Pickup Trucks



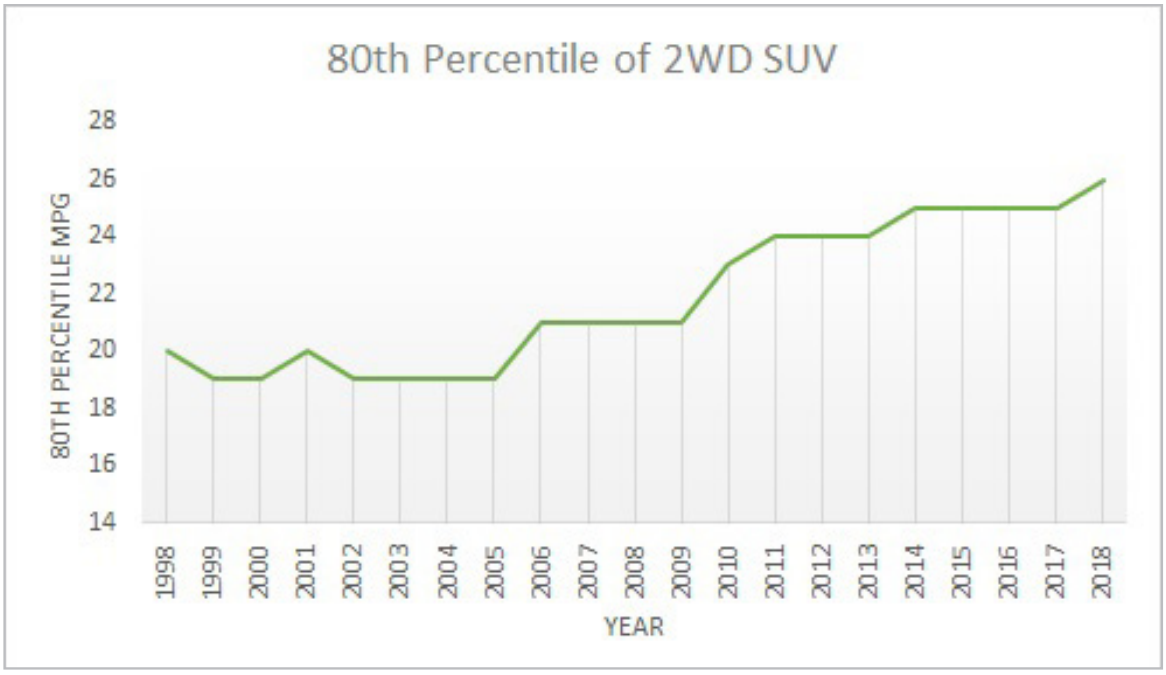
2WD SUV



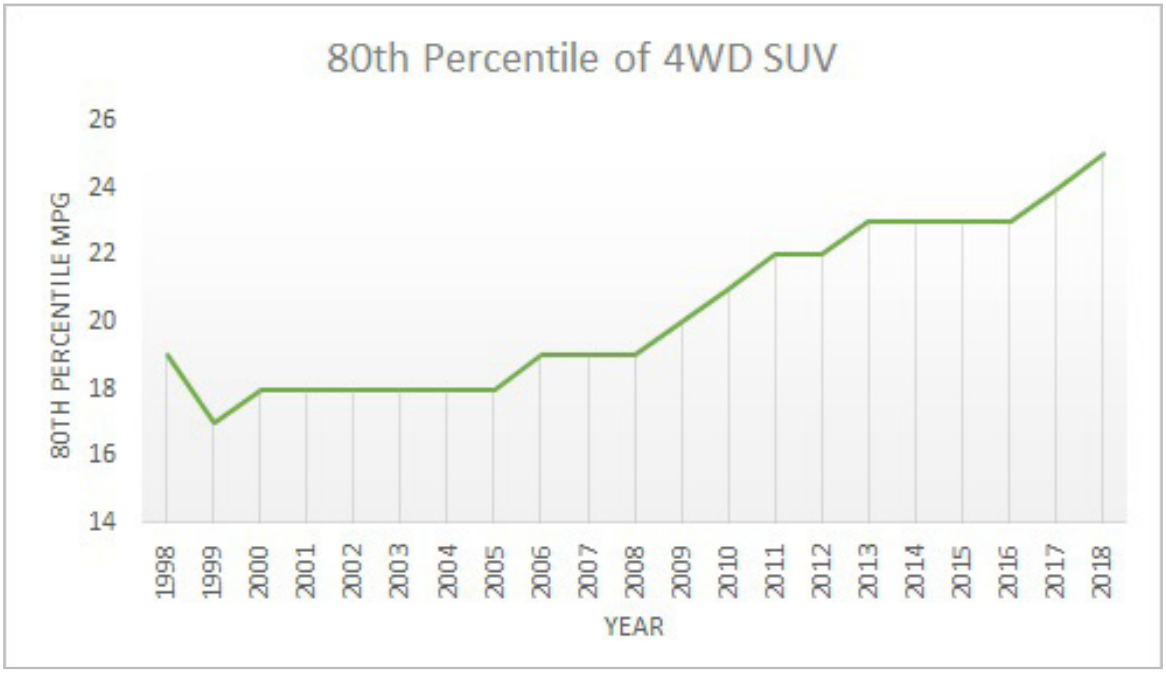
4WD SUV



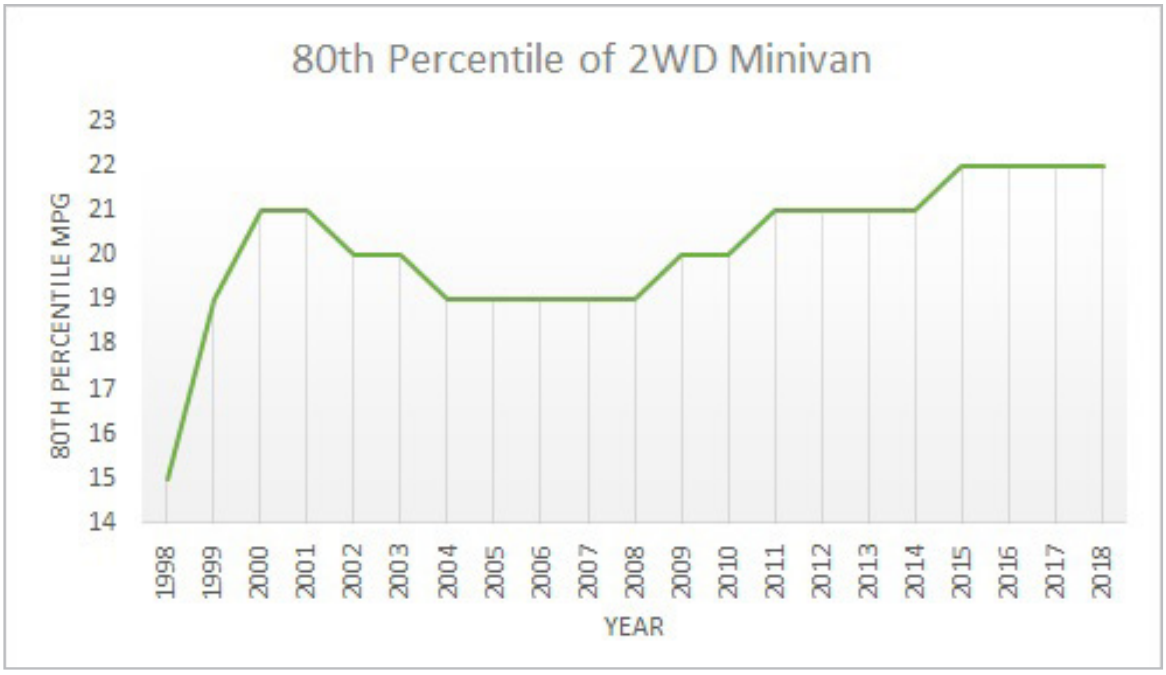
2WD SUVs



4WD SUVs



2WD Minivans



4WD Minivans