

Assessing the Application of Alternative Fuels in Vehicle Fleets

By

Ajaleigh Williams

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirement for the Degree of

Master of Natural Resources Management

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University of Manitoba
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ABSTRACT

The current fuels of choice in the transportation sector are conventional fuels, such as gasoline and diesel. However, conventional fuel sources are a finite fuel supply and the use of conventional fuels has negative impacts on the environment and human health. There are a number of cleaner burning alternative fuels that can be used in place of conventional fuels, some of which are also a renewable.

Early adopters of alternative fuels are often companies and organizations that have a large fleet of vehicles. Therefore, the purpose of this research was to develop an understanding of what vehicle fleet operators see as motivators and deterrents to using alternative fuels. The specific objectives of the research were to; identify the government alternative fuel policies in place in Manitoba; identify the current usage of alternative fuels in vehicle fleets; identify factors that need to be considered when using alternative fuels in vehicle fleets; and, establish the importance that fleet operators place on those factors.

The types of methods employed to achieve the research objectives included conducting detailed reviews of publications on government alternative fuel policies in Manitoba and reviews of publications on the use of alternative fuels in vehicle fleets in other regions. Following that a survey was distributed to vehicle fleets in Winnipeg to gain insight into Winnipeg fleet operator's perspectives on the use of alternative fuels in their fleets. The research focused on alternative fuels that were readily available and technically feasible

in the region, including ethanol, biodiesel, electricity (gas/electric hybrids), natural gas and propane.

The study results indicated that there is minimal use of alternative fuels in Winnipeg for the vehicle fleets surveyed, with government fleet operators using alternative fuels more often than industry fleet operators. The minimal use of alternative fuels can be attributed to the fact that there are limited alternative fuel retail refueling stations in the region, limited availability of vehicles for some types of alternative fuels, and limited access to information on alternative fuels.

Ethanol was the fuel of choice among respondents, as it is the most widely available alternative fuels source at local retail stations. Propane and hybrid electric vehicles are also used in the region, which is not surprising since propane used to be the number one alternative fuel in Canada and the electric gas hybrid vehicle market is currently expanding throughout Canada.

Based on the study findings, there are many factors that motivate fleet operators to adopt alternative fuels. Results indicated that government and industry fleet operators hold differences of opinions as to what motivates them to use alternative fuels. With the exception of the municipal fleet, who felt that fuel consumption being equivalent to gas or diesel is a top motivator to using alternative fuels, government fleet operators are generally more motivated to use alternative fuels because of social reasons, such as the environment, human health and government regulations, whereas industry fleet operators

are more motivated to use alternative fuels if fuel consumption and fuel cost are equivalent to gas or diesel and economic incentives are provided.

The study also established that there are a number of factors that deter fleet operators from using alternative fuels. Unlike with factors that motivate fleet operators to use alternative fuels, there is not a direct link between deterrents and type of fleet. This is largely because fleet operational needs are diverse. For example, trucking companies and messengers and couriers both operate large vehicle fleets, but have differences of opinions when it comes to what deters them from using alternative fuels.

Overall, the research illustrates that effectively implementing the use of alternative fuels in vehicle fleets is a complex undertaking, where a number of specific factors need to be addressed. The study results is an information set that can help decision makers and promoters of alternative fuels increase the use of alternative fuels in vehicle fleets, building capacity for expansion into the consumer vehicle market in the future.

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CHAPTER 1

1.0 INTRODUCTION

1.1 Background

In Canada there are over 17 million vehicles on the road, and each year 1.9 million motor vehicles are added to the vehicle population (Environment Canada, 1998). If the Canadian vehicle absorption level remained the same, there would be more vehicles on the road in 10 years than there are people in Canada as of 2004. The majority of motor vehicles are fueled by conventional fuels, such as gasoline and diesel. From their extraction to their end use, conventional fuels cause the emission of pollution that has many negative impacts on human health and the environment.

Canadian studies attribute 5000 deaths per year to air pollution, and Ontario alone spends \$1 billion dollars per year on hospital admissions, emergency room visits and absenteeism resulting from increased air pollution (Caucus Working Group on Environmental Technologies, 2002). Asthma rates are reported to be increasing due to the increased release of diesel fuel particulates that settle deep into human lungs (Mitchell, 2004). Vehicle emissions also contribute to climate change, smog, acid rain, stratospheric ozone depletion and increase the release of toxic pollutants into the air.

For all practical purposes, conventional fuels are a finite source of energy. Estimates on the volume of world's supply of oil vary greatly depending on the types of assumptions made during the compiling of the estimate. Most sources claim that there are

approximately 40 years left in the world's known oil reserves based on current demand (BP, 2003; Rifkin, 2002; Ogden, 2002; Bolger and Isaacs, 2003). Over time, prices for conventional fuels will rise as the source becomes less abundant and the transportation sector may see a dramatic shift away from the use of conventional fuels when it is no longer economical to use them.

Alternative transportation fuels are used in place of conventional fuel sources to accomplish a number of positive outcomes including: reducing environmental impacts from the transportation sector, increasing quality of life from a human health perspective, providing energy security by diversifying into renewable energy sources, increasing economic development in a region and supporting political policies on air pollution.

Ethanol, biodiesel, electricity, propane, natural gas, hydrogen and methanol are all listed as alternative transportation fuels in the Canadian Federal Government's Alternative Fuels Act (President of the Treasury Board, 2001). The Act also recognizes hybrid gas electric vehicle technologies as means to reduce vehicular emissions. The U.S.

Department of Energy also categorizes these fuels as alternative fuels (U.S. Department of Energy, 2002a). Each alternative fuel comes from different resources, have different production processes and require different types of infrastructure to store and use the fuel.

Ethanol, biodiesel and hydrogen are renewable fuels, whereas fuels like natural gas and propane are not.

In Canada, the use and availability of alternative fuels is not widespread compared to the use of conventional fuels. Alternative fuels that are most commonly used in Canada are natural gas and propane. Both currently have some infrastructure in place for their use, but vehicle availability is currently decreasing for both fuel types as some major automobile manufacturers are discontinuing natural gas and propane vehicles from production lines (AltFuels Advisor, 2004). Other fuels that are used increasingly in Canada include low level blends of ethanol and biodiesel. High level blends of ethanol and biodiesel are currently used in limited amounts and are under investigation through demonstrations, usually involving government agencies, testing the fuel source for measures such as vehicle performance and emission reductions. Gas/electric hybrid vehicles are being used in some vehicle fleets, while hydrogen is also being investigated and demonstrated throughout Canada.

The federal government's Alternative Fuel Act provides an indication of the federal government's support for alternative fuels. The Alternative Fuel Act requires federal departments to make use of alternative fuel vehicles where economically and operationally feasible to do so. As a result of the Act, the federal vehicle fleets have increased their use of alternative fuels and the number of alternative fuel vehicles in their pool (President of the Treasury Board, 2001). The federal government also provides financial support for the expansion of the alternative fuel industry, through: funding to provinces to expand ethanol production, rebate programs that offer financial incentives to convert vehicles to natural gas, financial support to federal departments to demonstrate alternative fuel technologies new to Canada, and through providing outreach and

education on alternative fuels through Natural Resources Canada Office of Energy Efficiency (Janzen, 2004; Legault, 2003; Natural Resources Canada, 2004).

1.2 Purpose and Objectives

Before a region can implement the use of alternative fuels in the transportation sector it is necessary to understand, from a systems analysis perspective, the various environmental, social and economic factors that need to be considered when using these fuels. Vehicle fleets are often the first user group targeted to switch to using alternative transportation fuels. Gathering information on the factors that influence vehicle fleet operators' decisions to use alternative fuels provides valuable insight into both potential motivators and deterrents to expanding the market for these fuels. Fleet operator perspectives can be used by promoters and marketers of alternative fuels to facilitate the growth of the alternative fuel market.

Therefore, the purpose of this research was to assess the application of alternative fuels in vehicle fleets in Winnipeg, Manitoba from a fleet operator perspective. The research focused on fuels that were readily available and technically feasible in the region; these include ethanol, natural gas, propane, electricity (gas/electric hybrids included) and biodiesel. The research helped to clarify issues for government decision makers and other parties interested in promoting the alternative fuel industry, so that informed decisions can be made pertaining to the use of alternative fuels in vehicle fleets.

Objectives

The specific objectives of the research were to:

1. Identify the current government policy framework for alternative fuel development in Manitoba; and
2. Identify the current usage of alternative fuels in vehicle fleets in Manitoba; and
3. Establish factors that need to be considered when implementing alternative fuels into vehicle fleets; and
4. Assign values to the factors to assist alternative fuel decision makers in understanding the relative importance of the factors.

1.3 Research Orientation

There were a number of researcher qualifications that facilitated the development of the thesis including knowledge gained through work experience, knowledge of environmental issues and participation in alternative fuel related conferences. .

Since 2002, alternative fuel knowledge, practical experience and contacts with industry and government representatives were acquired as the coordinator for the Red River Valley Clean Cities Coalition Winnipeg Chapter Inc. The coalition is a U.S. Department of Energy program that supports the efforts of local coalitions to build markets for clean, secure alternatives to conventional fuels. More than 4,700 stakeholders, including municipal governments, state, provincial and federal agencies, public and private fleets, fuel providers, industry associations, and vehicle manufacturers and vendors, are

involved in the 80 Clean Cities coalitions working to advance the use of alternative transportation fuels and alternative fuel vehicles across North America, where Winnipeg is the only Canadian City participating in this program.

Understanding of environmental issues was gained during the pursuit of an undergraduate degree in Science, four year major in Environmental Science, and a Masters Degree in Natural Resource Management. Participation and attendance at a number of conferences was undertaken during the research process, including attendance at the Federation of Canadian Municipalities Sustainable Communities National Conference and Trade Show in Ottawa City, Ontario (2004); World Summit on Ethanol for Transportation in Quebec City, Quebec (2003); Province of Manitoba Biofuels conference in Winnipeg, Manitoba (2003); Transportation & and Climate Change in Manitoba Workshop (2003); and the National Clean Cities Conference in Palm Springs (2003).

1.4 Research Limitation

When compared to the U.S. and Europe, Manitoba's and Canada's alternative fuel industry is a relatively new market. As such, information on alternative fuels from a Canadian perspective is not widely available. A lot of the preliminary discussion on vehicle fleet perspectives on alternative fuels presented in the research is from U.S. or international context. Background information on Canadian fleet perspectives comes from Canada's experience with natural gas, and factors from the development of that industry may not be the same as for the development of other fuels such as biodiesel and ethanol. Also, since the industry is relatively immature, new developments in the field

are always occurring. Therefore, factors that may be presented as significant factors during this research may be overcome or may change in a relatively short time span.

1.5 Organization

The thesis is organized into five chapters. Following this chapter background information on alternative fuels, government alternative fuel policies in Manitoba and general fleet operator perspectives of using alternative fuels are considered in Chapter two. Chapter three provides a comprehensive overview of the research approach undertaken to deploy this research. Chapter four presents' results from a survey conducted with vehicle fleets in Winnipeg, and provides insight into what motivates or deters fleets from using alternative fuels. Chapter five is the concluding chapter that provides concluding statements and discussions on the use of alternative fuels in vehicle fleets. Appendix A is an overview on alternative fuels. Appendix B is the questionnaire that was sent to vehicle fleet operators in Winnipeg.

CHAPTER 2

2.0 ALTERNATIVE FUELS- UTILITY, IMPLEMENTATION AND USE

Although there are many types of alternative fuels available on the market, the discussions in this chapter focus on fuels that are technically feasible and available in Winnipeg, Manitoba. More discussion is given to fuels such as ethanol, biodiesel and electric gas hybrids since they are being promoted and/or investigated in Manitoba on a larger scale than other alternative fuels such as natural gas and propane. Fleet operator perspectives on the types of factors that may impact the use of alternative fuels in vehicle fleets are also discussed. Following that discussion, there is an overview on government alternative fuel policies in place in Manitoba.

2.1 Overview of conventional and alternative fuels

Gasoline and diesel fuel used in the transportation sector are made from crude oil that is extracted from the earth. It takes millions of years for plant matter to decompose and produce an extractable source of oil, and as such, oil is a non renewable resource. A large portion of the world's oil deposits were formed more than 150 million years ago (Rifkin, 2002). Extracting oil to produce gasoline and diesel fuel requires significant amounts of energy, largely derived from the burning of fossil fuels. Crude oil (petroleum) is taken out of the ground and transported to an oil refinery, where a number of different types of fuels are produced.

When oil is extracted from the tar sands in Alberta, a significant amount of natural gas and water is used to extract a useable form of oil. The processing also causes the release of a large amount of greenhouse gases (Bolger and Isaacs, 2003). One of the other means in which conventional fuels have an impact on the environment and human health is through motor vehicle pollution. Motor vehicles cause the release of emissions including gases such as Carbon Monoxide, Carbon Dioxide, Nitrogen Oxides, Particulate Matter, other organic carbon compounds (such as hydrocarbons) and other toxic air pollutants such as benzene, 1,3-butadiene, formaldehyde, acetaldehyde and polynuclear aromatic hydrocarbons (Organization for Economic Co-operation and Development, 1995).

The table on the following page lists the environmental issues associated with the release of the vehicle emissions and provides a description of the issue, in addition to the associated health and environmental impacts that the emission cause.

Table 1: Vehicle Emissions, the Environment and Human Health

Environmental Issue	Vehicle Emissions	Description of the Environmental Issue	Environmental and Health Impacts
Smog	Nitrogen Oxides (NOx) Volatile Organic Compounds (VOCs) Particulate Matter (PM)	A mixture of ground level ozone, particulate matter and other pollutants. Note: Ozone is formed when Nitrogen Oxides (NOx) combines with Volatile Organic Compounds (VOC) in sunlight.	Respiratory distress in humans Damage to vegetation May contribute to decline of forests
Human induced Climate Change	Greenhouse Gases: Carbon Dioxide (most significant) Methane Nitrogen Oxides(NOx) Ozone Water Vapour CFCs	The accumulation of heat trapping greenhouse gases in the atmosphere that causes the earth's temperature to increase. Note: Greenhouse gases are emitted by natural sources as well, but many scientists believe that human activity is significantly increasing the rate of climate change.	Changes in regional weather (more intense heat waves) Increase in global mean sea level More severe extreme high temperature events (floods and droughts) Global changes in soil moisture
Acid Rain	Sulfur Dioxide (SO2) Nitrogen Oxides (NOx)	When sulfur dioxide and nitrogen oxide in the atmosphere combine with water they form sulphuric and nitric acids, which travel long distances and are precipitated back to earth as acid rain.	Damage to vegetation Disrupt nutrient cycle of ecosystems Damage to wildlife Human health effects (SO2 has small particulates that affect the lungs)
Stratospheric Ozone Depletion	Chlorofluorocarbons (CFC's) Methyl Bromide Hydrochlorofluorocarbons (HCFC's) Halons Carbon Tetrachloride	The thinning of the ozone layer due to the emissions of gases, such as CFC's and HFCFCs in the atmosphere. The ozone layer protects the earth from the sun's ultraviolet rays.	Increased exposure to ultraviolet radiation
Toxic Air Pollutants	Particulate matter Polycyclic aromatic Hydrocarbons Benzene Aldehydes	Toxic substances, such as particulate matter, polycyclic aromatic hydrocarbons, benzene and aldehydes	Some are suspected carcinogens

Source: Information for this table was compiled from the following sources (Environment Canada, 1997; Environment Canada, 1998; National Round Table on the Environment and the Economy, 1997; Neitzert, 1999; Organization for Economic Co-operation and Development, 1995).

There are a variety of alternative fuels and vehicle technologies that can be used to mitigate vehicular pollution caused by conventional fuels. Alternative fuels and vehicle technologies that are technically feasible and available to fleet operators in Winnipeg, Manitoba include ethanol, biodiesel, electric gas hybrids, natural gas and propane. A profile of each fuel and vehicle technology is included in Appendix A.

Alternative fuels offer environmental benefits over conventional fuels and are promoted in Canada primarily for their ability to reduce greenhouse gas emissions from the transportation sector (Department of Justice Canada, 2003). Canada recently ratified the Kyoto Protocol, which is a policy aimed at reducing greenhouse gas emissions as a means of curbing the impacts of climate change. Canada contributes approximately 2% of the world's greenhouse gases. Even though Canada only contributes 2% of the world's greenhouse gasses per capita, Canada is the second highest producer of greenhouse gases among industrialized nations. Manitoba generates 3% of Canada's total greenhouse gas emissions, with transportation in Manitoba accounting for approximately 30% of greenhouse gas production from industries in the province (Manitoba Transportation and Government Services, 2004a; Manitoba Transportation and Government Services, 2004b). It is important to actualize the actual greenhouse gas reductions from using alternative fuels compared to conventional fuels.

The environmental benefits of alternative fuels vary depending on the fuel. One of the ways to measure the environmental benefits is by using a life cycle analysis approach. The life cycle approach measures all inputs and outputs used to create and use the alternative fuel. This method measures the total costs and benefits of using alternative

fuels compared to conventional fuels, and can clearly identify if there is in fact an environmental benefit to using alternative fuels over conventional fuels. This method can identify the reduction of Carbon Dioxide and other greenhouse gases, illustrate the energy balance of the fuel (to identify whether it takes as much energy to make the fuel as the fuel contains) (Lang, 2001); measure the amount of resources used to make and produce the fuel and measures the air, water and solid waste emissions generated by using the fuel (North Dakota Soybean Council, 2002).

It is important to validate the environmental benefits of alternative fuels to ensure that truly 'cleaner' fuels are being promoted in place of conventional fuels. Uncertainty surrounding the environmental benefits of alternative fuels that are promoted in a region can result in confusion and upset from groups that do not believe the fuels offer benefits over conventional fuel sources. Recently in Manitoba, there was discussion surrounding the environmental benefits of ethanol from a life cycle perspective, with critics from the National Farmers Union claiming that producing and using ethanol causes more environmental damage than using gasoline fuel. The claims from the National Farmers Union were made in 2003, around the same time that the provincial government of Manitoba established an ethanol panel to investigate the potential to expand the ethanol industry. The Farmers Union arguments about ethanol were based on the premise that ethanol fuel made from corn and wheat uses a large amount of water, degrades soil, and causes air pollution because of the intensive amounts of fossil fuels that are used to produce ethanol (Eco-Man, 2003.). A report commissioned by Natural Resources Canada, through an independent consultant, concluded that using Manitoba wheat to

produce and use ethanol fuel generates 50% less greenhouse gas emission than gasoline, and that ethanol made from Manitoba wheat produces more energy than is used to produce it. A fuel blended with 10% ethanol and 90% gasoline (as is typical in Canada) generates 5% fewer emissions (Falding, 2003; The Canadian Press, 2003). The discrepancy between the National Farmer's Union's claims and the Natural Resources Canada claims could be due, in part, to the use of Hydro power for electricity to run ethanol plants in Manitoba, and not fossil fuels, so the overall greenhouse gas emissions from ethanol made in Manitoba is lower than areas that use fossil fuel sources to operate the ethanol plants ((S&T)2 Consultants Inc, 2003).

This type of discrepancy on the benefits of ethanol stresses the importance of ensuring that analysis on the life cycle benefits of an alternative fuel is based on data specific to the region to which the fuel will be used in. Every region has different life cycle balances for ethanol depending on the type of resources used to make ethanol (e.g. corn vs. wheat) and on other factors such as the source of the energy used to run the plant and other processes to produce the fuel.

2.2 Fleet operator considerations

There are many potential factors that could either deter or motivate fleet operators to use alternative fuels in their operations. These factors relate to cost, infrastructure, vehicle and fuel characteristics and other general factors.

2.2.1 Cost

Costs that need to be considered when implementing the use of alternative fuels into vehicles fleets include costs associated with vehicle purchasing, vehicle conversions, vehicle operation and the alternative fuel price.

An alternative fuel vehicle study, undertaken at the University of California, surveyed over 2700 fleets in California and identified that vehicle purchasing and vehicles operating costs are important considerations to fleet operators when considering the use of alternative fuels in vehicle fleets (Nesbitt,1998). High capital costs of alternative fuel vehicles deter fleet operators from purchasing the vehicles, even in cases where the alternative fuel vehicles may offer operational cost savings, such as reduced maintenance costs. The operational cost savings are often overlooked by the fleet operators because of the initial high cost of alternative fuel vehicles.

Perceived high vehicle operating costs are also seen as a deterrent to fleet operators. . Some studies have suggested that fleet operators are more concerned with potential vehicle repair costs and extra refueling time (which results in higher driver wages) compared to any other types of costs (Nesbitt, 1998; Byrne, 2001).

Fuel price is also a cost issue that is important to fleet operators. The price for alternative fuels needs to be equivalent to costs associated with traditional automobiles, or the price will act as an impediment to alternative fuel vehicle purchases (Byrne, 2001). In the case of the natural gas program in the 1980's, the retail taxes were eliminated for natural gas

at both the federal and provincial government levels, which resulted in natural gas being less expensive than gasoline. The lower fuel price for natural gas made the fuel an attractive alternative for fleet operators (Flynn, 2002). While government incentives can be a good way to kick-start an alternative fuel program, they run the risk of having the industry dependent on ongoing subsidization. Therefore, if subsidization were to be removed by the government, the price of the fuel source could become cost prohibitive for fleet operators to continue using the fuel.

2.2.2 Infrastructure

The alternative fuel industry is faced with a variety of infrastructure challenges that will need to be overcome in order to ensure its long term sustainability. Some key infrastructure challenges include fuel source availability, vehicle availability and access to fueling stations.

Ensuring an adequate supply of the alternative fuel ensures that the fuel source will be readily available at fueling stations for fleet operators to use (Byrne, 2001). Mandating an alternative fuel can help to spur local production of the fuel, since fuel producers will have a market for the fuel source if it is required to be sold at local retail stations. As such, a mandate can ensure fuel source availability in a region by attracting fuel producers to create plants to make the fuel source. Manitoba recently passed legislation to mandate E10 in 85% of gasoline stations by 2005 (Government of Manitoba, 2004). As part of this strategy, the government provides incentives to producers to manufacture

ethanol fuel locally (Government of Manitoba, 2004). Shortly after the provincial ethanol mandate was announced, the Minnedosa Ethanol plant in Manitoba announced its plans to expand plant production capacity through the financial assistance of a federal government grant (Janzen, 2004).

Vehicle availability is also a concern for fleet operators who consider using alternative transportation fuels. Low alternative fuel vehicle availability and uncertainty about the future availability of alternative fuel vehicles may deter vehicle operators from using alternative fuels in their fleets. Currently, one of the concerns in the alternative fuel market is the availability of E85 vehicles. In 2004, Daimler Chrysler stopped supplying the Dodge Caravan E85 that was available in previous years. Other manufacturers are discontinuing some of their alternative fuel vehicle lines, including Ford, who is retiring its natural gas and propane vehicles and focusing on producing electric gas hybrids and hydrogen technologies (AltFuels Advisor, 2004).

If fleet operators do not have access to alternative fuel vehicles they cannot use the fuels. If vehicle demand for a particular alternative fuel drops substantially, because of lack of alternative fuel vehicles, investment in alternative fuel infrastructure will diminish and current alternative fuel stations may close. Manufacturers removing an alternative fuel vehicle line from their operations can have a domino effect on the existing and proposed infrastructure for alternative fuels and can lead to its eventual demise. Ford's discontinuation of the natural gas and propane vehicle, has the industry worried that if the vehicles are no longer made, the infrastructure for the fuels will diminish, and that will

have a negative impact for those fleets that are currently relying on the fuel for their vehicles (AltFuels Advisor, 2004).

When developing a market for alternative fuels it is important to establish an appropriate number of refueling stations to support the use of the fuel in question. There is an intrinsic link between fuel availability and vehicle purchase. Fleet operators will not want to purchase alternative fuel vehicles if there are not adequate refueling stations, and fuel suppliers will not want to build alternative fuel stations if there is not adequate vehicle availability or vehicle demand in a region (Flynn, 2002).

For some alternative fuels, there are additional technical considerations that need to be addressed because the storage of alternative fuels can require different fuel infrastructure or storage equipment than required for conventional fuels. Additional resources may need to be deployed by a fuel vendor to investigate fuel equipment compatibility with alternative fuels and/or investment may be required to modify and purchase new equipment to store alternative fuels. Compressed natural gas stations are a well understood technology and have been built throughout Canada in over 100 stations since the 1980's (Flynn, 2002). In contrast, E85 stations are a new type of fueling station being built in Canada and special equipment is required to store the fuel source (Legault, 2003; Natural Resources Canada, 2002a). If alternative fuels are offered through the current network of gasoline and diesel stations, technical changes and modifications to the current infrastructure could be a large cost investment for these corporations; even changes as small as nozzle modifications could represent a large investment and could

potentially become a barrier to the success of an alternative fuel vehicle program (Byrne, 2001).

2.2.3 Fuel and Vehicle Characteristics

Information on fuel and vehicle characteristics for alternative fuels needs to be shared with fleet operators. Educating fleet operators on both the benefits and drawbacks of owning an alternative fuel vehicle is very important (Byrne, 2001). Real environmental benefits and economic benefits should be reported; exaggerated claims about an alternative fuel or alternative fuel vehicle can damage the alternative fuel market. A report prepared by the University of Alberta that describes obstacles encountered with the natural gas industry in Canada states that one of the drawbacks that impeded the development of the natural gas program initiated by the Canadian government in the 1980's was that claims about the benefits of natural gas were exaggerated (Flynn, 2002).

The report specifically states that the economic and environmental statements about natural gas were misleading. Claims made in the 1980s that natural gas was cleaner burning were not accurate in practice since most natural gas vehicles at that time were vehicles that were converted from a gasoline engine that had stoichiometric control to natural gas engines that did not have this type of sophisticated stoichiometric control. Stoichiometric control enables emission systems to function properly. The end result was that natural gas from these conversions were not cleaner burning. The claims that natural gas was cheaper than gasoline were also built on false circumstances. Natural gas was

less expensive than gasoline because of differential taxation, where natural gas road taxes were not levied or were levied at a lower rate than gasoline was levied, making the fuel cheaper through required subsidization. Government rebates for Natural gas vehicle conversions were capped so that \$500 rebates applied to the first 35,000 conversions and the \$50,000 grant per vehicle station applied to the first 125 stations. These grants were offered as a market start up grant and without these subsidies natural gas vehicles were no longer an economically preferred purchase choice (Flynn, 2002).

Performance in cold climates is also an important consideration when implementing alternative fuels in a region like Winnipeg, Manitoba that is characterized by cold winters. Access to information about cold weather vehicle performance is important for fleet operators to receive since some alternative fuels are relatively new to the market in Canada and the profile on fuel performance in cold weather climates is not always well documented, such as the case with biodiesel. In Canada, biodiesel use is limited to a select number of fleets using the fuel. For instance, Toronto Hydro, the City of Brampton, and the City of Guelph are currently using biodiesel at levels of B20 (Paquette, 2004; Topia Energy, 2004; Toronto Hydro, 2004). Experience from fleet operators in Toronto, Brampton and Guelph will be useful to fleet operators in Winnipeg; however, these regions do not experience the same type of cold weather as Winnipeg.

A large scale biodiesel demonstration, called the biobus project, was recently completed in Montreal, where 155 transit buses operated on the fuel for one year. Montreal has similar cold weather seasons to Winnipeg, and as such, the biobus report provides fleet

operators in Winnipeg with an idea on how biodiesel performs in cold weather. In cold weather applications, biodiesel forms small, solid waxy crystals that merge to form larger crystals that plug the fuel filter in vehicles and equipment, which plugs the fuel line (McGraw, 1998). Pure biodiesel starts solidifying at -3 to -12 C, depending on the fats or oils it contains. When biodiesel is blended with petrodiesel, which can flow at temperatures up to -25C, it avoids the cold weather problems of using biodiesel in its pure form. The biobus project results indicate that it is safe to use a 20% blend of biodiesel (to 80% petrodiesel) in very cold weather, such as typified in the BioBus project where temperatures dropped to -30C. However, it should be noted that the buses used in this demonstration were parked in a heated garage overnight during the winter months. One blending tip that is presented in the biobus report is that the petrodiesel should not be at a temperature below the biodiesel cloudpoint during blending. The project also notes that biodiesel made from vegetable oil works better in cold weather conditions than biodiesel made from animal fat (Societe de Transport de Montreal, 2004). Ensuring that this type of information is easily available and communicated to other fleet operators would help fleet operators to make informed decisions about using the fuel effectively.

Fuel consumption differences sometimes exist between alternative fuels and conventional fuels, which could result in higher costs to the fleet operator. Fuel consumption from alternative fuels varies depending on the alternative fuel. If an alternative fuel has lower energy content than conventional fuels, vehicles would be required to refuel more frequently, which both reduce the vehicle driving range and increases fuel costs. An

example of an alternative fuel with a lower energy content than gasoline is E85.

According to *Energuide*, a federal government publication which provides information on energy efficiency of vehicles, E85 vehicles can be 30% less energy efficient than gasoline vehicles, which means they would have to refuel 30% more often than gasoline vehicles. If the fuel cost is not subsidized by the government, the additional fuel cost would be incurred by the fleet operator.

Natural gas and propane vehicles also have a more limited driving range than gasoline or diesel vehicles, and have to be refueled more often (Natural Resources Canada, 2003).

For some fleets this is seen as a deterrent, but to other fleets the driving range limitation is outweighed by the cost savings benefits from using the fuel (Natural Resources Canada, 2003; Red River Valley Clean Cities Coalition, 2002).

2.2.4 Other Factors

There are also other factors that could motivate fleets to use alternative fuels. Studies indicate that both corporate image, environmental concerns and health concerns are cited as top motivators to use alternative transportation fuels (Nesbitt, 1998). Government regulations such as the Kyoto Protocol are another motivator for fleets to use alternative fuels. The Kyoto Protocol was ratified by Canada and requires that Canadian greenhouse gas emissions are reduced. Other government regulations also act as motivators to use alternative fuels, such as the federal government's Alternative Fuels Act. The act has changed the purchasing behavior for federal fleets. The alternative fuel act was

developed in 1995 as a means to increase the use of alternative fuels by federal government departments (Department of Justice Canada, 2003).

2.3 Alternative Fuel Policies in Manitoba

Currently, the provincial government involvement in developing alternative fuel policy is more significant than the municipal government's policy development. The provincial government's larger role in alternative fuel policy development is appropriate since matters concerning air quality are a provincial jurisdiction. While provincial government's have policies on alternative fuels, municipal governments do not, however municipal government's do have policy documents that address the issue of air quality and present alternative fuels as one means of committing to improving air quality. The following section highlights the alternative fuel policies of the respective governments.

2.3.1 Provincial Government Policies on Alternative Fuels

The Province of Manitoba's energy policy focuses on developing clean, renewable energy sources that are readily available in Manitoba. The provincial government has a number of strategies for individual alternative fuels such as ethanol, hydrogen and biodiesel. There is no current document in circulation that speaks to the development of the natural gas, propane or electric/hybrid electric vehicles industry in Manitoba (Kraynyk, 2004; Zdan, 2004).

Ethanol Strategy

The ethanol strategy is the provincial government's most developed alternative transportation fuel policy. In 2003, the provincial government passed legislation to mandate the use of E10 in 85% of gasoline stations in Manitoba by September 2005 (Janzen, 2004). The process that led to the E10 mandate began in 2002 when the provincial government expressed their interest in investigating the potential development of the ethanol industry in Manitoba (Province of Manitoba- Manitoba Energy Development Initiative, 2002a). In July, 2002, the Province of Manitoba established the 'Ethanol Advisory Panel', to undertake public and industry consultations throughout Manitoba to prepare a comprehensive report, listing a set of recommendations that would maximize the social, environmental and economic benefits associated with introducing a mandate for ethanol blended fuels in Manitoba (Province of Manitoba- Manitoba Energy Development Initiative, 2002a). The 32 recommendations developed by the ethanol advisory panel were adopted by the Province of Manitoba in 2003. Key panel recommendations included:

- Mandating E10 by as early as 2005. From an environmental perspective, the mandate is said to reduce the consumption of 143 million litres of gasoline, which, in terms of reduction in greenhouse gases, is equivalent to taking 10,000 vehicles off the road in Manitoba (Manitoba Energy Development Initiative, 2002b).

- Providing financial incentives to fuel users, equating to approximately 1.5 C/L of gasoline that is blended with E10. This is a declining tax preference that will be in place from 2005-2013. This is equivalent to approximately \$150 million dollars in subsidy by the provincial government to ensure that the pump price of ethanol is equivalent to that of gasoline.
- Researching and developing feedstock and co-products, to which the province has now set up a working group with Saskatchewan so that both jurisdictions can combine their financial and technical expertise to investigate feedstock and co-product opportunities.
- Establishing an ethanol office to co-ordinate development of the ethanol industry and local economic opportunities.
- Promoting public awareness and education on the environmental benefits of increased ethanol use (Province of Manitoba- Manitoba Energy Development Initiative, 2002a).

While the ethanol strategy is the most comprehensive alternative fuel strategy, it is not targeted at vehicle fleets, but at developing local economic opportunities and ensuring environmentally sustainable transport. The lack of a focus on fleets in the ethanol strategy is likely because the strategy focuses on E10, which is a low level fuel blend that is well understood and used by many vehicles in Manitoba, Canada and the U.S. It is more suitable to target vehicle fleets are targeted more when the fuel is a new technology whose performance has not been extensively documented.

Biodiesel Strategy

The provincial government does not have a policy document on biodiesel but is currently investigating the opportunities for biodiesel development in the province. A similar process as was enacted to investigate the ethanol opportunities has been established to investigate biodiesel.

As with the Ethanol Advisory Panel, the Province of Manitoba has established a Bio-Diesel Advisory Council. The council was established in November of 2003 and is charged with the task of investigating the potential for biodiesel development in Manitoba. The purpose of investigating biodiesel is both to support the government's commitment to reducing greenhouse gas emissions and to diversifying the rural economy. The council is co-chaired by the Canadian Canola Growers Association and the Manitoba Trucking Association. The other members have a cross section of backgrounds including transportation, agriculture and environment. The council works together to investigate all facets of the biodiesel industry and provides the Provincial Government with a report outlining the council's recommendations.

Hydrogen Strategy

The province has a strategy to develop the hydrogen industry in Manitoba. Since this study does not focus on hydrogen fuel, details of that strategy will not be discussed here,

however, it is important to note that this activity is going on along with other alternative fuels strategies.

Kyoto and Beyond- A Climate Change Action Plan

In 2002, the provincial government released a climate change action plan that supports the use of alternative fuels as a means of reducing greenhouse gases from the transportation sector. Kyoto and Beyond, the Province's action plan to meet and exceed Canada's Kyoto commitments, states that both the mandating of ethanol and use of vehicles like the hybrid gas electric vehicles are ways in which to reduce impacts of climate change. The report states that alternative fuels will help in mitigating the effect of climate change by promoting technological development and innovation, such as hydrogen fuel demonstrations. The climate change action plan does not specifically cite that vehicle fleets are the recommended venue for alternative fuel use, but provides examples of vehicle fleets, such as Manitoba Conservation that have alternative fuel vehicles (Province of Manitoba, 2002).

2.3.2 Municipal Government Policies Relating to Alternative Fuels

The municipal government has two policy documents that pertain to air pollution. One is Plan Winnipeg and the other is the Environmental Strategy.

Plan Winnipeg - 2020 Vision

Plan Winnipeg is the City of Winnipeg's long term policy plan that provides the foundation for all civic activity and whose principles are intended to be incorporated in City documents, budgets, public works, programs or developments. Plan Winnipeg was adopted by City Council in 2001. This policy document does not speak directly to the implementation of alternative transportation fuels but does provide direction on how the City should move forward with respect to supporting sustainable transportation options. The policy document provides guidelines as they relate to transportation policy, which include the following recommended actions:

- Reduce greenhouse gases
- Encourage non-motorized transport such as biking and walking
- Support capital investment in infrastructure that support non-motorized transport
- Provide alternatives to single occupant auto use
- Provide incentives to reduce reliance on the automobile
- Increase transit rider-ship
- Invest in rapid transit corridor development
- Implement an energy management plan to improve energy efficiency in a number of areas including city-operated vehicles (The City of Winnipeg, 2004).

In 2001, Winnipeg City Council created the Civic Environmental Committee to provide advice on sustainability issues, as they pertain to the environment and urban issues. One of the first tasks that the Committee undertook was the development of an Environmental Strategy that could provide Council with guidance on how to address environmental and

urban sustainability issues. The environmental strategy was developed to be consistent with the principles and vision of Plan Winnipeg, but has not yet been adopted by City Council (Winnipeg Civic Environmental Committee, 2004).

Sustainable Winnipeg: A Comprehensive Environmental Strategy

In the Environmental Strategy the use of alternative fuels in vehicle fleets is presented as a key strategy to implement the policy objective of mitigating the City of Winnipeg's contribution to air pollution. The alternative fuel strategy presented in this policy document is to integrate the use of gas/electric hybrid vehicles in the existing City of Winnipeg fleet and explore the use of alternative fuels for fleet vehicles. The strategy's recommendation for alternative fuels represents only a small portion of the entire strategy. The bulk of recommendations in the environmental strategy are aimed at promoting sustainable transportation through reducing the number of vehicles on the road and not so much on promoting ways to reduce emissions from vehicles (Winnipeg Civic Environmental Committee, 2004).

2.4 Chapter Summary

There are a variety of alternative fuels and technologies currently available for use in Winnipeg, Manitoba including ethanol, biodiesel, natural gas, propane and electric gas hybrid vehicles. Ethanol, biodiesel and electric gas hybrids are being more heavily promoted than propane and natural gas in Winnipeg. All alternative fuels are said to

offer environmental benefits over conventional fuels. Currently in Canada alternative fuels are largely being promoted on the basis of their ability to reduce greenhouse gases from the transportation sector, which can help to achieve targets set out in the Kyoto Protocol. Some alternative fuels, such as ethanol and biodiesel, also provide additional benefits to greenhouse gas reductions, in that they are renewable, and can be used in the future to displace the use of conventional fuel. The United States is largely promoting alternative fuels on the basis that their renewable qualities can help to ensure energy security in the region by creating the sources locally (U.S. Department of Energy Efficiency and Renewable Energy, 2004).

While the use of alternative fuels may offer environmental and other benefits, there are a number of factors that fleet operators have to consider before implementing the use of these fuels fleet wide. Through conducting a document review on fleet operator perspectives of using alternative fuels in fleets, a list of factors were identified, including, cost, infrastructure requirements, vehicle and fuel characteristics and other general factors. Cost considerations are costs associated with vehicle purchasing, vehicle conversion, vehicle operation and alternative fuel price. Infrastructure challenges include fuel availability at refueling stations, fuel storage equipment, fuel source availability and vehicle availability. Some vehicle and fuel characteristics that need to be considered when implementing the use of alternative fuel in vehicle fleets are cold weather issues, vehicle maintenance issues and fuel consumption. Corporate image and environmental and health concerns are motivators for fleet operators to use alternative transportation fuels. Finally, government regulations are another motivator for fleets to use alternative

fuels. The variety of factors that could motivate or deter fleet operators from using alternative is extensive and once identified can be used to develop appropriate approaches to increase the use of alternative fuels in vehicle fleets.

One of the other important elements to consider when implementing the use of alternative fuels in a region is the type of support local governments provide for the promotion of the fuels. In Manitoba, alternative fuel policies at the provincial level do not have a distinct focus on vehicle fleets, but focus on exploring the development of the alternative fuel industry for economic and environmental benefits. This is largely because the only completed policy document on alternative fuels focuses on an ethanol fuel source that is already well established in Manitoba and where vehicle performance has already been clearly demonstrated. For fuels like biodiesel, which the province is currently investigating, there may be more of a vehicle fleet focus since biodiesel vehicle performance still needs to be demonstrated in Manitoba.

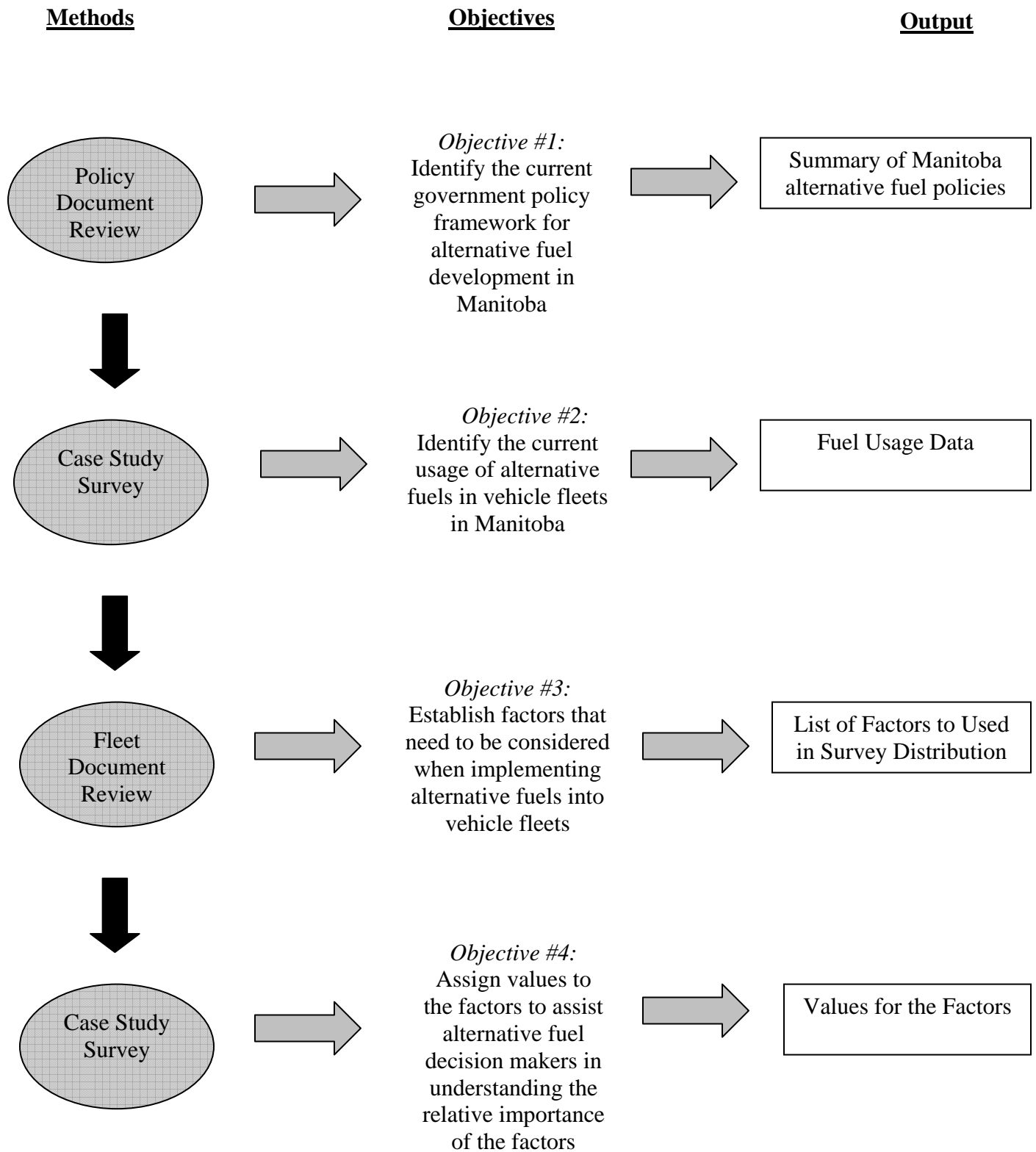
Municipal government policy is more concerned with making the transportation system more sustainable by employing strategies that focus on encouraging communal transportation such as public transit or non-motorized transportation such as biking and walking, rather than finding ways to make vehicles more efficient, through means such as alternative fuels.

CHAPTER 3

3.0 RESEARCH APPROACH

Multiple approaches were taken to conduct the research presented in this thesis. The first step in the research process was to conduct a literature review on alternative fuels to document background information on each fuel. Two other methods were employed to gather research data, including document reviews and survey distribution. The first document review was a fleet document review which helped to identify some of the key factors of implementing alternative fuels into vehicles fleets. The second document review was a review of local government alternative fuel policies in Manitoba. After compiling information in the document reviews, a survey was distributed to select vehicle fleets in Winnipeg. The Winnipeg case study served to identify the level of importance fleet operators in Winnipeg place on the factors of implementing alternative fuels in fleets. The final step in the research was to discuss the research conclusions. The research approach is summarized in figure 1 on the following page. Each method is described in detail in this chapter.

Figure 1: Research Approach



3.1 Literature Review

The literature review provided a broad overview on alternative fuel options. Alternative fuels included in the literature review were readily available and technically feasible fuels for use in fleets in Winnipeg, Manitoba. The purpose of conducting the literature review was to identify each fuel type, identify how the fuel is made, identify the types of vehicles that can use the fuel and the fuel availability and fuel storage requirements. The literature review consisted of a review of primarily Canadian and U.S. government websites, reports, thesis dissertations, books, pamphlets and other like publications.

3.2 Policy Document Review

Information for the policy document review was compiled through personal communications with representatives in the provincial and municipal governments and a through a review of publications relating to government policy on alternative fuels. The purpose of conducting the policy document review was to gain an understanding of the policies in place in Manitoba that pertained to alternative fuels, particularly anything regarding use in fleets.

3.3 Fleet Document Review

A fleet document review was conducted to identify the factors to be considered when using alternative fuels in vehicle fleets. The fleet document review was a targeted review

of publications that presented fleet perspectives on using alternative fuels. Publications that were reviewed included journal articles, newspaper articles, pamphlets, websites, reports and other like publications. Some additional information was compiled through personal communications with representatives involved in management of municipal and provincial fleets, email correspondences, participation in alternative fuel site tours, and general information gained through work related discussions with fleet managers in Manitoba. The information gathered through these venues was used to identify some initial factors that may be relevant to Winnipeg fleet operators.

The research focused on identifying the factors that could motivate or deter fleet operators from using alternative fuels. Some transportation analysts and environmental psychologists involved in assessing how to effect sustainable behaviour change and draft effective policies and programs to effect that change, emphasize the importance of identifying factors of importance to the population that is being targeted for change, before implementing the change. Factors include both barriers and benefits to a particular behavior change (Manheim, 1979; McKenzie-Mohr, 1999). As such, all potential factors of importance to fleet operators were identified in the fleet document review.

3.4 Case Study – Survey Distribution

A case study of fleet operator opinions on the use of alternative fuels in Manitoba vehicle fleets was conducted by developing and analyzing a survey that was distributed to vehicle

fleet operators in Winnipeg, Manitoba. The sample population, survey purpose, survey approach and how the survey was analyzed are discussed in the following four sections.

3.41 Sample Population

Vehicle fleets are often the first user group targeted to switch to using alternative fuels, and as such they were the sample population for the survey. Industry and government fleets were included in the survey. The selection of industry categories to survey was based on a set of defined criteria. The criteria list and justification for using the criteria are described below.

Criteria #1- Vehicle fleets operational in Winnipeg, Manitoba

Fleet operators with vehicle fleets operational in Winnipeg were included in the survey distribution for a number of reasons. The primary reason was to gather primary data from Winnipeg, so that a new set of data on the use of alternative fuels could be developed, since there is not a large amount of data from a Canadian perspective relating to alternative fuels in vehicle fleets. Winnipeg fleets were surveyed because Winnipeg is the economic center of Manitoba, with 644,500 people residing in the City of Winnipeg as of 2003 (City of Winnipeg, 2004). Sixty percent of residents reside in Winnipeg, of the total provincial population of 1,162,800 (Destination Winnipeg, 2004a).

Transportation is one of the key industries in Winnipeg and the City is a major transportation hub for the shipment of goods across Canada and into the U.S., because of

its central location in North America (Destination Winnipeg, 2004b). If companies explicitly identified that they did not have head offices in Winnipeg and/or did not have a fleet operator in Winnipeg who could make decisions pertaining to the fuel used in the vehicles, these fleets were excluded from the survey process. Additionally, focusing the survey on Winnipeg provided a geographic boundary for the survey distribution.

Criteria #2- Rely on transportation service as the primary source of income

Vehicle fleets are often targeted for the adoption of alternative fuels. These fleets generally use large amounts of fuel annually and rely on transportation services as the primary source of income. If vehicle fleets switched from using conventional fuels to alternative fuels, the switch could have a significant impact on reducing vehicular emissions and be pivotal in developing the alternative fuel market.

Criteria #3- Are assumed to follow predictable routes and/or have centralized fueling

Vehicle fleets with predictable routes and/or centralized fueling are often targeted for the adoption of alternative fuels. Fleets with predictable routes often track their fuel usage and know what how far their vehicles travel daily. For this reason, they are able to make informed decisions about switching to alternative fuels where factors such as vehicle range and fuel costs are issues. It is further assumed that fleets with centralized fueling (i.e. refuel at their own private fueling station) could make an easy switch to alternative fuels by incorporating the use of alternative fuels at their existing fueling stations, thereby

eliminating the need to wait until there is an adequate alternative fuel supply at retail fueling stations.

Criteria #4- Have an employee like a fleet manager/fleet operator or other representative, who makes or can influence decisions about the fuel source used in fleet vehicles.

The criteria to have a fleet manager/fleet operator or other representative who influences fuel purchasing decisions was used so that the opinions of representatives who could influence fuel related decisions for fleets were consulted. Targeting these types of representatives provides a more valuable data set than, for example, individual owner operators within a business since fleet managers and other like reps manage an entire vehicle fleet. Fleet managers can be decision makers pertaining to the use of alternative fuels in their fleets and are anticipated to have long term experience with managing vehicle fleets, being knowledgeable on the impacts of introducing a new fuel source like alternative fuels.

Fleets that were sent surveys included:

- Trucking Industry
- Messengers and Couriers
- Taxis
- Bus Lines
- Provincial Government Fleets
- Municipal Government Fleets

Industry fleets were included in the survey distribution. Municipal and provincial government fleets were also included in the survey so that comparisons could be made between opinions of private industry and governments as it pertains to decisions to use alternative fuels in vehicle fleets.

The way in which trucking companies were selected for inclusion in the survey distribution were by obtaining company contact information through the 2002 business directory and 2002 yellow pages. From there, the list of trucking companies to be surveyed were sent to the Manitoba Trucking Association for verification to ensure that all key players in the industry were included in the distribution of the surveys.

Messenger and Courier companies were selected the same way as trucking companies, through the 2002 business directory and 2002 yellow pages. The companies listed in these sources are well known and available to the general public as service providers to move small goods within the limits of Winnipeg.

3.42 Survey Purpose

A survey was distributed to vehicle fleet operators in Winnipeg to identify fleet operator opinions on the use of alternative fuels in vehicle fleets. A list of factors identified through the survey included:

- Use of alternative fuels
- Access to information on alternative fuels
- Consideration of using alternative fuels in fleets

- Motivators and Deterrents to using alternative fuels in fleets

The survey questionnaire is in Appendix B.

The central part of the survey was the identification of what fleet operators thought were the motivators and deterrents to using alternative fuels in their fleets. Through the fleet document review, a list was compiled to identify an initial list of factors that need to be considered when using alternative fuel in vehicle fleets, based on opinions from fleets throughout Canada, the U.S. and other regions. The questions included in the survey on motivators and deterrents were developed using the factor list compiled through the fleet document review and were presented to Winnipeg fleet operators to identify the level of importance they placed on these factors, essentially verifying whether the factors identified in the fleet document review were relevant to Winnipeg fleets. The way in which this was verified was by asking survey candidates to rank the level of importance they would assign to the motivators or deterrents. For both the motivator and deterrent question, there was a list of 10 potential motivators that fleets were asked to rank on a scale of 1 to 10, where 1 represented the highest motivator/deterrent and 10 represented the lowest motivator/deterrent. There was also space provided for fleets to identify any other motivators or deterrents that were not on the list supplied.

3.43 Survey approach

Surveys were distributed to private industry by mail and to government by email. Within the initial survey distribution, a cover letter was included to fleet operators indicating the purpose and benefits of participating in the research, as well as providing some background on the research purpose. For three months following the survey distribution, the researcher conducted follow up calls to fleets. Part of the follow up call process was to verify that the initial population surveyed met the specified criteria to complete the surveys so that information obtained through the surveys was consistent with the research objectives.

3.44 Survey Analysis

A software program called Statistical Package for the Social Sciences (SPSS) was used to input and analyze the survey responses. SPSS is a recognized software package used to analyze social science data gathered through various methods of research. The analysis conducted for this survey consisted of descriptive qualitative statistics such as frequency and means. Two components in the analysis process that require explanation are how the response rate was calculated and how the value for motivators and deterrents to using alternative fuels was analyzed.

The response rate was calculated using an adjusted population size. During the follow up calls, after the initial survey distribution, it became apparent that 53 out of the original

170 organizations surveyed did not fit the intended population, and as such, they were not included in the survey process. This meant that 31% of the initial population could not be included in the survey process. For this reason, when computing the response rate for surveys, an adjusted population was calculated, to take into account the 53 fleets that did not represent the targeted population.

To calculate the level of importance that fleets placed on motivators and deterrents, the researcher calculated means to measure the level of importance that fleets placed on each factor. The numbers presented in the tables and graphs in Chapter four, represent the means for a scale where number 1 is the least important motivator and 10 is the most important motivator. For the actual survey distribution, the scale had 1 as the highest motivator and 10 as the lowest motivator, but for purposes of creating graphs that illustrate which motivator is the highest importance, the researcher adjusted the scale so that the graphs would make logical sense from a visual perspective. All other analysis in the case study section relating to the survey was done using SPSS tools.

3.5 Conclusions and Discussions

The conclusions and discussions section involved compiling all of the information gained throughout the research process into a concise overview of the factors that need to be considered when implementing alternative fuels into vehicle fleets. For the development of the conclusions, information compiled from the policy document review, fleet document review and case study were assessed and presented in a fashion that could be

used easily by decision makers such as government policy makers or alternative fuel promoters to help understand the issues facing the development of the alternative fuel industry.

CHAPTER 4

4.0 ALTERNATIVE FUEL USE IN VEHICLE FLEETS IN WINNIPEG, MB

Private industry and government fleet operators in Winnipeg, Manitoba were surveyed to determine their opinions about the use of alternative fuels in vehicle fleets. The survey investigated factors such as the use of alternative fuels in fleets, fleet operators' access to information on alternative fuels, if fleet operators considered using alternative fuels in fleets and fleet operators' opinions on motivators and deterrents to using alternative fuels in fleets. A copy of the survey is provided in Appendix B.

As outlined in Chapter 3, the fleets that were sent surveys included:

- Messengers and Couriers
- Trucking
- Provincial Government fleets
- Municipal Government fleets
- Taxis
- Bus Lines

4.1 Survey response rate

Surveys received from trucking, messenger and couriers, municipal government and provincial government fleets were included in the survey analysis. Taxis, bus lines and schools were excluded from the survey analysis because of very low response rates. For

example, only one survey was received for taxis and bus lines respectively. Low response rates for bus lines and taxis may have been due the fact that it was difficult to get in touch with fleet managers and/or representatives responsible for fleet decisions for taxi companies and bus lines. Low response rates for schools may have occurred because follow up calls were conducted during the summer months, when key staff could not be spoken to since most were on holidays.

Messenger and courier response rate was 28% (9 respondents), trucking response rate was 21% (15 respondents), and municipal (3 respondents) and provincial (6 respondents) response rates were both 60%. The total response rate was 28% with 33 surveys completed by fleet operators, all of which were included in the survey analysis.

The remainder of this chapter provides a profile of all fleets surveyed and detail on trends for all organizations surveyed, beginning with the use of alternative fuels in fleets, followed by factors that would motivate or deter fleet operators from using alternative fuels.

4.2 Profile of fleets surveyed

4.21 Messengers and Couriers

There is limited information available on the messenger and courier companies in operation in Winnipeg. In 2001, the courier industry employed 604 people in Manitoba,

and the estimated number of carriers in the population was 1,018 (Statistics Canada, 2004a; Transport Institute- University of Manitoba, 2003). Messengers and couriers can be defined as an industry sector that is “primarily engaged in providing national/ international courier delivery services as well as messenger and delivery services of small parcels within a single urban area. The type and size of parcels carried, the speed of delivery and premium services such as guaranteed delivery and track and trace service, are the main features of their activities” (Statistics Canada, 2004b). For the purpose of this research, surveys were sent to courier companies that provide delivery of goods in Winnipeg, Manitoba.

4.2.2 Trucking

Trucking is an extremely important industry to Manitoba both economically and socially. Truck driving is stated to be the most frequently cited occupation by Canadian men, with over 255,990 Canadians employed as truck drivers (Manitoba Trucking Association, 2004). Goods movement in Manitoba is highly dependent on the trucking industry, with 95% of inter-provincial goods movement reliant on trucks (Manitoba Trucking Association, 2004). An estimated \$1.18 billion dollars is contributed to Manitoba’s Gross Domestic Product (GDP), through both direct and indirect services from the for-hire trucking industry in the province (Manitoba Trucking Association, 2004). The trucking industry is also pivotal to sustaining export trade to U.S. trading partners. Daily truck trips traverse through the mid-continent trade corridor, delivering goods to a market of 100 million people, with an average of 1,000 trucks crossing the Manitoba-U.S. border

every day (Manitoba Trade and Investment, 2003). In the last ten years, the Manitoban Canada/US trans-border truck movements have increased by 9%, which makes Manitoba the fastest growing Canadian provinces in terms of truck trips across the border (Manitoba Transportation and Government Services, 2004a).

Two of Canada's ten largest for-hire trucking organizations are stationed in Winnipeg, and there are a large number of other trucking companies in Manitoba (Manitoba Industry Trade & Mines, 2004). Some statistics indicate that there are 525 for hire motor carriers who operate in Manitoba and a further 2,000 carriers that operate in or through Manitoba (Manitoba Industry Trade & Mines, 2004). Other studies provide similar estimates on the size of the trucking industry, but maintain that the exact number of firms in operation in Manitoba is difficult to assess since an accurate list of the companies operating in the region is hard to acquire (Transport Institute- University of Manitoba, 2000).

4.2.3 Government- Municipal and Provincial

Both municipal and provincial government fleet operators were surveyed. Federal government fleets that operate in Winnipeg were not surveyed because the federal government is involved in different types of alternative fuel promotion and programs than provincial and municipal fleets, such as the federal government's Alternative Fuels Act. This type of federal directive that requires federal fleets to use alternative fuels does not exist for either provincial or municipal fleets. Also, in some instances, the federal

government provides subsidies to federal fleet departments to use specific alternative fuels in fleets, where the provincial and municipal governments do not offer similar incentives for their departments.

A large portion of the provincial vehicle fleet is managed by the Fleet Vehicles Agency, which leases vehicles to provincial departments. The Fleet Vehicles Agency operates as a Special Operating agency, which is an arms length organization from the province. The Fleet Vehicles Agency manages approximately 2600 vehicles primarily for provincial departments, but also for federal fleets, municipalities, crown corporations, school divisions and non-for profit agencies (Fleet Vehicles Agency-Province of Manitoba, 2004). Surveys were sent out to all provincial departments that are managed through the Fleet Vehicles Agency, in addition to being sent to other key operators in Winnipeg fleets that are Crown Corporations, not managed through Fleet Vehicles Agency. One key provincial department that was not included in the research process was the Mechanical Equipment Services Branch, the provincial department responsible for the management of 2,300 pieces of heavy equipment. This was realized after the survey had been distributed and analyzed. Presentation of survey results for provincial surveys includes responses from Fleet Vehicles Agency combined with responses from Crown Corporations.

The bulk of municipal vehicles are also managed through a Special Operating Agency called the Fleet Management Agency, which is a branch of the municipal government. The Fleet Management Agency manages a fleet of approximately 1300 vehicles. Surveys

were sent to all municipal departments that manage their vehicles through the Fleet Management Agency, in addition to other key municipal fleet operators that are not managed through the Fleet Management Agency. The provincial and municipal departments and publicly funded customers that lease or purchase their vehicles through provincial and municipal fleet agencies would have the ultimate decision as to what type of vehicle and fuel is used in the vehicles; however, the agency itself could play a role in encouraging the use of other fuel sources and/or the purchase of new vehicles at the right time of the vehicle life cycle (Chartrand, 2004; Lupien, 2004).

The provincial government vehicles refuel primarily at retail fueling stations throughout the province, while municipal vehicle fleets refuel at privately owned City of Winnipeg fueling sites. The provincial fleet, managed by the Fleet Vehicles Agency, is comprised of light duty vehicles. The heavy duty vehicles and equipment is managed by the Mechanical Equipment services branch, where the heavy duty vehicles were not included in the survey distribution. The City of Winnipeg's fleet is made up of an equal split of heavy duty and light duty vehicles (Chartrand, Andy, 2004; Lupien, Yvan, 2004).

4.3 Fleet Size

The number of vehicles in each fleet that responded to the survey varied from fleets that had one vehicle to fleets that had twenty six hundred vehicles, as such, opinions captured in the survey come from a cross section of fleet sizes. Of the total 33 surveys that were received, there were eleven fleets with 1-100 vehicles, six fleets with 100-500 vehicles,

three fleets with 500-1000 vehicles, three fleets with over 2000 vehicles and ten fleets that did not disclose the number of vehicles in their fleet.

4.4 Use of alternative fuels in fleets

Of all of the fleets surveyed there was a strong trend indicating that the majority of fleets do not use alternative fuels. Only 24% of all fleet operators surveyed indicated that they use alternative fuels in some capacity in their fleet operations. This represents 8 out of 33 fleet operators who cited that they use alternative fuels in some capacity in their fleets.

Government fleet operators cited using alternative fuels more than industry fleet operators.

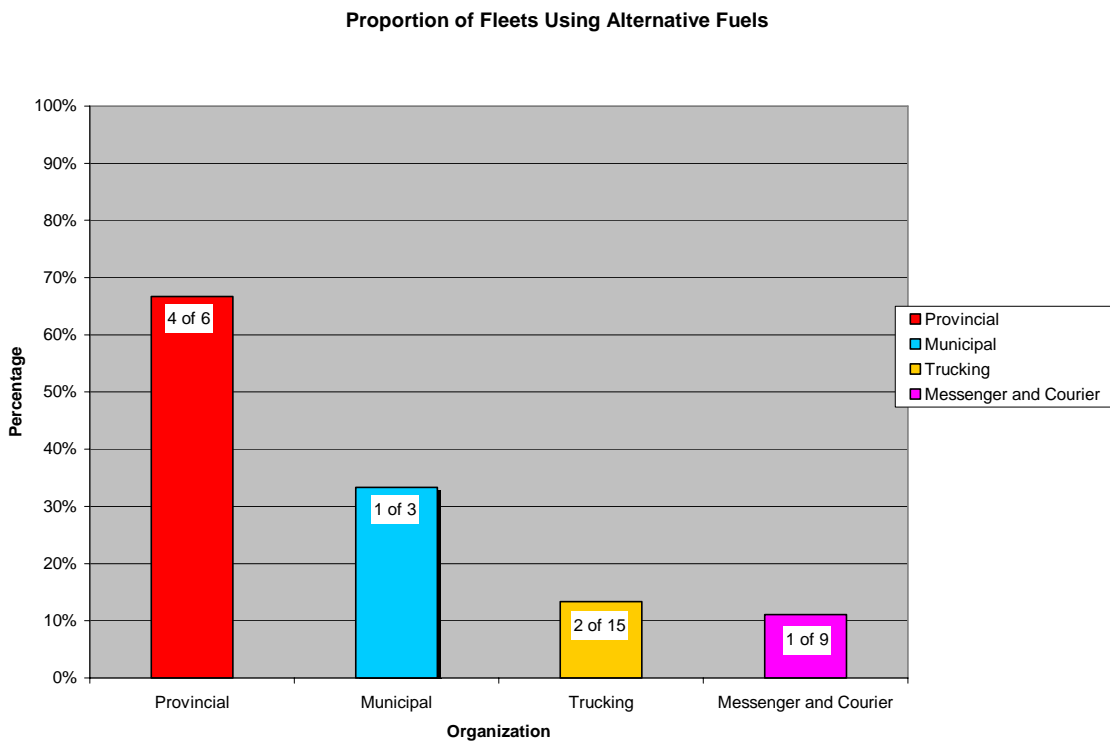


Figure 2: Proportion of Fleets Using Alternative Fuels

The use of the alternative fuels in fleets represented only a small portion relative to the size of the entire fleet. Of the fleets surveyed, the proportion of alternative fuels to fleet size was less than 3% (with the exception of one fleet that had 2 out of its 3 vehicles operating on alternative fuels). Fleet operators were also asked whether they had considered using alternative fuels in their fleets. A much higher proportion of government fleets operators have considered using alternative fuels in their fleets than industry fleet operators.

The type of alternative fuel most commonly used by all fleet operators was E10, which is offered at 23 stations in Manitoba. Other fuel sources and vehicle technologies used are propane and hybrid electric vehicles. Fleet operators using propane indicated that the fuel is used in vehicles that are not the standard vehicle for the fleet operations. For instance propane is used in forklifts in some trucking companies. Fleet operators using gasoline electric hybrid vehicles all stated that the vehicles are still in the evaluation period.

4.5 Access to current information on alternative fuels

The survey asked fleet operators to indicate whether they have adequate access to current information on alternative fuels to decide which fuel type is most suitable for their respective operations. A large percent of fleets surveyed indicated that they did not have adequate information on alternative fuels. Of all fleets surveyed only 36% of fleet operators (12 of 33) felt they had adequate access to information on alternative fuels.

Government fleets cited having significantly more access to information on alternative fuel compared to industry.

The graph below illustrates that fleet operators with more information on alternative fuels will be more likely to use the fuels in their fleets.

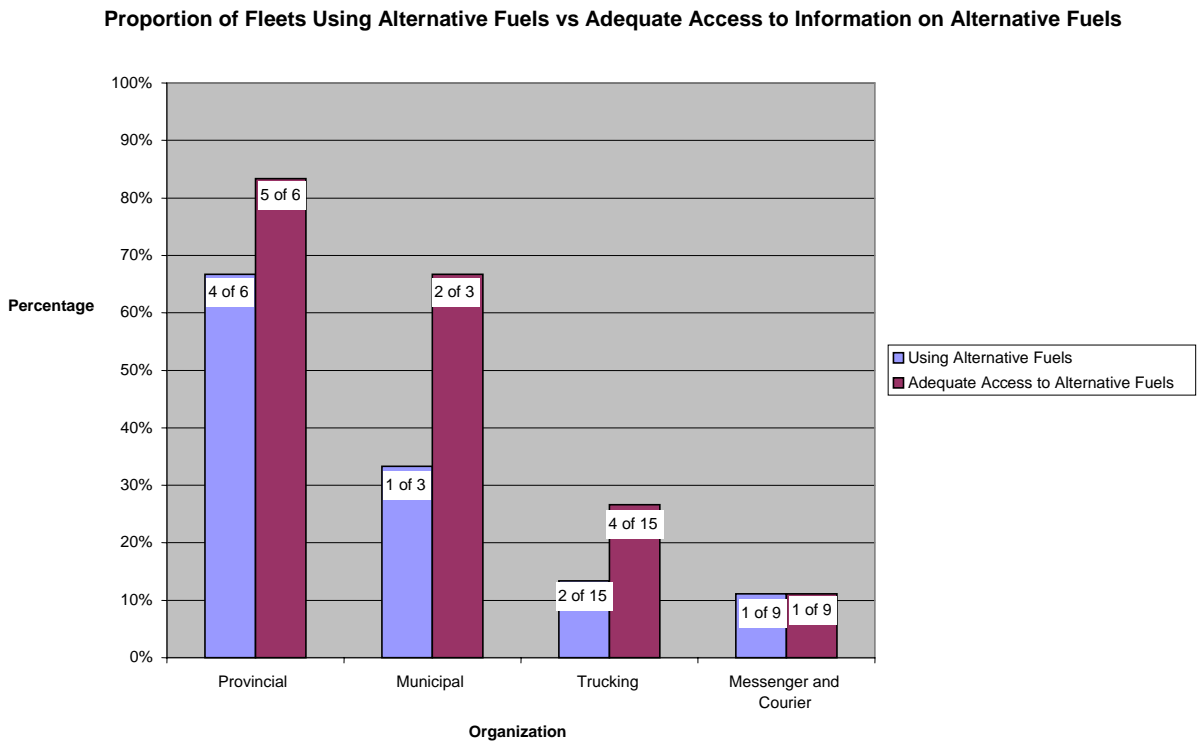


Figure 3: Proportion of Fleets Using Alternative Fuels vs. Access to Information on Alternative Fuels

4.6 Motivators- What motivates fleets to use alternative fuels?

The following section provides insight into what motivates fleet operators to use alternative fuels in their fleets. The survey that was sent to fleet operators provided them

with a list of 10 potential factors that could motivate them to use alternative fuels. Fleet operators were asked to rank each potential motivator. There was also space provided for fleet operators to identify any other motivators that were not on the list supplied. These additional motivators were not included in the analysis, but a list of ‘other’ motivators identified in the survey responses is provided at the end of this section.

The numbers presented in the tables and graphs to follow represent the mean number that fleet operators ranked for each potential motivator. For this scale, number 1 is the least important motivator and 10 is the most important. Please note: for the actual survey distribution, the scale had 1 as the highest motivator and 10 as the lowest motivator, but for purposes of creating graphs that illustrate which motivator is the highest importance, the researcher adjusted the scale so that the graphs would make logical sense from a visual perspective (see Chapter 3, Research Approach for further details).

4.6.1 Messenger and Couriers

In order of importance, the messenger and courier fleets listed following factors as the top 3 motivators to use alternative fuels in their fleet: fuel price, fuel consumption and economic incentives.

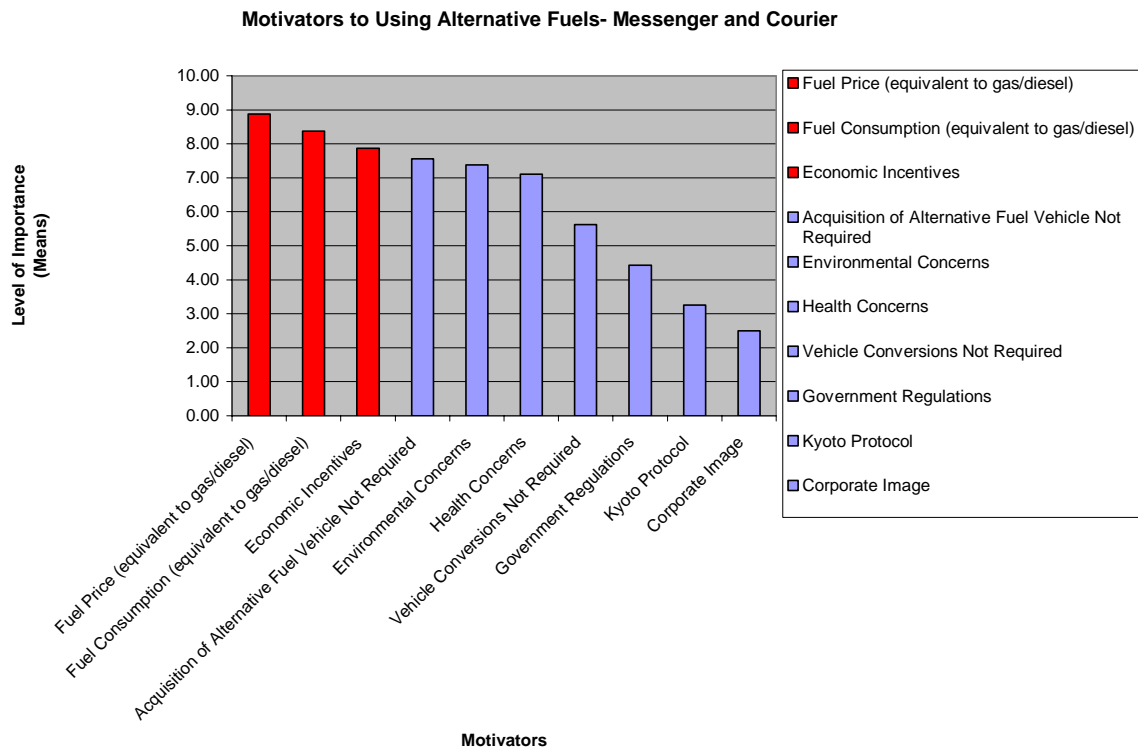


Figure 4: Top 3 motivators to Using Alternative Fuels (Messenger and Couriers)

The top three motivators all related to cost. Other messenger and courier motivators that are high priority (above a 6 on the ranking scale) related to not having to purchase a new vehicle, concern for the environment and concern for human health.

4.6.2 Trucking

In order of importance, trucking fleets listed the following factors as the top 3 motivators to using alternative fuels in their fleet: fuel price, fuel consumption and economic incentives.

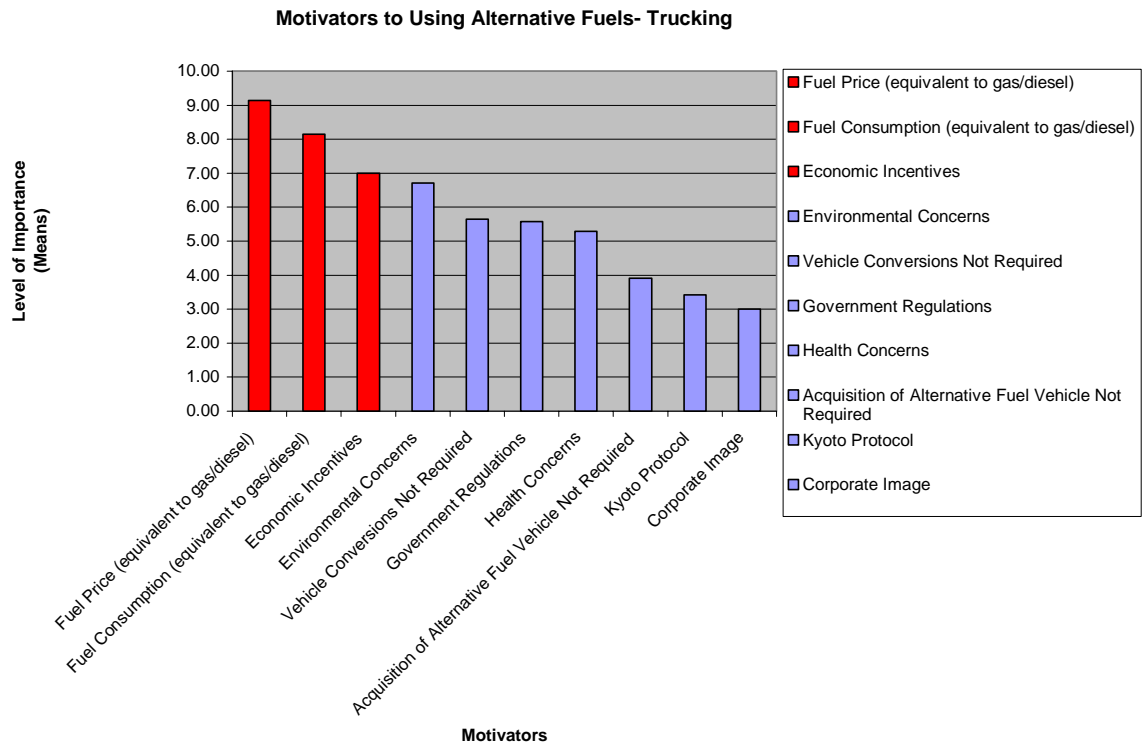


Figure 5: Top 3 motivators to Using Alternative Fuels (Trucking)

The top three motivators for trucking related to cost. The other trucking motivator that was ranked as high priority related to the environment.

4.6.3 Municipal

In order of importance, municipal fleets listed the following factors as the top 3 motivators to use alternative fuels in their fleet: health concerns, environmental concerns and fuel consumption (equivalent to gas/diesel).

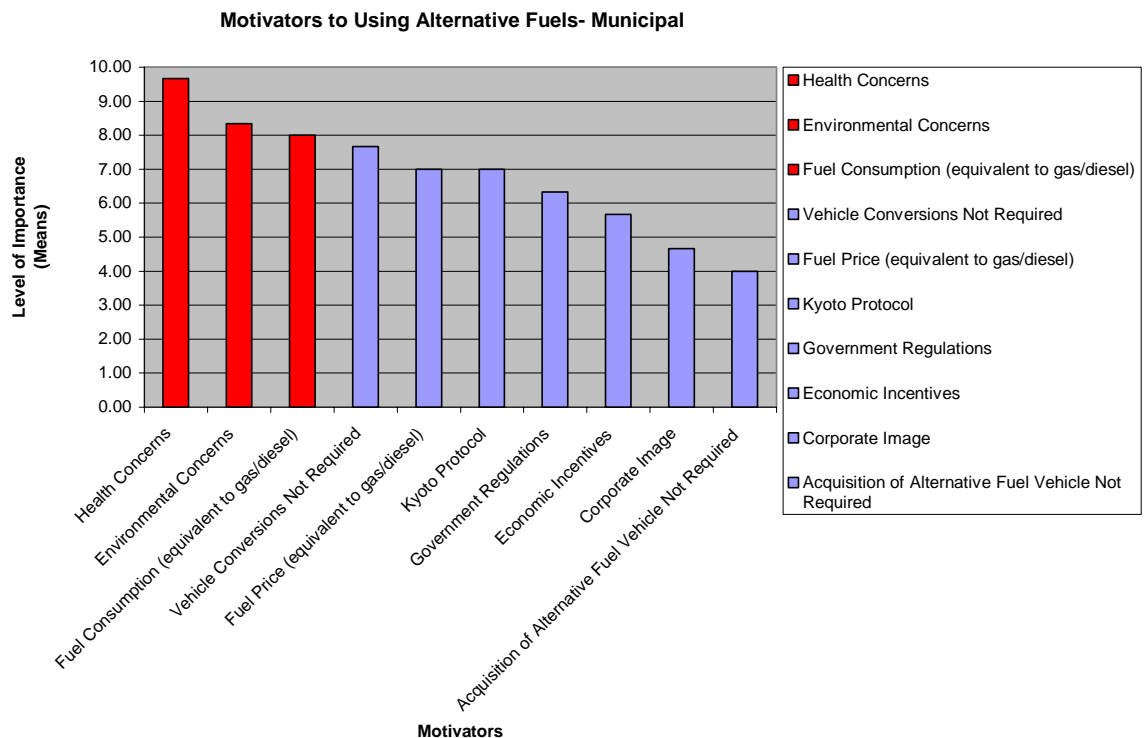


Figure 6: Top 3 motivators to Using Alternative Fuels (Municipal)

The top motivators primarily related to social issues such as human health and the environment, with the exception of fuel consumption being equivalent to gas or diesel also being a top motivator to using alternative fuels. Other municipal motivators that are high priority related to political and cost issues.

4.6.4 Provincial

In order of importance, Provincial fleets listed the following factors as the top 3 motivators to use alternative fuels in their fleet: environmental concerns, government regulations and health concerns.

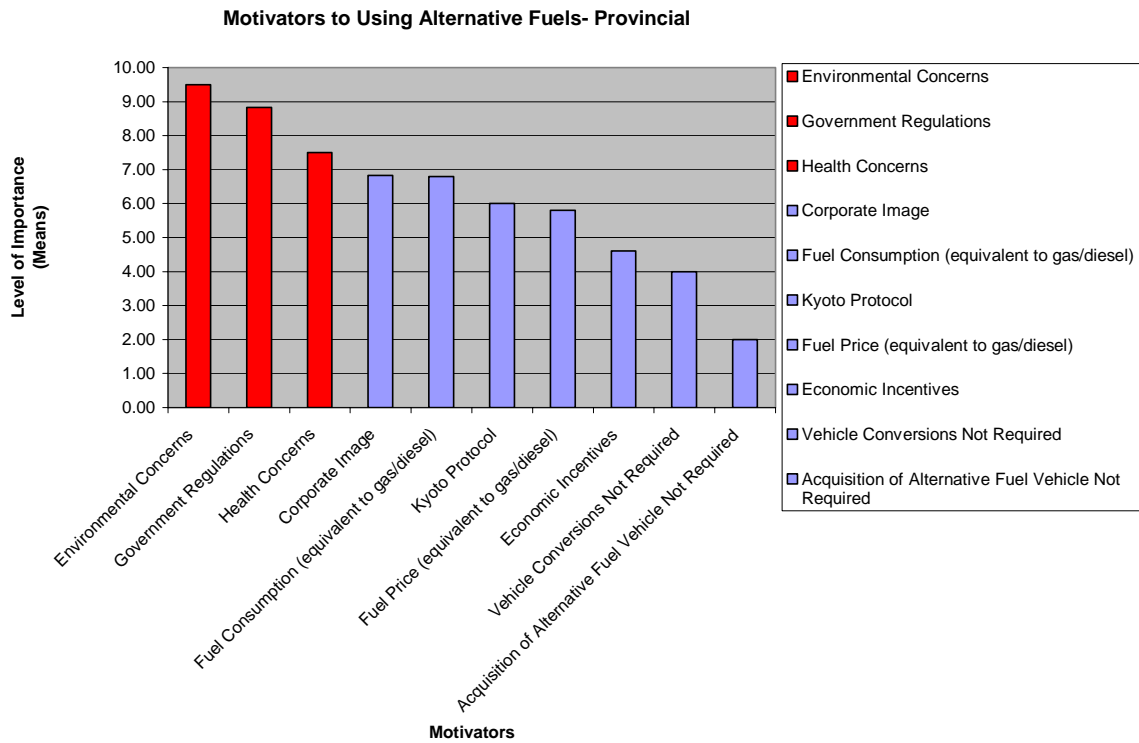


Figure 7: Top 3 motivators to Using Alternative Fuels (Provincial)

The top three motivators for provincial fleets related to social and political issues such as environment, government regulations and health concerns. Other provincial motivators that were high priority related to social, cost and political issues.

Industry and government did not hold the same opinions on what would motivate their respective fleet operators to use alternative fuels. Industry's top three motivators were identical and deal with issues that related to cost and driving range of the vehicle (fuel consumption). Government's top three motivators were not focused on cost, with the exception of the municipal government's concern for fuel consumption, but focused on social and political issues such as the environment, health concerns and government regulations.

4.6.5 Other Motivators

The survey also asked fleets to provide feedback on 'other' factors that would motivate them to use alternative fuels, other than the factors in the ranking list. Some of the factors were entirely new factors that were not identified in the survey and some of the factors provided further insight into the factors listed in the ranking table. For instance, in the ranking table there was a category for fleets to select economic incentives as a motivator, but some fleets identified what type of economic incentives would motivate them to use fuels, such as government subsidies of fuels cost or subsidies toward vehicle conversions.

Other Motivators for Using Alternative Fuels (All Fleet Operators Surveyed) included:

Cost

- Government subsidies on fuel costs

- Government subsidies towards vehicle conversions
- Competitive advantage for fleets using alternative fuels
- Lower overall cost of operation

Infrastructure

- Having a selection of fuels available from multiple fuel providers
- Availability of trained maintenance staff
- Multiple vehicle and repair parts

Environmental

- Proof that alternative fuels are cleaner burning

Other

- Fleet operators being made aware of what alternative fuel options exist for their fleet applications
- One alternative fuel becoming the standard for a specific industry

4.7 Deterrents- What deters fleets from using alternative fuels?

The following section provides insight into what deters fleet operators from using alternative fuels in their fleets. The survey sent to fleet operators provided them with a list of 10 potential deterrents and the operators were asked to rank each potential deterrent, as it related to their decision to use alternative fuels in their fleets. There was also space provided for fleets to identify any other deterrents that were not on the list

supplied. These additional deterrents were not included in the analysis, however a list of the 'other' identified deterrents is provided at the end of this section.

As was the case with the motivators, the numbers presented in the tables and graphs to follow represent the mean number that fleet operators assigned to each deterrent. For this scale, number 1 is the lowest deterrent and number 10 is the highest deterrent. Please note: for the actual survey distribution, the scale had 1 as the highest deterrent and 10 as the lowest deterrent, but for purposes of creating graphs that illustrate which deterrent is the highest importance, the researcher adjusted the scale so that the graphs would make logistical sense from a visual perspective. (see Chapter 3, Research Approach for further details).

4.7.1 Messenger and Courier

In order of importance, for messenger and courier fleet operators the following factors were the top three factors that would deter them from using alternative fuels in their fleet: low alternative fuel vehicle availability, vehicle conversions costly and new alternative fuel vehicle acquisition costly.

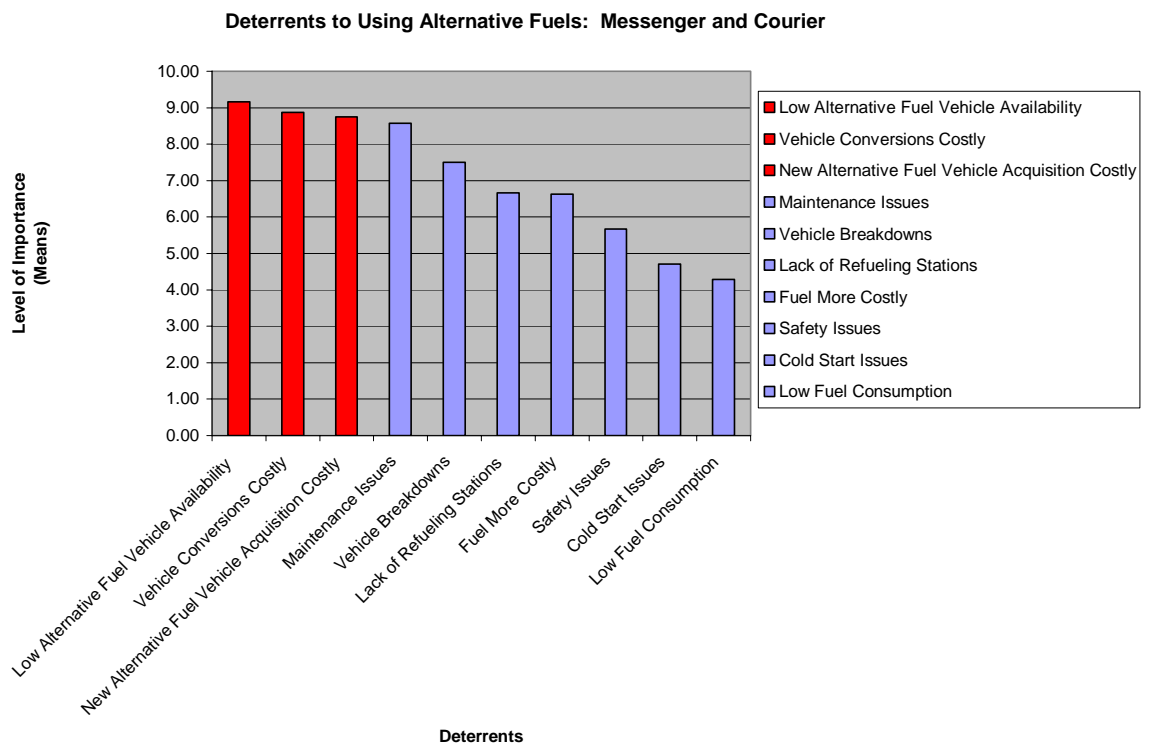


Figure 8: Top 3 Deterrents to Using Alternative Fuels (Messenger and Courier)

The top deterrents for messenger and couriers related to infrastructure and cost. Messengers and couriers also gave high priority to a number of different types of deterrents, mostly relating to maintenance issues, infrastructure and cost.

4.7.2 Trucking

In order of importance, for trucking fleet operators the following factors were the top three factors that would deter them from using alternative fuels in their fleet: fuel more costly, new alternative fuel vehicle acquisition costly and lack of refueling stations.

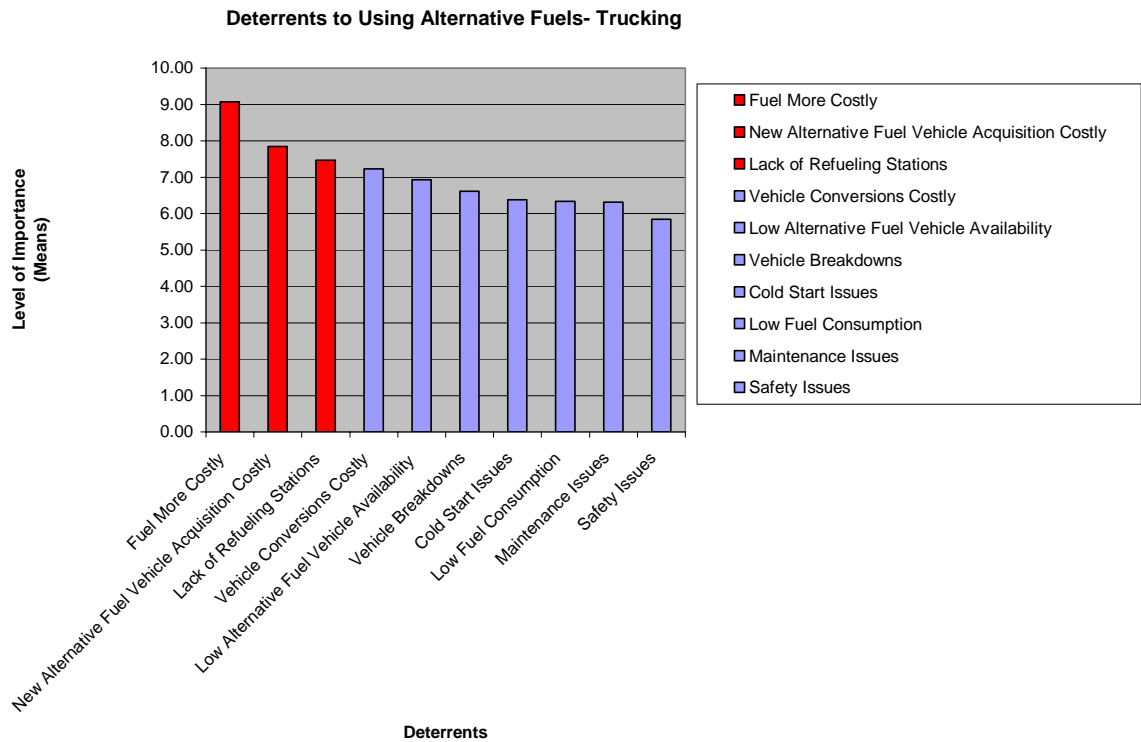


Figure 9: Top 3 Deterrents to Using Alternative Fuels (Trucking)

The top deterrents for trucking companies related to cost and infrastructure. Trucking companies ranked the majority of the deterrents provided in the deterrents list as high priority items to be addressed, including factors relating to cost, infrastructure, maintenance issues and vehicle performance.

4.7.3 Municipal

Municipal fleets assigned the same level of importance to the following top three deterrents that would deter them from using alternative fuels in their fleet: lack of refueling stations, new alternative fuel vehicle costly and vehicle conversions costly.

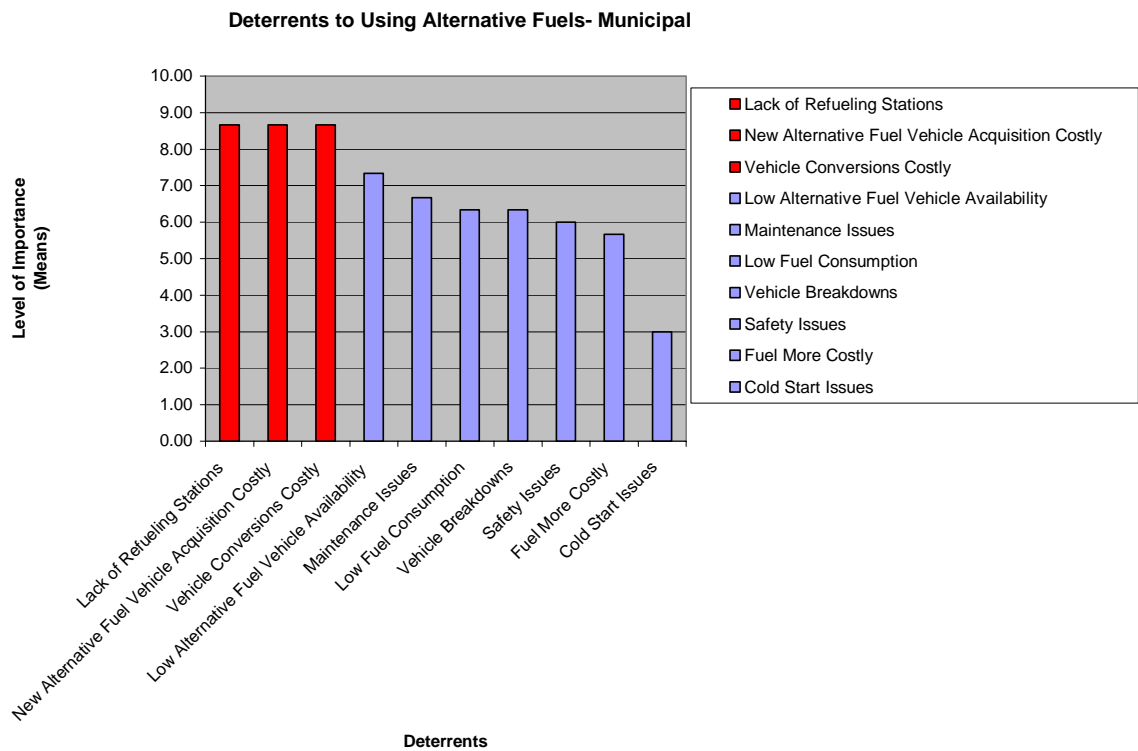


Figure 10: Top 3 Deterrents to Using Alternative Fuels (Municipal)

The top municipal deterrents related to infrastructure and cost. Municipal fleet operators ranked the majority of the deterrents provided in the deterrents list as high priority items to be addressed, including factors relating to infrastructure, maintenance issues and cost.

4.7.4 Provincial

In order of importance, for provincial fleet operators the following factors were the top three factors that would deter them from using alternative fuels in their fleet: lack of refueling stations, low alternative fuel vehicle availability, fuel more costly and acquisition of alternative fuel vehicle costly.

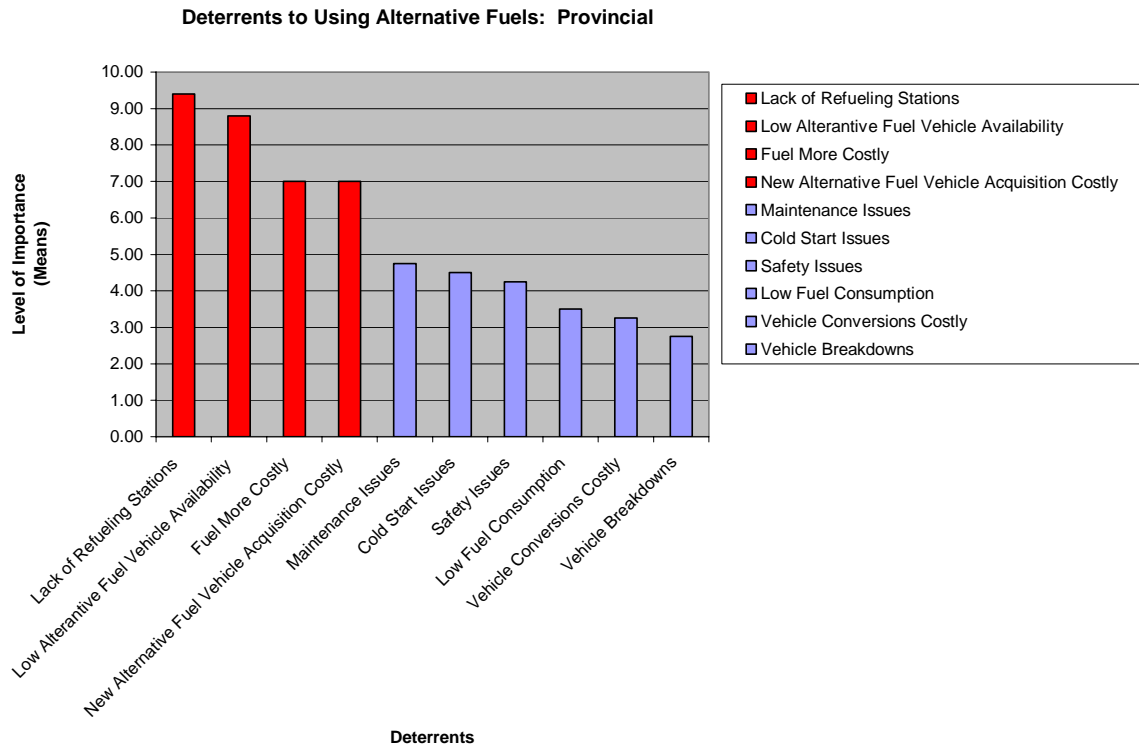


Figure 11: Top 3 Deterrents to Using Alternative Fuels (Provincial)

The top deterrents for provincial fleets related primarily to infrastructure and costs. The provincial fleet operators did not give high priority to any other deterrents.

There is a difference between what the various organizations believed were the most significant deterrents. Regardless of these differences, with the exception of the provincial fleet operators, all of the fleet operators ranked more than 7 and up to 9 out of the 10 deterrents as having a high level of importance. This suggests that most of the deterrents in the deterrents list will need to be addressed before these fleet operators use alternative fuels.

4.7.5 Other Deterrents

The fleet operators surveyed also identified other deterrents to using alternative fuels in fleets that were not included in the distributed survey. A listing of these other deterrents were as follows:

Cost

- Ongoing costs to operate the vehicles and maintain the infrastructure.
- High overhead cost for constructing a privately owned fueling site for fuels that are available.

Infrastructure

- Safety, health, building, fire and electrical code implications on facilities to legally and safely store, dispense and maintain alternative fuel infrastructure.

- Alternative fuel industry is not mature enough (i.e. there are not adequate service outlets, fuel outlets, unreliable equipment and there are high costs for repair and maintenance).
- Low availability of fuel and trained personnel who can work on alternative fuel engines across North America.

Vehicle and Fuel Characteristics

- Lack of information on fuel supply, vehicle reliability and performance issues.
- Obsolescence and changing technologies is a major concern when selecting alternative fuel vehicles.
- Many Alternative fuel vehicle technologies introduce issues such as greater weight of the vehicle or lower passenger carrying capabilities.
- Alternative fuels tend to be promoted by one manufacturer or fuel supplier and as such there is a very high inherent risk for a company banking on the existence of a single or limited range of suppliers for things as fundamental as vehicles, repair parts and fuel.
- Down time switching over to alternative fuels.
- No reliable fuel source.

Environmental

- Whether the alternative fuel actually delivers the theoretical benefits in terms of emission reductions.

- Alternative fuel vehicles may have a more detrimental impact on the environment than a single diesel vehicle.
- Unsure if the fuel will meet near future emission control standards.

Other

- There are no articles in trade magazines that would suggest this decision will be of financial benefit to companies.
- Lack of time to investigate alternatives.
- Lack of support from original equipment manufacture for warranty recovery with alternative fuels.

4.8 Summary of Survey Results and General Discussion

Industry and government fleet operators in Winnipeg, Manitoba were surveyed to gain an understanding of their experience and opinions on the use of alternative fuels in vehicle fleets. The survey captured the opinions of fleet operators in Winnipeg, providing an idea of the current use of alternative fuels in the region and provided insights into what types of challenges and opportunities would relate to the development of the alternative fuel industry in Winnipeg from a fleet operator's perspective. Fleet operator opinions are an important perspective to identify because fleet operators are one of the end users of alternative fuels and they have a collective power as decision makers that could influence trends that could then be implemented in the domestic vehicle sector.

The key findings from the survey were that alternative fuels are not a primary fuel source for vehicle fleets in Winnipeg. Alternative fuels are used in government fleets more often than industry fleets, but even government fleet the use of alternative fuels is minimal compared to the use of conventional fuels. Survey results indicated that access to information on alternative fuels plays a role in encouraging fleet operators to use alternative fuels. For instance, government fleets, with more access to information on alternative fuels than industry, cited a larger use of alternative fuels in their fleets than industry. The most commonly used alternative fuels and vehicle technologies are ethanol, propane and electric gas hybrids.

There is a significant difference between the operational needs of one fleet to another. This trend is most dramatically seen with the differences that exist between industry and government. Industry fleet operators agreed that cost is a driving factor in terms of what motivates them to use alternative fuels, while government fleet operators are not as concerned with cost factors, but use alternative fuels because of social, political and environmental reasons. One of the consistent motivators to using alternative fuels is that they are stated to offer environmental benefits over conventional fuels. However, while the environment is a motivator to fleet operators, the environmental claims for the fuels need to be justified in order for fleet operators to use the fuel.

Fleet operators within industry and within government have much more varied opinions when it comes to factors that deter them from using alternative fuels. This finding clearly demonstrates that fleet's operational needs dictates what types of factors would act as

impediments to using alternative fuels. Factors that were high priority for trucking firms to have addressed were not necessarily high priority for messenger and courier companies.

CHAPTER 5

5.0 CONCLUSIONS AND DISCUSSIONS

5.1 Introduction

This study investigated vehicle fleet operator perspectives regarding the expansion of the use of alternative fuels in vehicle fleets. Vehicle fleets were the primary focus of the study because they are often the first user group targeted to switch to using alternative fuels. The study began with a review of publications and other media that helped to identify the various factors that could influence fleet operators' decisions to use alternative transportation fuels. The study focused on fuels that were readily available and technically feasible for the region, which included ethanol, biodiesel, electricity (gas electric hybrids), natural gas and propane.

The specific objectives of the research were to identify the local government alternative fuel policies in place in Manitoba, assess the current usage of alternative fuels in vehicle fleets in the region, identify factors that could influence fleet operator's decisions to use alternative fuels and establish the importance that fleet operators place on those factors.

The research identified the key issues that need to be addressed when promoting the use of alternative fuels to vehicle fleets. The main conclusions from the research findings can help to clarify issues for decision makers who are investigating the potential to implement the use of alternative fuels in vehicle fleets.

5.2 Alternative Fuel Policies

There are no local government alternative fuel policies in place in Manitoba that focus directly on increasing the use of alternative fuels in vehicle fleets. The provincial government has three policies that focus on strategies to develop the alternative fuel industry, which includes an ethanol policy that has been fully deployed, a biodiesel strategy that is under investigation and a hydrogen action plan. Kyoto and Beyond is another provincial strategy that promotes the use of alternative fuels as a means to reduce greenhouse gases. The municipal government does not have any policies relating directly to alternative fuels, but does have two policies, 2020 Vision and the Environmental Strategy (not yet adopted) that indicate that the use of alternative fuels could help to reduce air pollution.

Provincial policies focus on promoting low level blends such as E10 and technologies such as hybrid electric vehicles that do not require changes to fueling infrastructure. Once a market for low level blends is established, a transition to higher level blends could be a potential for Manitoba. In the interim, it might be beneficial for provincial and municipal governments to conduct studies on high level blends so that information on the high level blends can be used to develop future policies.

The provincial ethanol strategy, the province's most developed alternative fuel policy document, identifies economic development as a key motivator for promoting the ethanol industry. The government believes that the ethanol industry will be self-sufficient in the

future. Promoting fuels that have the promise to become self sufficient in the future, thereby eliminating the need for indefinite government subsidies, reduces the risk to vehicle operators. A self-sufficient, sustainable market system is likely to ensure adequate refueling stations, vehicle availability and fuel supply. On the other hand, alternative fuels that do not offer the promise of sustaining themselves put fleet operators who use them in a high risk position, where they are relying on government subsidies to make the fuel cost neutral to conventional fuels or to provide rebates for alternative fuel vehicles. If the government subsidies are removed, fleet operators will no longer be able to afford the fuel or vehicles. This could also lead to the collapse of the infrastructure that was built up while the fuel subsidies were in place.

The federal government currently has an Alternative Fuel Act that serves to increase the use of alternative fuels in federal fleets. Currently, local governments in Manitoba do not have a comparable alternative fuel act. Ultimately, the Alternative Fuels Act serves to increase the use of alternative fuels in government fleets, increase the local alternative fuel infrastructure, increase in local production of alternative fuels to meet government fuel needs, develop expertise with alternative fuels and create a formal reporting framework on alternative fuel use in government vehicle fleets.

5.3 Alternative Fuel Usage in Vehicle Fleets

The survey results showed that the majority of fleets surveyed in Winnipeg do not use alternative fuels. It is mostly government fleets that are using alternative fuels rather than

industry fleets, and, even in government fleets. One of the reasons for the higher use of alternative fuels in government fleets is that governments generally do not tend to have the same pressures as industries to make a profit and have more access to government funding programs for alternative fuel initiatives and governments also have the role of leaders in these types of environmental commitments. However, even in government fleets, the use of alternative fuels does not represent a large portion of fuel used in comparison to the use of conventional fuel. The proportion of alternative fuels used in comparison to total fuel used in the surveyed fleets was less than 3%.

It is difficult to qualify the actual use of alternative fuels in Manitoba compared to the use of conventional fuels, since there is not a consolidated data set that tracks the use of alternative fuels in the region. There are however, some estimates, from various sources that provide some insight into the amount of alternative fuel used in the region. In Manitoba, ethanol blended gasoline makes up less than five per-cent of the gasoline fuel market (Province of Manitoba- Manitoba Energy Development Initiative, 2002b). Statistics from 1999 data suggest that propane use is 1.02% of the net sales of gasoline and 3.4% of the net sales of diesel fuel in Manitoba and that propane net sales in Manitoba are 3% of the Canadian propane sales for 1999 (Statistics Canada, 2001). The inventory of alternative fuel vehicle maintained by the Red River Valley Clean Cities Coalition Winnipeg Chapter Inc. reports that in Manitoba there are currently 197 alternative fuel vehicles in Manitoba, of which 62 are operating on alternative fuels since some of the alternative fuel vehicles currently owned in the region can operate on conventional and alternative fuels sources, but do not currently have access to the

alternative fuel the vehicle can use. Based on 1999 data that lists 624,353 registered on road vehicles in Manitoba, the use of alternative fuel vehicles to the regional vehicle population suggests a usage of .01% (Statistics Canada, 1999). While none of these data sets captures the total usage of alternative fuels in Manitoba, it is evident from these estimates that the usage is minimal compared to the usage of conventional fuels.

The minimal use of alternative fuels in Winnipeg is not surprising since there is a lack of alternative fuel fueling stations in Winnipeg which prevents fleets from using alternative fuels. As described in Chapter 2, Winnipeg does not have any natural gas retail stations, has limited propane stations, has 23 retail E10 stations and has no retail biodiesel stations. In terms of vehicle technologies like the gas electric hybrid, the selection of vehicle models for these vehicles is also limited.

The lack of alternative fuel availability is a similar scenario for the rest of Canada. E10 is currently offered at 1,000 retail stations in Canada (Natural Resources Canada, 2002a), E85 at no retail stations in Canada, Biodiesel at 1 retail station in Canada Topia Energy, 04), propane is offered at 3,000 stations in Canada (Natural Resources Canada, 2002c) and natural gas at 120 retail outlets in Canada (Natural Gas Vehicle Alliance, 2003). The availability of gas electric hybrid vehicles in Canada is also limited, especially in comparison to its availability in the United States (McDonald, 2004). E85 stations that exist in Canada are operated primarily by the federal government, and as such its use is only by government officials (Kraynyk, 2004). It is also government fleets that are involved in biodiesel demonstrations throughout Canada, and the fuel source is made

available to them at private stations that they operate (City of Saskatoon, 2004; Societe de Transport de Montreal, 2004; Toronto Hydro, 2004).

Findings indicated that E10 is the most commonly used alternative fuel amongst surveyed fleets. Other fuels and technologies used, are propane and hybrid gas electric vehicles. The higher usage of E10 is likely due to a number of factors including its availability at retail stations, the ability for gasoline vehicles to operate on E10 with no modification and the fuel performance being well documented in Canada, the U.S. and elsewhere. The use of E10 will increase dramatically when the provincial fuel mandate comes into effect in 2005. The fact that propane was also cited as one of the alternative fuels being used is not surprising since propane used to be the number one alternative fuel in Canada (Natural Resources Canada, 2002c), and as such some fleets may still have some vehicles operating on this fuel source.

The increasing use of electric gas hybrids is likely due to three factors; the use of these vehicles does not require any changes to the infrastructure and can be used within current fuel network, vehicle manufacturers are increasing the number and selection of vehicle makes and models of electric gas hybrids on the market, and hybrid vehicle manufacturers claim that the vehicles improve fuel economy and could present fleet operators with the ability to reduce operational costs. Fleet operators in Winnipeg using gas electric hybrids stated that they were still in the evaluation period, which indicates that vehicle performance is still being monitored.

The use of gas electric hybrids could increase in Winnipeg since there are no infrastructure obstacles to using this technology and since vehicle manufacturers are continually increasing their selection of gas electric vehicles. For example, Ford is discontinuing their lines of natural gas and propane vehicles in favour of gas electric hybrids and hydrogen vehicles. Toyota has also stated that they will be offering all of their lines of vehicle makes and models in the gas electric hybrid within the next 10-15 years (McDonald, 2004). As fleet operators are offered larger vehicle selection for the hybrid vehicles, their use in fleets in Winnipeg may increase over other alternatives, such as natural gas and propane, that do not have the same level of vehicle availability.

Another important point to draw from the results of the survey is that there is a difference between the needs of one fleet and the next. Even within government, there was a large difference between fleet operators citing the use of alternative fuels in their fleet. For example, provincial fleet operators cited using alternative fuels more than twice as much as municipal fleet operators. One reason for this is because of the ways these fleets refuel. Provincial vehicles refuel at retail stations throughout the province, where there are 23 E10 stations. The municipal vehicles refuel exclusively at centralized refueling stations operated by the City of Winnipeg, none of which have E10 fuel. E10 fuel is not offered at municipal stations because the current fuel contractor for the City does not offer an E10 fuel source (Lupien, 2004). This example illustrates that even within different levels of government there are different circumstances that affect a fleet operator's ability to use alternative fuels. Survey results showed a similar case where messengers and couriers identified different types of top deterrents to using alternative

fuels versus what trucking industry identified as top deterrents. Both are industry vehicle fleets, but because of operational differences, they are facing different deterrents to using alternative fuels.

Another factor that appears to influence the use of alternative fuels in Winnipeg is fleet operator access to information on alternative fuel options. The survey results illustrated that government fleet operators have more access to information on alternative fuels and use alternative fuels more than their industry counterparts, who have limited access to information on the fuels. This indicates that fleet operators with more information on alternative fuels may be more likely to use the fuels in their fleets. This trend is evident for all fleets surveyed. For example, there is a higher usage of alternative fuel in provincial fleets than in municipal fleets, with provincial fleets stating that they have more access to information on alternative fuels than municipal fleet operators. Similarly, government fleets with more access to information on alternative fuels use alternative fuels more than industry fleets with limited access to information on alternative fuels.

Government fleet operators are likely to have more information on alternative fuels and clean vehicle technologies than industry because they are directly involved in air pollution related policies. The government's involvement with policy development provides them with a larger network of contacts to provide them with information on alternative fuels. As such, government fleets are more likely to be familiar with current developments in the alternative fuel industry. Additionally, most of the alternative fuel demonstrations throughout Canada involve government. For example, the Montreal

Biobus demonstration in Quebec involved Montreal transit, the biobus demonstration in Saskatchewan involves Saskatchewan transit, E85 fueling station pilot projects in Manitoba and throughout Canada are being spearheaded by federal government departments. Therefore, information sharing between municipalities and provincial governments throughout Canada may be greater than information sharing among industry who are not as involved in the alternative fuel pilot projects and demonstrations.

Another reason why industry may not be using alternative fuels as much as government is because in Manitoba there is no cost incentive or competitive advantage for industry fleet operators to be using alternative fuel sources, which, according to the survey, could decrease industry fleet operator interest in investigating alternative fuels. In Manitoba there is a non-profit organization committed to sharing information on alternative fuels that can serve to bridge the gap between information sharing on alternative fuels between industry and government fleet operators. The Red River Valley Clean Cities Coalition Winnipeg Chapter Inc. is a group that promotes alternative transportation fuels in Manitoba through outreach and education, proposal development to gain funds for alternative fuel infrastructure, building partnerships and sharing alternative fuel success stories with key stakeholders in Manitoba. The Clean Cities group is part of a U.S. Department of Energy Program whose mandate is to promote the alternative transportation market. There are 80 Clean Cities coalitions throughout North America and Manitoba is the only Canadian province participating in this large network of coalitions. The membership for the group is a cross section of government, industry and

non profit groups. One of the primary purposes of the group is to act as a venue to share experiences with alternative fuels and partner on alternative fuel projects.

5.4 Factors to Consider When Implementing Alternative Fuels in Vehicle Fleets

Since vehicle fleets are often one of the first user groups targeted for alternative fuel usage it is important to identify the types of factors that would motivate or deter them from choosing to use alternative fuels in their fleets. Winnipeg fleet operators gave a high level of importance to the motivator and deterrent list generated from the fleet document review that identified factors that were important to fleet operators outside of Winnipeg. This shows that Winnipeg fleet operator opinions are consistent with the opinions of fleet operators outside of Winnipeg. Specifically, Winnipeg fleet operators identified that more than four and up to seven out of the ten motivators on the list of factors generated from the opinions of fleet operators outside of Winnipeg were high priority. These motivators can be used to capture near term opportunities that would encourage the switch to alternative fuels in fleets.

Likewise, fleet operators identified that more than four and up to nine out of the ten deterrents generated from fleet operator perspectives outside of Winnipeg were high priority to fleet operators in Winnipeg. Identifying factors that are high priority to fleet operators when switching to alternative fuels can help to understand what types of issues will need to be addressed to increase the use of alternative fuels in vehicle fleets on a whole. The consistency between opinions from fleet operators outside of Winnipeg and

Winnipeg fleet operators is important to note because information on alternative fuels from other regions is applicable to Winnipeg and can be used by decision makers planning to expand the alternative fuel market in Winnipeg.

The environment was ranked as a factor that would be an important motivator to encourage all fleet operators to use alternative fuels. Government fleets ranked the environment as one of their top three motivators to using alternative fuels. While industry did not rank the environment as one of the top three motivators, the environment was ranked as a high priority motivator that encourages industry to use alternative fuels. Survey responses further stipulated that in order for the environment to be a motivator, the environmental benefit of the fuel has to be clearly substantiated.

Alternative fuels are largely promoted based on the fact that they offer environmental benefits over conventional fuels and as such it is extremely important to ensure that these claims are validated and communicated to fleet operators. This type of issue became important when there were contradictions in 2003 between the National Farmers Union and the Province of Manitoba regarding the environmental benefits of ethanol. Similar disputes were raised in the late 1980's when claims were made that natural gas was cleaner burning in all vehicles, when this was not always the case. Life cycle analysis is the best way to document environmental benefits of fuels since it compares energy and resources used in the production and use of alternative fuels in relation to conventional fuels. The federal government currently has a model, called the GHGenius model that can determine life cycle analysis for alternative fuels, and by inputting data relevant to

Manitoba made alternative fuels, can generate a life cycle analysis for fuels made in Manitoba.

Winnipeg fleet operators also identified a list of 'other' factors that would motivate or deter them from using alternative fuels in their fleets, over and above the list provided to them for ranking. Specifically, fleet operators identified ten other motivators to using alternative fuels and seventeen other factors that would deter them from using alternative fuels. From this study alone, twenty factors were identified that might motivate fleet operators to use alternative fuels and twenty seven factors were identified that might deter vehicle fleet operators from using alternative fuels. On the whole it is clear that the implementation of alternative fuels is a complex issue with many obstacles and opportunities to building the industry.

The survey results also revealed that there was a marked difference between the opinions of industry and those of government. Cost issues were the main motivator for industry to introduce alternative fuels into their fleet. Social, political and environmental concerns were motivators for government to use alternative fuels in their fleets, with the exception of municipal fleet operators who felt that fuel consumption is also a top motivator. Both industry sectors surveyed agreed with each other one hundred percent on the top motivators to using alternative fuels, which all relate to cost. While government did not have one hundred percent the same views, their opinions were closely related. For this reason, different strategies will have to be incorporated to encourage an increase of alternative fuels in government versus industry. Government has to recognize that at this

time their priorities and motivations to use alternative fuels are different than industry and in order to increase the use of alternative fuels in industry fleets a top down approach like a fuel mandate or subsidies are the primary options to implement the use of fuels into industry vehicle fleets.

5.5 Further Research

At the completion of the research process it became apparent that there are a number of unanswered questions surrounding the use of alternative fuels that could be answered by conducting further research on this topic. Specific areas of research that would provide further insight into the implementation of alternative fuels into vehicle fleets and other vehicle markets are the following:

1. Characterization of the alternative fuel market in Manitoba

Conducting a detailed inventory on the use of alternative fuels in Manitoba compared to the use of conventional fuels would provide a more detailed understanding on the proportion of alternative fuel used relative to conventional fuel. Conducting the inventory on a per litre equivalency basis, would be beneficial because it could then be compared to the per litre usage of diesel and gasoline. As part of this research it would be worthwhile to develop an approach of how to best continue to monitor the use of alternative fuels on an annual basis, so that current statistics are readily available. These types of statistics could define the demand for alternative fuels in the region and could

track the growth of the market. Once the inventory for Manitoba is completed an inventory across Canada could be conducted, so that data is available to easily compare the usage of alternative fuels across the Country.

2. Federal, Provincial and Municipal Cooperation

It would be informative to develop an understanding on the type of cooperation between the federal, provincial and municipal levels of governments as it pertains to efforts to build the alternative fuel market. This thesis did not conduct any research into this topic area, but it would be beneficial to know if there is a concerted effort from all levels of government to promote alternative fuels. This type of research could also lead to the development of a model that provides insight into what type of cooperation would be needed from all levels of government in Canada to effectively increase the use of alternative fuels throughout the country. Within this model, consideration could be given to the type of cooperation that might be needed with the various levels of the Canadian and U.S. governments as well, since a significant amount of trade from Manitoba is with U.S. trading partners.

3. Policies and other factors influencing the use of alternative fuels

This study focused only on local government alternative fuel policies and factors from a fleet perspective that could influence the use of alternative fuels in vehicle fleets. There are also many other types of government policies and industry policies that could

influence the use of alternative fuels in Manitoba that were not researched for this study. Research focusing on the various types of policies, both at the governmental and industry level could help to identify the main policy drivers and factors influencing the use of alternative fuels. For example, federal level programs that offer financial incentives to provincial government's to build plants to make alternative fuels may influence the development of the alternative fuel market in Manitoba. Additionally, internal industry policies could also influence the use of alternative fuels by other industries. For instance, IKEA, a well established low priced global furniture, bathroom and kitchen retail outlet, has many internal policies relating to environmental and social responsibility. A newly proposed IKEA policy is aimed at only using carriers who meet certain environmental criteria for shipment of IKEA goods, which could effectively play a role in the use of alternative fuels or other energy efficiency improvements in transport (Canadian Trucking Alliance, 2004).

Other county comparisons would also be helpful for this type of research as it would quantify what types of policies and factors influenced the use of the development of the alternative fuel market in those regions. For example, Brazil has an extensive ethanol industry and Germany has an extensive biodiesel industry. It would be informative to analyze how these two countries came to be leaders in these respective alternative fuels.

5.6 Concluding Remarks

Overall, the research illustrated that incorporating the use of alternative fuels into vehicle fleets is a very complex undertaking. Currently, there is minimal use of alternative fuels in vehicle fleets in Winnipeg, Manitoba. Vehicle fleets all have different operational needs, and as such, different strategies should be employed to increase the use of alternative fuels in vehicle fleets depending on specific operation needs. Increasing access to information could increase the use alternative fuels in vehicle fleets. Since environmental concerns could encourage fleet operators to use alternative fuels, it is important to ensure that environmental benefits of these fuels can be validated, so that fleet operators are ensured that they are investing in a cleaner technology. Without addressing vehicle fleet concerns, alternative fuels will not be a sustainable option for the transportation sector. The opinions of fleet operators can be used when developing policies on alternative fuels and when promoting an alternative fuel market since vehicle fleet operator opinions are reflective of the issues that need to be dealt with in order to effectively create a transition from the use of conventional fuels to alternative fuels.

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Appendix A

Background on Alternative Fuels

Ethanol

Ethanol is a renewable fuel source made from any feedstock that contains significant amounts of sugar, starch or cellulose that can be converted into sugar (U.S. Department of Energy, 2002b). Examples of resources that can make ethanol are corn, wheat, wood, straw and other grasses, sugar beets and sugar cane (Natural Resources Canada, 2002a).

Ethanol is an alcohol based fuel which is typically blended with gasoline in concentrations of 10 percent ethanol to 90% gasoline, this blend is known as E10.

Ethanol can also be blended with gasoline in higher concentrations, such as 85% ethanol to 15% gasoline, this blend is known as E85 (U.S. Department of Energy, 2002b).

Typically, in Canada, vehicles are fueled by E10 since E10 blends can be used in any vehicle with no modification and E10 has the same type of storage equipment as regular gasoline (Natural Resources Canada, 2002a). E10 is currently offered at approximately 1,000 outlets across Canada (Natural Resources Canada, 2002a) and at 23 stations in Manitoba offer E10 (Fleet Vehicles Agency-Province of Manitoba, 2004). Higher blends of ethanol such as E85 require a special vehicle called an E85 flexi-fuel vehicle, which is offered on a limited basis in Canada (U.S. Department of Energy, 2002b). E85 is not currently offered at any retail stations in Manitoba. E85 generally has the same type of storage requirements as gasoline but has some special storage requirements that differ from gasoline storage (Legault, 2003).

Biodiesel

Biodiesel is a renewable fuel source that is made from resources such as canola, soy, sunflower, mustard seed, recycled restaurant oil, and rendered animal fat (U.S. Department of Energy, 2003). Biodiesel is blended with diesel fuel typically at concentrations below B20 (20% biodiesel to 80% diesel fuel). Biodiesel can be blended at higher concentrations, up to a B100 blend (100% biodiesel). B20 can be used in most diesel vehicles and equipment with little or no engine modification (U.S. Department of Energy, 2003). Most engine manufacturers have stated that the use of biodiesel up to the B5 level will not void warranty (National Biodiesel Board, 2004). For use with levels higher than B5, individual engine manufacturers should be consulted. Most new vehicles can operate on B100, but biodiesel has cold flow problems at high level blends. Biodiesel is currently offered at 1 retail fueling station in Canada (Topia Energy, 2004). For biodiesel that is blended at less B20 the storage and distribution equipment currently used for diesel is compatible. Higher level blends of biodiesel may require different management for transportation and storage.

Electric Gas Hybrids

Hybrid electric gas vehicles have a conventional fuel engine and an electric motor. Hybrid vehicles do not need to be plugged in and are fueled with conventional fuel. Hybrid gas electric vehicles are new to the Canadian market and availability is still limited (McDonald, 2004). Hybrid electric diesel buses are also available. Hybrid gas electric vehicles are more energy efficient than conventional vehicle technologies.

Electric gas hybrids do not require any infrastructure changes to the current fueling systems since they use conventional fuel sources.

Natural Gas

Natural gas is a non-renewable resource and is extracted from beneath the earth's surface. Light duty vehicles and heavy duty vehicles can both operate on natural gas (Natural Resources Canada, 2002b). A gasoline vehicle can be converted to operate on natural gas. Specially designated natural gas vehicles can also be purchased from an original equipment manufacturer (Natural Resources Canada, 2002b); however, many manufacturers are discontinuing their natural gas vehicle lines (AltFuels Advisor, 2004). In Canada there are approximately 127 natural gas stations (Natural Gas Vehicle Alliance, 2003). Manitoba does not have any retail natural gas stations. Natural gas has different storage requirements than conventional fuels.

Propane

Propane is a non-renewable resource and is derived from natural gas or separated from crude oil during the refining process. Until recently propane was Canada's number one alternative fuel (Natural Resources Canada, 2002c). Most of Canada's propane is a by-product of natural gas production. Gasoline vehicles can be converted to run on propane (Natural Resources Canada, 2002c). Some manufacturers offer vehicles that run on propane, but recently some manufacturers are discontinuing their propane lines (AltFuels Advisor, 2004). In Canada there are approximately 3,000 propane retail stations (Natural

Resources Canada, 2002c). Propane has different storage requirements than conventional fuels.

Appendix B- Questionnaire

Instructions for questionnaire

The survey is to be filled out by the fleet manager or a representative that makes decisions and/or provides recommendations about the type of fuel or vehicles that are purchased for the fleet.

For the entire survey, please put an X in the box(es) that capture your answers most accurately or provide a brief answer in the ‘other’ category (unless otherwise stated).

For the purpose of this questionnaire “alternative fuels” means all non-conventional fuels that are readily available and technically feasible in the Red River Valley Region. These fuels include natural gas, propane, ethanol, biodiesel and electricity.

Questionnaire for Fleet Managers

BACKGROUND INFORMATION

1. What type of organization do you work for?

		Additional Comments
Government		
Private Corporation		
Public Corporation		
School		
Small Business		
Other (please specify)		

2. How many vehicles are in your fleet?

Additional Comments

Number of Vehicles		
--------------------	--	--

3. Do your vehicles follow predictable routine routes?

Yes	
No	
Both	_____ % yes _____ % no

4. Do your vehicles refuel at a centralized fueling location? (i.e. do vehicles refuel onsite or at a specific location, typically not a station opened to the general public)

Yes	
No	
Both	_____ % yes _____ % no

5. What is your approximate fuel consumption per year?

Gas (per vehicle)	litres	gallons
Diesel (per vehicle)	litres	gallons
Gas (per total fleet)	litres	gallons
Diesel (per total fleet)	litres	gallons

6. What is your approximate mileage per year?

Gas (per vehicle)	km	miles
Diesel (per vehicle)	km	miles
Gas (per total fleet)	km	miles
Diesel (per total fleet)	km	miles

7. What are your approximate fuel costs per year?

Gas (per vehicle)	\$	CDN / US
Diesel (per vehicle)	\$	CDN / US
Gas (per total fleet)	\$	CDN / US
Diesel (per total fleet)	\$	CDN / US

8. What type of daily operation(s) is your fleet involved with? If more than one operation, please indicate percentage.

Administrative		%
Construction		%
Delivery Service		%
Maintenance		%
Passenger Travel		%
Trucking / Freight		%
Other (please specify)		

9. Please indicate from the list below, which alternative fuel(s) you are most familiar with and why.

		Why
Biodiesel		
Compressed Natural Gas		
Electricity		
Ethanol		
Propane		
None of the Above		

DECISION MAKING

10. Have you ever considered using alternative fuels for your fleet?

Yes	
No	

11. Do you have current information of the various alternative fuels to determine which fuel is most suited for your fleet?

Yes	
No	

12. Rank the table below as it relates to your decision to move towards using alternative fuels (1 is highest motivator and 10 is lowest motivator).

Acquisition of alternative fuel vehicle not required	
Corporate image	
Economic incentives (i.e. rebates, tax considerations, etc.)	
Environmental concerns	
Fuel consumption (equivalent to gas / diesel)	
Fuel price (equivalent to gas / diesel)	
Government regulations / policy	
Health concerns (air quality)	
Kyoto Protocol	
Vehicle conversion not required	
Other (please specify)	

13. Rank the table below as it relates to your decision to move towards using alternative fuels. (1 is highest deterrent and 10 is lowest deterrent)

Cold start issues	
Fuel more costly	
Lack of refueling stations	
Low alternative fuel vehicle availability	
Low fuel consumption	
Maintenance issues	
New alternative vehicle acquisition costly	
Safety issues	
Vehicle breakdowns	
Vehicle conversions costly	
Other (please specify)	

EXPERIENCE WITH ALTERNATIVE FUELS

If you do not use alternative fuels in your fleet please answer questions 14-16. Once you have answered question 16 the survey will be complete

If you use alternative fuels in your fleet please answer questions 17-24. Once you have answered question 24 the survey will be complete.

14. Please specify any other reason(s) why you have not considered alternative fuels for your fleet.

1	
2	
3	
4	
5	

15. Please specify any other factor(s) that might encourage you to switch to alternative fuels in the future.

1	
2	
3	
4	
5	

16. Please provide any other comment(s) or recommendation(s) about the survey.

1	
2	
3	
4	
5	

17. What type of alternative fuel/vehicle usage does your fleet consume annually?

	Number of Vehicles	Total Consumption	
		Litres	Gallon
Biodiesel			
Compressed Natural Gas			
Compressed Natural Gas Bi-Fuel (uses gas or compressed natural gas)			
Electric (fully electric)			
Electric Hybrids (uses gas and electric)			
Ethanol- 10% (uses 10% ethanol with 90% gasoline)			
Ethanol-E85 Flexible Fuel (uses 85% ethanol with 15% gas or 100% gas)			
Propane			
Propane Bi-Fuel (uses gas or propane)			
Other (please specify)			

* Note: If total consumption does not equal question 5, please explain.

18. Did your fleet experience any of the following benefits while using your alternative fuel(s) of choice?

	Biodiesel	Compressed Natural Gas	Compressed Natural Gas Bi-Fuel	Electric	Electric Gas Hybrid	Ethanol at 10%	Ethanol-E85 Flexible Fuel	Propane	Propane Bi-Fuel	Other (please specify)
Enhanced Corporate Image										
Fuel Cost Savings										
Health Benefits (Air Quality)										
Improved Vehicle Performance										
Increased Environmental Performance										
Vehicle Maintenance Cost Savings										
Other (please specify)										

19. Did your fleet experience any of the following problems while using your alternative fuel(s) of choice?

	Biodiesel	Compressed Natural Gas	Compressed Natural Gas Bi-Fuel	Electric	Electric Gas Hybrid	Ethanol at 10%	Ethanol-E85 Flexible Fuel	Propane	Propane Bi-Fuel	Other (specify)
Cold start issues										
Fuel more costly										
Lack of refueling stations										
Low alternative fuel vehicle availability										
Low fuel consumption										
Maintenance issues										
New alternative vehicle acquisition too costly										
Safety issues										
Vehicle breakdowns										
Vehicle conversions too costly										
Other (please specify)										

20. Was your decision to use your alternative fuel(s) of choice over other alternative fuel options, influenced by any of the following factors?

	Biodiesel	Compressed Natural Gas	Compressed Natural Gas Bi-Fuel	Electric	Electric Gas Hybrid	Ethanol at 10%	Ethanol-E85 Flexible Fuel	Propane	Propane Bi-Fuel	Other (specify)
Availability of fuel										
Availability of reliable information on the fuel										
Availability of vehicles										
Fuel consumption										
Heard it was successful in other fleets										
New alternative fuel vehicle(s) not required										
Price of fuel same/cheaper than gas or diesel										
Vehicle(s) conversion not required										
Other (please specify)										

21. Please specify any other reason(s) why you are using alternative fuels in your fleet.

1	
2	
3	
4	
5	

22. Please specify any other factor(s) that might encourage you to switch to using other types of alternative fuels in the future.

1	
2	
3	
4	
5	

23. Please specify any reason(s) why you may stop using alternative fuels?

1	
2	
3	
4	
5	

24. Please provide any other comment(s) or recommendation(s) about the survey.

1	
2	
3	
4	
5	

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