Bio-diesel: The New Driving Force Behind Dalhousie's Maintenance Vehicles

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ENVS 3502
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Abstract:

This project investigates the feasibility of running Dalhousie University's maintenance vehicles on bio-diesel. This project proposes the use of an on campus bio-diesel refinement facility to convert waste cooking oil produced by on campus dining facilities to create fuel. The methods used to deduce our conclusions are as follows: surveys, interviews, and exploratory research. Through our research we found that it environmentally, socially, and economically viable for Dalhousie to run its maintenance vehicles on bio-diesel.

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Introduction

Background and Setting:

The Talloires Declaration is a ten-point action plan that encourages incorporating sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities. Over 300 university presidents and chancellors in over 40 countries have signed this declaration (University Leaders for a Sustainable Future, 2001). When Dalhousie signed the Tallories declaration in 1999, the school agreed to take reasonable measures to create a more sustainable campus. Unfortunately, Dalhousie still runs its maintenance vehicles on unsustainable fossil fuels despite the existence of viable alternatives. The greenhouse gasses emitted today by vehicles around the world are contributing to the warming of the earth. Those who stand to benefit from the consumption of fossil fuels, like Kenneth P. Cohen, vice president for public affairs at Exxon Mobile, are now admitting that the use of fossil fuels is destroying our environment. Cohen has stated that "the global ecosystem is showing signs of warming, particularly in polar areas and the appropriate debate isn't on whether the climate is changing, but rather should be on what we should be doing about it" (Mufson, 2007). This type of thinking on behalf of those whose livelihoods depend on the sale of fossil fuels is clear proof that a fundamental change must be made with regards to our consumption of fossil fuels. A first step in this change would be shifting to the use of alternative fuels, such as bio-diesel. Bio-diesel is an alternative form of fuel that can be derived from the processing of many natural resources such as vegetable oil or locally abundant fish oil. In order to make bio-diesel, the oil must go through a process called transesterification. The main ingredient in our case will be canola oil, acquired free of

charge form on campus dining facilities. The process of transesterification is completed when a fat or oil is reacted with a catalyst like potassium and an alcohol like methanol in order to produce glycerin and methyl-esters or, bio-diesel. The alcohol is recovered and reused (Appendix 1). Due to the fact that global warming is a growing concern among Canadians and people around the world, it is clear that those who are capable of making a fundamental change have the responsibility to take action. Through the use of 100% bio-diesel in Dalhousie's maintenance vehicles the fleet could cut its CO_2 emissions by 78.3%, CO emissions by 43.2%, HC emissions by 56.3 % and particulates by 55.4%. Even if the university were to run its fleet on a 20% bio-diesel and 80% diesel fuel blend the fleet would still reduce its CO_2 emissions by 15.7 %, its CO emissions by 12.6%, HC emissions by 11% and particulates by 18% (Ellis, 2004). (Appendix 2) This project investigates the feasibility of converting Dalhousie's Maintenance vehicles to run on Bio-diesel. If Dalhousie's maintenance vehicles are converted, it will not only make the university more sustainable by lowering emissions, but will also act as a beacon showing that viable alternatives to fossil fuels exist and can be practically implemented. Our rational behind this project includes setting the stage for a large-scale fundamental change to take place in Canadian society, starting with Dalhousie, by demonstrating the feasibility of bio-diesel use on campus.

Problem Stated:

The greening the campus movement strives to integrate sustainable teaching into all disciplines of higher education, increase communication between campuses, the communities they are a part of, as well as to integrate sustainable practices into the universities operations. With the current global warming crisis at hand, reducing

Dalhousie's dependence on conventional fossil fuels should be seen as a cornerstone for the greening the campus movement. The consumption of fossil fuels on a university campus, given a reasonable alternative, is completely unacceptable. Therefore, the problem that is addressed by this project is Dalhousie's continued use of fossil fuels despite the clear environmental and social harm caused by their use.

Purpose of Project:

The purpose of this project is to discover if it is feasible on an environmental, economic, and social level to run Dalhousie's maintenance vehicles on bio-diesel. The research conducted was meant to deduce whether or not it is in fact viable to, in the future, run Dalhousie maintenance vehicles on bio-fuel through the use of surveys, interviews, and exploratory research. This report includes the results the surveys, interviews, and exploratory research conducted, as well as a critical analysis of the situation. This report will prove, using the above stated methods, that in fact it is financially, environmentally, and socially beneficial for the university to operate its maintenance fleet on bio-diesel. Essentially, it is feasible for bio-diesel to become the new driving force behind Dalhousie's maintenance vehicles.

Methods

The research question that we used to guide us through our project is as follows: Is switching one (or more) Dalhousie maintenance vehicles to bio-diesel environmentally, socially, and financially viable? In light of our research question we used three typological research objectives: exploratory, descriptive, and relational. The exploratory research was done to better our understanding surrounding the implications of bio-diesel use in North America. This was done through a number of case studies of

other universities that had already implemented successful bio-diesel projects. There has been a vast amount of research conducted with regard to the technical workings of a variety of bio-fuels, their environmental impacts, as well as comparisons drawn between conventional fuels and bio-diesel. Information regarding other universities projects was found on the internet, in journal articles, and in similar greening the campus projects.

Descriptive research was conducted in order to gain a better understanding of what vehicles could be converted, the processes involved in retrofitting the vehicles, and the opinions of the Dalhousie community with regard to our research question. The relational aspect of our research dealt with the differences in cost, efficiency, emissions, and ease of use between bio-diesel and conventional fuels.

Our project also assessed the interest in and opinions of the Dalhousie community on the conversion of maintenance vehicles to bio-diesel through the use of a sampling tool in the form of a questionnaire (Appendix 3). Our survey was non-probabilistic, primarily qualitative, and was conducted in a "hap-hazard" manner at various locations on the university campus. Our sample population consisted of 200 individuals from the Dalhousie community. A sample size of n=200 was chosen due to the nature of non-probabilistic sampling techniques (Palys, 2007). Also, we chose a non-probabilistic survey technique because a probabilistic survey needed more time and resources then we could allocate. There are three reasons why we conducted this survey. First, we wanted to have quantitative data that shows that the university population would support a bio-diesel project at Dalhousie. Second, we wanted to see if the student population would be willing to fund a project of this nature. Third, we wanted to know if a bio-diesel project would attract prospective students. By demonstrating that this project was important to

the university population, and that students would be willing to fund this project, we believe that decision makers at Dalhousie will look more seriously at a bio-diesel project.

For further insight, a face-to-face interview was conducted with Dave Ronn, a local bio-fuel expert, and former director of the Maritime Bio-Diesel Co-op (Appendix 4). Through this interview we ascertained a valuable amount of qualitative information on bio-diesel, as well as basic local knowledge with regard to the use of bio-diesel in the Halifax area. Our main goal for this interview was to gather information about the implications surrounding the use of bio-diesel in the cold Canadian climate. We had previously conducted some research that indicated that B100 (100% bio-diesel) could not be used at certain temperatures because of increased viscosity, and wanted some local expertise on dealing with this issue. We also wished to attain further insights into the practicality of using bio-diesel on an institutional and personal level. This interview was conducted in person and took just over one hour. Dave Ronn gave us his history of working with bio-diesel, some solutions with regard to our climate problems, information pertaining to the manufacturing of bio-diesel, and some additional ideas that he felt would aid our project.

A number of other experts where contacted in order to gain more knowledge pertaining to this project. A face-to-face interview was conducted with Derrick Hines, the food services director at Dalhousie University to learn more about the waste oil produced on the Dalhousie campus (Appendix 5). Email correspondence was conducted with Paul Bourgeois from facilities management to find out more about the universities maintenance fleet, as well as John Houck, the bio-fuel project manager at Wilson fuels to find out more about the costs of commercial bio-diesel (Appendix 6).

Through the synthesis of the information gathered from the above methods, we have generated accurate, concise, and pertinent information that has assisted is answering our research question. By using a variety of sources and methods (triangulation), was beneficial in making our conclusions more valid. The information that we have gathering was relevant to our problem for a number of reasons. By gathering the views and opinions of the Dalhousie community, we not only understand that the university supports our project, but also understand their commitment to this project. The interview portions of our research gave us the necessary local knowledge which has mitigated the problems of bio-diesel vehicles in colder climates.

By gathering hard facts that support the effectiveness, efficiency and reliability of bio-diesel, and reviewing other successful university bio-diesel projects, we can confidently state that the conversion of Dalhousie maintenance vehicles to bio-diesel will benefit the university environmentally, socially and financially. Through the use of these research methods we have been able to effectively, and with as little bias as possible, answer our research question.

Results

The graphical representations of our survey questions were closely examined and conclusions were drawn from the data. The first question from the questionnaire, aimed at displaying the diversity in our sample population (n=200), shows that 39% of the population surveyed were science students, 38% were arts students, 11% were business students, 7% were staff, 3% were faculty, and finally 2% were other (not associated with the institution) (Appendix 7, figure 1). The results from the second survey question were geared towards gaining the overall feeling of the sample population on the issue of

whether or not bio-diesel will positively increase the environmental image of Dalhousie University. The results revealed that 75% agreed that it would boost Dalhousie's environmental image, 25% moderately agree, 1% disagreed, and 1% strongly disagreed (Appendix 7, figure 2). The third and most quantitative question, asked how much money students would be willing to pay per semester to see a functional bio-diesel project implemented on campus. The graph demonstrates that 33% of the sample population would be willing to give $3-5 per semester, 24% were willing to give $6+ per semester, 21% were willing to give $1-2 per semester, 13% were not willing to pay any extra amount, and the question did not apply to 9% of the population surveyed (faculty, staff, or non-Dalhousie students) (Appendix 7, figure 3). The fourth question was more qualitative, asking if an on-campus bio-diesel project would make Dalhousie University more attractive to prospective students, the results displayed that 59% of the population said that it would, 21% didn't know, and 20% said no (Appendix 7, figure 4).

The majority of the qualitative data was collected from face-to-face interviews. Interviews were administered to Derrick Hines, Aramark food service director for Dalhousie University, and Dave Ronn, director of NSPIRG, Nova Scotia Public Interest Research Group. The overall trends and suggestions of the interviews were reviewed and examined. The interview with Derrick Hines revealed the used canola oil provided by on campus dining facilities is not only compatible for making bio-diesel, but is also readily available and free (Appendix 5). After the interview, we measured the oil reciprocal outside of Howe Hall, made some basic calculations, and found that the on campus dining facilities produce 1143 liters of used vegetable oil every two weeks, approximately 81 liters per day. The interview with bio-diesel expert Dave Ronn gave us

insight into both the most practical methods for the production of bio-diesel, as well as some solutions for running bio-diesel vehicles in colder climates (Appendix 4). The interview also provided us with valuable information regarding the benefits and costs of doing this type of project on a university campus (Appendix 4).

Along with the face-to-face interviews, contact through email was made with Paul Bourgeois, Dalhousie's resource manager, as well as John Houck, Wilson fuels bio fuel project manager. Paul Bourgeois not only gave us a list of the current maintenance vehicles on campus (Appendix 8), but also gave us valuable information regarding the amount of fuel consumed monthly on Dalhousie's campus by the maintenance vehicles. Dalhousie's maintenance vehicles consume approximately 5,000 liters of fuel (gasoline) per month (Paul Bourgeois, 2007) (Appendix 6). The information provided by John Houck was valuable in our cost analysis. He states that "Our pricing for this product (fish oil based fuel) is approximately the same as that of our petroleum based diesel transportation fuel (clear diesel). There is no appreciable difference between the conventional methyl ester bio-diesel and the fish oil based ethyl ester fuel that we provide" (Houck, 2007).

Exploratory research, along with some simple calculation, provided the basis for our cost analysis of the project. It was found that if each student at Dalhousie paid an additional $5 for one semester, $77,500 would be available to fund this project. ELSBETT, a German company offering bio-diesel conversion kits listed the price of a conversion kit for comparable trucks to Dalhousie's maintenance vehicles to be $2,623.87 CAD. For Dalhousie to convert four maintenance vehicles (the current fleet size) to run on bio-diesel, it would cost $10,495.48 CAD. The costs involved with the

purchasing of the module bio-diesel processor were acquired from a Tennessee based company by the name of Continental Bio Industries co. The cost of the processor is $17,975 CAD (Continental Bio Industries co., 2007). The start up cost of the project including the conversion kits, and the processor is $28,470.48 CAD. With fuel costs at $1.11 per liter in Halifax N.S. as of April 2, 2007, Dalhousie is paying $5,550 per month to run its maintenance fleet. This has Dalhousie spending $333,000 in fuel cost over the next five years keeping the price of fuel constant.

Discussion

The fossil fuels used today to power the majority of our society's vehicles are one of the major contributors to greenhouse gas emissions, which are perpetuating the current global climate change crisis. Greenhouse gas emissions are primarily produced through the burning of fossil fuels which was recently addressed in a report from the Intergovernmental Panel on Climate Change (IPPC). The IPPC stated, "fossil fuels remain the dominant form of energy utilized in the world, and energy use accounts for more than two thirds of the greenhouse gas emissions" (Intergovernmental Panel on Climate Change, 2001). The IPPC also clearly states, "the vast majority of scientists agree that global warming is real, it's already happening and that it is the result of our activities and not a natural occurrence" (Intergovernmental Panel on Climate Change, 2006). This statement clearly outlines that climate change is real and furthermore that humans are the driving force behind global warming.

Universities represent an important pillar in our society on which the formation of knowledge is generated. In many cases, universities are looked upon to set the stage for

future changes in our world. Thus, we argue that universities have an inherent responsibility to make positive social and environmental changes wherever and whenever possible. The "Greening the Campus" movement is a realization of this responsibility and an attempt to evoke positive environmental stewardship within universities.

Our Project is an investigation into the feasibility of implementing a bio-diesel program for the maintenance vehicles at Dalhousie University. The implementation of a bio-diesel program would reduce Dalhousie's dependence on traditional fossil fuels, lower the universities $C0_2$ emissions, reduce the universities ecological footprint, and portray Dalhousie as positive environmental role model. Our project also investigated the feasibility of using waste cooking oil produced by on campus food services as the main component of the bio-diesel to be used in the operation of Dalhousie's maintenance vehicles. By using the waste oil produced on campus our bio-diesel project would be taking a waste product and recycling it into a useful resource. This element of our project would be an act of "closing the loop", a fundamental goal of the "Greening the Campus" movement where university campuses become more self sustained.

Through a literature review of relevant publications that focused on the use of bio-diesel, our results have illustrated that vehicles operating on a B100 blend of bio-diesel would greatly reduce greenhouse gas emissions (appendix 2). It also becomes evident that the lower the blend of bio-diesel, the lower the environmental benefits associated with using bio-diesel as an alternative fuel (appendix 2). The cold climate of Nova Scotia strongly influences the blend of bio-diesel or the procedures surrounding the use of bio-diesel, for Dalhousie maintenance vehicles. A B100 blend would become too viscous in the cold weather and would not pass freely through a cold engine. A possible

solution to this potential problem is mixing the bio-diesel with various additives to prevent the fuel from becoming viscous. However, adding chemicals to the bio-fuel blend could have adverse environmental consequences (appendix 4). Local bio-diesel expert, Dave Ronn suggested various solutions to overcome this problem. Dave Ronn suggested that the vehicles could be kept in a warm indoor environment, which would keep the fuel in a liquid state. He also suggested that the tanks only be filled with enough fuel to complete a task, and never to leave excess fuel sitting in the vehicles tank. These solutions would enable the maintenance vehicles to run on a lower blend or even 100% bio-diesel which would maximize the environmental and economical benefits that bio-diesel can offer.

Our haphazard, non-probabilistic survey of 200 students, staff, and faculty was fairly representative of the Dalhousie community as evident from the graph of our sample population demographics (appendix 7, figure 1), adding validity to our research. This survey was used to gather information for social and economical considerations surrounding the feasibility of retrofitting Dalhousie's maintenance vehicles to operate on bio-diesel.

When considering the feasibility of converting Dalhousie's maintenance vehicles to operate on bio-diesel economic costs and benefits of the proposed program must be considered. It was understood early in our research that for Dalhousie to implement a new program the payback must fall within a five-year timeframe. The reasons behind this temporal boundary are a result of the structure of the universities budget. In order to ensure the feasibility of this bio-diesel project we wanted to consider the possibility of implementing it without the financial aid of the university. Our survey asked how much

an enrolled student would be willing to pay per semester to fund our project. The results illustrated that only 13% of our sample population were not in support of a marginal onetime increase in tuition fees to fund our project. Only 9% felt that the increase didn't apply to them. The remaining 78% of the sample population agreed to a minimum $1- 2 increase in tuition fee's. With the current student population at Dalhousie being roughly 15,000 there would be more than enough money to retrofit the vehicles and purchase an on-campus automated refining processor to convert large amounts of waste oil to bio-diesel. It is also important to note that at the current time Dalhousie does not own any diesel powered maintenance vehicles. Bio-diesel can only be run through a diesel engine; so converting the fleet at the present time would not make sense. However, looking at the current list of maintenance vehicles (appendix 8) one can deduce that the university upgrades their vehicles roughly every 10 years. Because of this, our project recommends that the next time the university looks to upgrade a vehicle, they consider a diesel powered one seeing as the price is comparable to a gasoline powered truck. Only when the university begins to acquire a fleet of diesel vehicles would the implementation of our project be feasible. However, once Dalhousie acquires a full fleet of diesel vehicles, all conversions could be made, and the university maintenance fleet could be operating on bio-diesel, eliminating the cost associated with purchasing traditional fossil fuels off campus. Our research has also illustrated that the university produces sufficient amounts of waste oil available for a functional bio-diesel program. This project also considered the possibility that Dalhousie might have signed a contract with an outside organization to oversee the removal of the waste oil generated by the university. Through the face-to-face interview with Derrick Hines, it was found that although the receptacle is emptied

approximately every two weeks by Rothsay Recycles, neither Aramark nor Facilities Management were aware of any contract or costs associated with the removal of the oil (appendix 5). Our research also uncovered that Dalhousie may need to collect waste oil from the surrounding community as the amount of waste oil produced by the university is lower during the summer months. After contacting John Houck, Wilson fuels representative, it was clear that purchasing fuel from them was a simple alternative. Furthermore, the cost per liter decreases significantly as the batch size increases (appendix 4). Dalhousie would also want to refine large batches of bio-diesel in order to achieve efficient testing practices, which include lab tests used to ensure consistency of the fuel being refined. If the university were to refine small batches, it would require testing every small batch before use in the vehicles. Large batches obviously reduce the frequency of tests required, as the consistency would be the same for a large batch (appendix 4). When the university eliminates its dependence on outside fuel resources, the savings would quickly outweigh the initial costs of implementing the project. Furthermore, Dodge and other automobile manufactures have changed their policies surrounding the use of bio-diesel in specified diesel engines stating that it will no longer void the manufactures warranty (National Bio-diesel Board, 2006). This is a major milestone surrounding the feasibility of implementing our project, as the perceived risk of voiding warranties on new vehicles operating on bio-diesel would be a major concern for Dalhousie administration.

Our research unearthed numerous social elements surrounding the feasibility of implementing a bio-diesel program for maintenance vehicles at Dalhousie. Through our questionnaire we discovered that the majority of the sample population felt that

implementing a bio-diesel program for the maintenance vehicles would create a better overall environmental image of the university. It is important that the university community sees this bio-diesel project as beneficial to the overall environmental image of institution and not as an un-influential project that would waste both time and money. It is also important that the students, staff, and faculty see the benefits of converting the university maintenance vehicles to operate on bio-diesel. It will influence the minds of many who will be in position to make decisions in the outside world, spreading the environmental stewardship that they were immersed in at Dalhousie.

Another social benefit illustrated in the results is that over half the population surveyed felt that implementing a bio-diesel program at the university would make the institution more attractive to prospective students (appendix 7, figure 4). This fact makes a bio-diesel program attractive to university administration that are constantly looking for new inventive ways to attract prospective students to enroll at Dalhousie. The greater the number of students that find Dalhousie as an attractive option for post secondary studies would only be beneficial for the universities rankings against other institutions. Furthermore, this increased popularity due to a bio-diesel project would not only lead to greater profit, but also proves that Dalhousie is a leader in the fight against climate change and is committed to the 'Greening the Campus" movement.

Our research also illustrated that the feasibility of Dalhousie implementing a bio-diesel program for its maintenance vehicles is greatly increased with the institutions acceptance of numerous environmental declarations, such as the "Halifax Declaration" and the "Talloires Declaration". Dalhousie signed the Talloires Declaration in 1999, which bounded the university to operating in accordance to the 10 actions of the

declaration. The 10 actions generally include generating environmental stewardship through awareness, education, and implementing programs of sustainable practice on all levels (local, national, and international). The 5th action outlined by the Talloires Declaration is the most applicable to this project, "Practice Institutional Ecology". This is to be "achieved through setting an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations" (University Leaders for a Sustainable Future, 2001). Implementing our proposed bio-diesel project would be one way that Dalhousie could satisfy its requirements outlined by the Talloires Declaration by not only reducing the harmful tailpipe emissions from its maintenance vehicles, but also effectively "closing the loop" by recycling waste cooking oil produced within the university. Dalhousie should convert its maintenance vehicles to bio-diesel in order to illustrate that the university is accountable for the declarations it has signed.

Our exploratory research illustrated that it is feasible for Dalhousie to convert its maintenance vehicles to operate on bio-diesel because other North American universities have similar programs in place. Such universities include the University of British Columbia, the University of Calgary, and the University of Tennessee to name a few. The fact that other universities have overcome issues pertaining to the implementation of bio-diesel to power on campus vehicles only further proves that it is a feasible alternative to traditional fossil fuel usage on university campuses. In the case of the University of British Columbia their bio-diesel initiative was sparked by the interest of two students. From our questionnaire, it is obvious that the population of Dalhousie University sees a bio-diesel project as worthwhile and could potentially follow in the footsteps of the

University of British Columbia's student run program (appendix 7). The University of Calgary is another example of a successful on-campus bio-diesel project operating within the constraints of a cold Canadian climate. Furthermore, the University of Calgary has stated that it was able to reduce its $C0_2$ emissions by 67.7 tones simply by switching their maintenance equipment to operate on bio-diesel (University of Calgary, 2003). The University of Calgary when questioned on the success of their bio-diesel project stated, "Using bio-diesel has also resulted in savings on fuel bills for grounds department, which purchased 18,426 litres of diesel in the last year. Bio-diesel also does a better job of lubricating engines than ordinary diesel" (University of Calgary, 2003). In light if the University of Calgary's success, the real question is why Dalhousie has not already converted their maintenance fleet to bio-diesel. It seems as though Dalhousie is quickly falling behind in developing a more environmentally sustainable campus and needs to take action to become more environmentally sound.

Conclusion

In conclusion, our research illustrates that the Dalhousie University community supports the retrofitting of university maintenance vehicles to operate on bio-diesel. Based on our results, the majority of the population surveyed support a marginal increase in tuition fees to fund the project. Using waste oil from on campus dining facilities to create the bio-diesel is feasible, sustainable, and a viable solution in reducing Dalhousie's dependence on traditional fossil fuels. Finally, universities have an obligation to promote and implement sustainable practices, as they are in the position to promote change in the world through education. The results and conclusions drawn from this paper can be used

in the future by Dalhousie policy makers when deciding whether or not to implement a bio-diesel project on campus.

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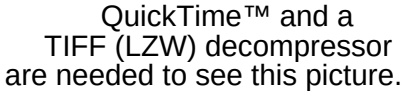
Appendix 1.
Bio-diesel refinement process.



Appendix 2.

Bio-diesel emissions compared to conventional diesel.

Emission	B100	B20
C0	-43.2%	-12.6%
HCs	-53.3%	-11.0%
N0x	+5.8%	+1.2%
C02	-78.3%	-15.7%
Particulates	-55.4%	-18.0%
Air Toxics	-60 to -90%	-12 to -20%
Mutagenicity	-80 to -90%	-20%

Appendix 3.

Dalhousie Bio-Diesel Questionnaire
ENVS 3502
Interviewers: Zak Bush, Scotty Sherin, Luke Godin & Dean Petty

We are a group of Dalhousie students investigating the potential benefits of converting Dalhousie University maintenance vehicles to bio-diesel (an alternative fuel source produced through the refinement of vegetable oil). The purpose of this survey is to gather information regarding student and faculty members' views surrounding this subject. If at any time during this survey you feel uncomfortable answering the questions we ask you to please feel free to skip that question or withdrawal from answering the survey. We thank you very much for your time and can assure this information will be kept confidential and will be used strictly in an appropriate academic manner.

1. Circle the category below that best describes your involvement with Dalhousie.
    a. Student (from which department: _____)
    b. Staff
    c. Faculty (from which department: _____)
    d. Other (Please specify: _____)

2. For the following statement, indicate below the extent to which you agree or disagree: Having maintenance vehicles on Dalhousie campus run on bio-diesel would create an overall better environmental image of the university.
    a. Agree
    b. Moderately agree
    c. Disagree
    d. Strongly disagree

3. How much of an increase in tuition fees would be acceptable (per semester) for you to have current Dalhousie maintenance vehicles retrofitted to bio-diesel?
    a. $ 0
    b. $ 1 – 2
    c. $ 3-5
    d. $ 6+
    e. Does not apply

4. Do you think having a fleet of bio-diesel vehicles will make Dalhousie University more attractive to prospective students?
    a. Yes
    b. No
    c. Don't know

Please explain: _____

Appendix 4.

Bio-diesel Expert Interview
Interviewers: Scott Sherin and Zak Bush
Interviewee: Dave Ronn, Director of NSPIRG Nova Scotia Public Interest Research Group.
Date: March 19, 2007.

Q. What is your experience with bio-diesel?
A. I was a Dal student who did my thesis on converting vegetable oil to bio-diesel using natural enzymes instead of traditional chemicals. I also helped create the Maritimes Bio-diesel Coop in 2002. Later I left the Coop to go to New Brunswick to create automated bio-diesel refining equipment.

Q. What is the difference between an automated refining system and a manual one?
A. Basically that the manual systems are extremely labor intensive, and hard to regulate and keep batches consistent. To convert an oil drum size of bio-diesel takes up to six hours manually. The Automated system cuts down on batch time, and allows you to make more bio-diesel at once making the process more cost effective.

Q. Which type of system would be best for our project?
A. The automated system would be better for this type of project because it not only cuts down on the amount of time it takes to make batches, but also is more cost effective and consistent in the quality of fuel produced. In the case of bio-diesel production bigger is better. Because it is more cost effective to make lots of bio-diesel, you guys should look into the possibility of heating some of Dalhousie's buildings with bio-diesel as well.

Q. Do you think this type of project is feasible on the Dalhousie Campus?
A. Yeah, Dalhousie should already have a bio-diesel project in the work. Universities are good places for bio-diesel projects because of the amount of labs available, making it easy to test each bio-diesel batch which keeps the fuel consistent. Having these labs readily available keeps the costs associated with testing the fuels down, which is a huge factor for other organizations trying to produce bio-fuel.

Q. In our research we have come across difficulties with running vehicles on bio-diesel in cold climates, is this a real problem and what are the best solutions to overcome it?
A. It is a problem, but you can always blend the bio-fuel with additives which alleviates this problem. However, once you go beyond a B50 mixture, 50% bio-diesel 50% diesel, you lose the majority of environmental benefits bio-diesel has to offer.

Q. Is there any way around this?
A. Dalhousie can always store its maintenance vehicles indoors, which keeps the fuel warm overcoming the cold weather issues. Further, Dalhousie could simply put the amount of fuel required for each task into the vehicle, reducing left over fuel to solidify in the tank.

Appendix 5.

Aramark Interview
Interviewers: Luke Godin and Dean Petty
Interviewee: Derrick Hines, Aramark Food Service Director for Dalhousie University
Date: March 13, 2007

Q. What type of oil is used in the on campus deep fryers?
A. Aramark uses canola oil, which is trans fat free oil for all its cooking services here on campus.

Q. Where does the used vegetable oil go once it is no longer usable in the kitchen?
A. All of the used vegetable oil from the on campus dining facilities is collected in a large black reciprocal at the back of Howe Hall.

Q. How often do the on campus dining facilities change the vegetable oil in their deep fryers?
A. The oil is replaced every five to seven days.

Q. How long does it take for the oil reciprocal to become full?
A. The reciprocal becomes full about every two weeks.

Q. At this point in time, who takes the used oil? And do you pay them for the removal or do they pay you?
A. The oil is removed about every two weeks by Rothsay Recycles, and there are no payments made by either party for the removal of the oil.

Q. Does this mean that if an on campus bio-diesel project was initiated we would have free access to the used oil?
A. Yeah, I don’t see why not if the oil was used for an on campus project you would have priority.

Appendix 6.

Email correspondence from John Houck, Bio Fuel Manager Wilson Fuel Co.

Greetings Scotty,

As you can see, I received this e-mail from Ocean Nutrition. Wilson Fuel is the sole distributor of the ethyl ester biodiesel produced at ONC. Our pricing for this product is approximately the same as that of our petroleum based diesel transportation fuel (clear diesel). There is no appreciable difference between the conventional methyl ester biodiesel and the fish oil based ethyl ester fuel.

Depending on feedstock, the cold temperature cloud point properties of esters can vary between -3^{o}C to +11^{o}C. Wilson's Fuels B-100 product has a cloud point of +6^{o}C. For our climate, the cloud point temperature is too high for normal winter application. This is why we recommend a 5% to 10% Blend (B-5 to B-10). At B5 our product has a cloud point of -18^{o}C and at B-10 our product has a cloud point of -16^{o}C

We would be very interested in supplying Dalhousie with Biofuels. This would include our ethyl ester as well as vegetable oil based methyl esters. Please feel free to contact me to further discuss this opportunity.

Regards,

John Houck, P.Eng.

Bio Fuel Project Manager Wilson Fuel Co. Limited 3617 Barrington St. Halifax, Nova Scotia Canada B2K 2Y3 Tel: (800) 894-5766 Cell: (902) 402-1565 FAX: (800) 595-6427 email: jhouck@wilsons.ca

Email correspondence from Paul Bourgeois, Resource Manager Dalhousie University.

Bourgeois Hi Scott;
On average, we consume about 5,000 litres of fuel (gasoline) per month for our fleet.
Thanks
Paul Bourgeois

Hi Scott;

Please see the attached spreadsheet. Pretty well all of our vehicles are gasoline powered so this might not be very helpful...

Thanks

Paul Bourgeois

Appendix 7.

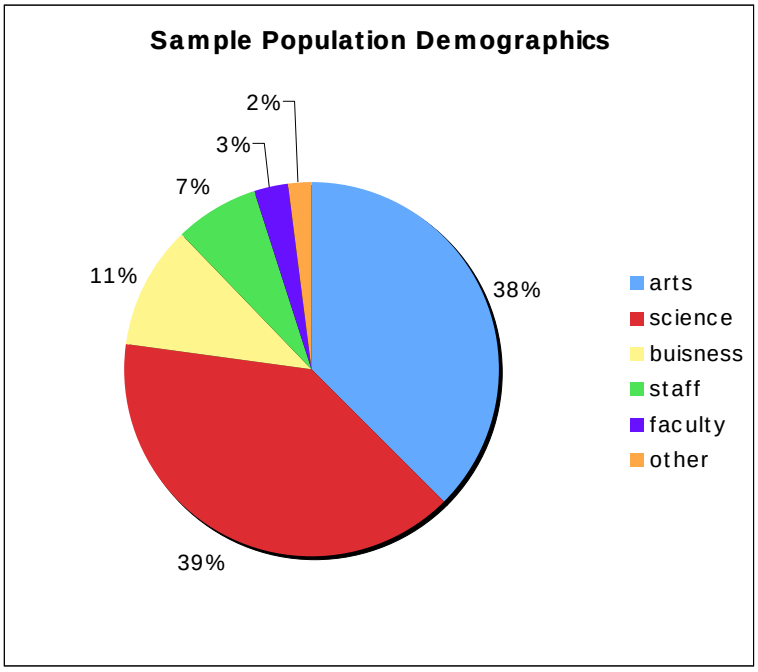


Figure 1. Questionnaire population demographics (n=200) haphazardly sampled on the Dalhousie campus.

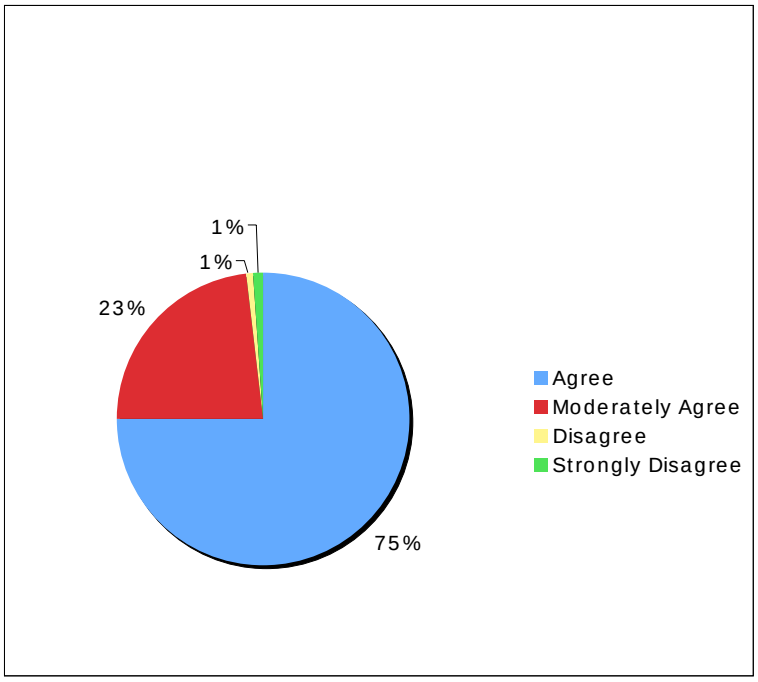


Figure 2. Questionnaire question 2, having maintenance vehicles on Dalhousie campus run on bio-diesel would create an overall better environmental image of the university?

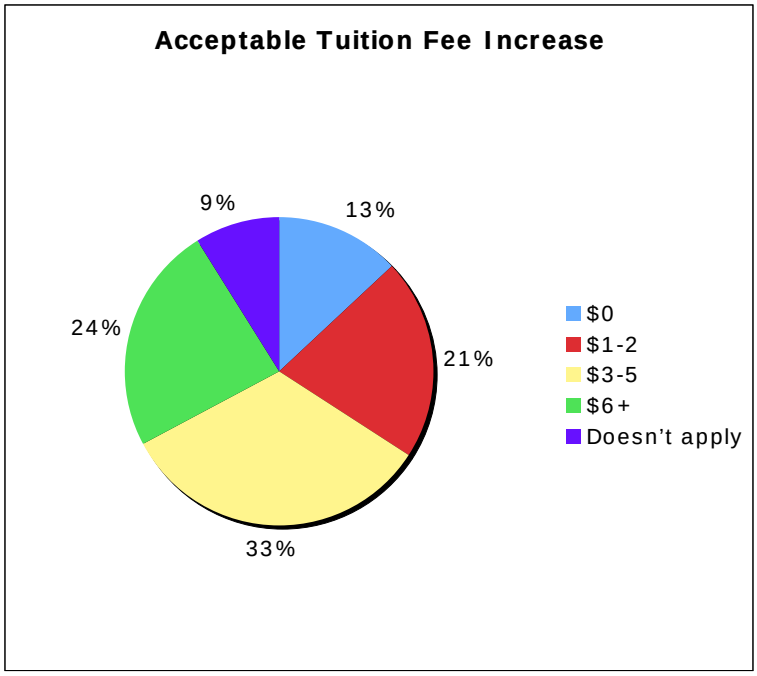


Figure 3. Questionnaire question 3 results, acceptable tuition increases per-semester to convert Dalhousie University's maintenance vehicles to run on bio-diesel.

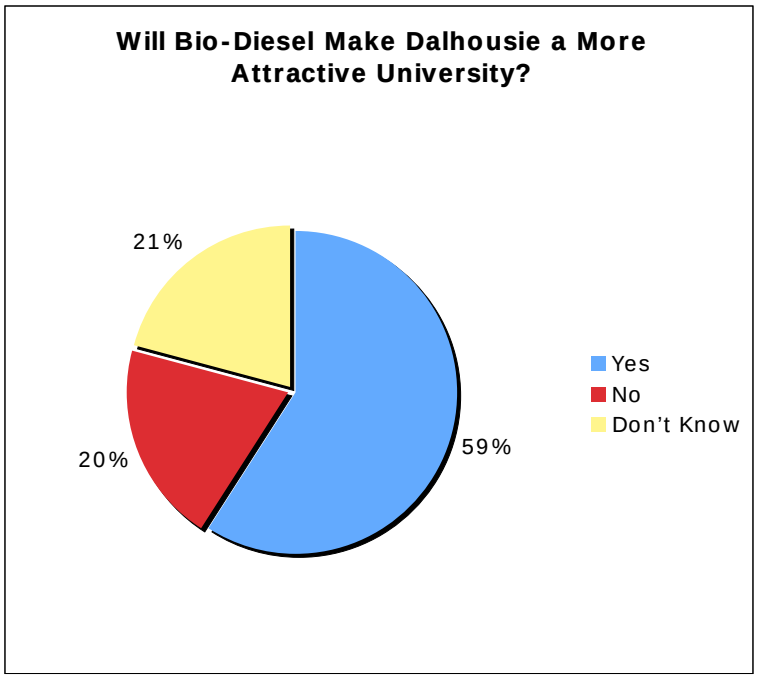


Figure 4. Graphical representation of question four survey results. Would an on-campus bio-diesel project make Dalhousie a more attractive university to prospective students?

Appendix 8.

Department	Year	Make	
Environmental Services			
Grounds	1988	John Deere Tractor	
Grounds (Sexton Campus)	1989	Bobcat 743 Loader	
Grounds	1990	Ford Tractor	
Grounds	1994	Ford F150 Pickup	
Recycling	1995	Ford F700 3 Ton with Box	retired from service
Custodial (Sexton Campus)	1995	Chevrolet 1/2 Ton Pickup	
Trucking	1997	Ford F150 Pickup (1996 on permit)	retired from service
Trucking	2006	GMC G2500 3/4Ton Pickup	
Recycling	1998	Ford E350 Cube Van	retired from service
Recycling	2006	GMC -C6500 Reg Cab TopKick	
Grounds	1999	Dodge Ram 1500 1/2 Ton Pickup	
Trucking	2002	Ford E450 Cube Van	
Trucking	2006	GMC -C6500 Reg Cab TopKick	
Grounds	2003	Bobcat 753 Loader	
Trucking	2003	Dodge Ram 2500 3/4 Ton Pickup	
Trucking	2006	GMC - C4500 Top Kick	
Grounds	2003	Dodge Ram 1500 1/2 Ton Pickup	
Custodial	2004	Chevrolet 2500 3/4 Ton Cargo Van	
Mail Delivery	2004	Chevrolet 2500 3/4 Ton Cargo Van	
Trucking (Library Run)	2004	Chevrolet 2500 3/4 Ton Cargo Van	
Grounds	2005	Chevrolet 1500 1/2 Ton Pickup	
Utility Trailer	2005	Pronovost	
Utility Trailer	2005	Pronovost	
Trades Equipment			
Mechanical Maintenance	1973	Lincoln Welder	
General Maintenance	1992	Bark H - Utility Trailer -great!	

Appendix 9.

ENVIRONMENTAL PROGRAMMES
FACULTY OF SCIENCE
DALHOUSIE UNIVERSITY

APPLICATION FOR ETHICS REVIEW OF RESEARCH INVOLVING HUMAN PARTICIPANTS
UNDERGRADUATE THESES AND IN NON-THESIS COURSE PROJECTS

GENERAL INFORMATION

1. Title of Project: Investigating the Environmental and Economic Costs and Benefits of Converting Dalhousie Vehicles to Bio Fuels

2. Faculty Supervisor(s) Department Ext: e-mail:

3. Student Investigator(s) Department e-mail: Local Telephone Number:

Dean Petty
Luke Godin
Zak Bush
Scotty Sherin

4. Level of Project:
Non-thesis Course Project [X] Undergraduate [ ] Graduate Specify course and number: ENVS 3502

5. a. Indicate the anticipated commencement date for this project: February 27th 2007

b. Indicate the anticipated completion date for this project: April 8th 2007

SUMMARY OF PROPOSED RESEARCH

1. Purpose and Rationale for Proposed Research
Briefly describe the purpose (objectives) and rationale of the proposed project and include any hypothesis(es)/research questions to be investigated.

The purpose of this project is to investigate the viability of converting Dalhousie maintenance vehicles to run on bio-fuels. We will obtain an understanding of how such alternative fuel sources function. We will assess the pros and cons of bio-fuels against conventional fossil fuels. In addition an understanding of students views on this topic will be assessed.

2. Methodology/Procedures

a. ***Which of the following procedures will be used? Provide a copy of all materials to be used in this study.***.

[ ] Survey(s) or questionnaire(s) (mail-back)
[X] Survey(s) or questionnaire(s) (in person)
[ ] Computer-administered task(s) or survey(s)]
[X] Interview(s) (in person)
[ ] Interview(s) (by telephone)
[ ] Focus group(s)
[ ] Audio taping
[ ] Videotaping
[ ] Analysis of secondary data (no involvement with human participants)
[ ] Unobtrusive observations

[ ] Other, specify
_____

b. ***Provide a brief, sequential description of the procedures to be used in this study. For studies involving multiple procedures or sessions, the use of a flow chart is recommended.***

. Background research on the topic
. Development of survey, questionnaire, and interviews
. Data collection (Complete surveys and interviews)
. Data analysis
. Discuss and formulate conclusions from data analysis
. Present findings to relevant actors

3. Participants Involved in the Study

a. ***Indicate who will be recruited as potential participants in this study.***

Dalhousie Participants: [X] Undergraduate students
[X] Graduate students
[X] Faculty and/or staff
Non-Dal Participants: [ ] Children
[ ] Adolescents
[ ] Adults
[ ] Seniors
[ ] Persons in Institutional Settings (e.g. Nursing Homes, Correctional Facilities)

[ ] Other (specify) _____

b. ***Describe the potential participants in this study including group affiliation, gender, age range and any other special characteristics. If only one gender is to be recruited, provide a justification for this.***

. Survey will we non-probalistic and "hap hazard"
. Interview will be self administered to a relevant professional in the field of study

b. ***How many participants are expected to be involved in this study?***

~200

4. Recruitment Process and Study Location

a. ***From what source(s) will the potential participants be recruited?***

[X] Dalhousie University undergraduate and/or graduate classes
[X] Other Dalhousie sources (specify) _____
[ ] Local School Boards
[ ] Halifax Community
[ ] Agencies
[ ] Businesses, Industries, Professions
[ ] Health care settings, nursing homes, correctional facilities, etc.
[ ] Other, specify (e.g. mailing lists)
_____

c. ***Identify who will recruit potential participants and describe the recruitment process.*** *Provide a copy of any materials to be used for recruitment (e.g. posters(s), flyers, advertisement(s), letter(s), telephone and other verbal scripts).*

. Random recruitment for survey questionnaire
. Seek out Dave Ronn, bio-diesel expert

5. Compensation of Participants

Will participants receive compensation (financial or otherwise) for participation? Yes [ ] No [X]
If **Yes**, provide details:

6. Feedback to Participants

Briefly describe the plans for provision of feedback and attach a copy of the feedback letter to be used. Wherever possible, written feedback should be provided to study participants including a statement of appreciation, details about the purpose and predictions of the study, contact information for the researchers, and the ethics review and clearance statement.

Note: When available, a copy of an executive summary of the study outcomes also should be provided to participants.

We are planning on providing a note of appreciation to the relevant interviewee.

POTENTIAL BENEFITS FROM THE STUDY

1. **Identify and describe any known or anticipated direct benefits to the participants from their involvement in the project**.

   None.

2. **Identify and describe any known or anticipated benefits to society from this study.**

   .General understanding of the environmental and economic costs and benefits of bio-fuel usage.
   . Understanding the student bodies' position regarding bio-fuel usage on campus.

POTENTIAL RISKS TO PARTICIPANTS FROM THE STUDY

1. **For each procedure used in this study, provide a description of any known or anticipated risks/stressors to the participants. Consider physiological, psychological, emotional, social, economic, legal, etc. risks/stressors**

   [X] No known or anticipated risks
   Explain why no risks are anticipated: No names will be attained. Participants will have the option to leave the survey at any point. The questions being asked are non-invasive.

   [ ] Minimal risk
   Description of risks:

   [ ] Greater than minimal risk
   Description of risks:

3. **Describe the procedures or safeguards in place to protect the physical and psychological health of the participants in light of the risks/stresses identified in Question 1.**

   None

INFORMED CONSENT PROCESS

Refer to: http://pre.ethics.gc.ca/english/policystatement/section2.cfm

1. **What process will be used to inform the potential participants about the study details and to obtain their consent for participation?**

   [ ] Information letter with written consent form; provide a copy
   [ ] Information letter with verbal consent; provide a copy
   [ ] Information/cover letter; provide a copy

[X] Other (specify) Verbal Agreement

2. If written consent cannot be obtained from the potential participants, provide a justification.

Our questionnaire will only be four questions long, and is intended to complete quickly. It would be overkill to have a written consent form longer than the questionnaire.

ANONYMITY OF PARTICIPANTS AND CONFIDENTIALITY OF DATA

1. Explain the procedures to be used to ensure anonymity of participants and confidentiality of data both during the research and in the release of the findings.

We will not be taking personal information therefore; no confidentiality bridges will be burned.

2. Describe the procedures for securing written records, questionnaires, video/audio tapes and electronic data, etc.

Disclosed in a safe and secure location.

3. Indicate how long the data will be securely stored, the storage location, and the method to be used for final disposition of the data.

[ ] Paper Records
- [ ] Confidential shredding after _____ years
- [ ] Data will be retained indefinitely in a secure location
- [X] Data will be retained until completion of specific course.

[ ] Audio/Video Recordings
- [ ] Erasing of audio/video tapes after _____ years
- [ ] Data will be retained indefinitely in a secure location
- [X] Data will be retained until completion of specific course.

[ ] Electronic Data
- [ ] Erasing of electronic data after _____ years
- [ ] Data will be retained indefinitely in a secure location
- [X] Data will be retained until completion of specific course.

[ ] Other

_____

(Provide details on type, retention period and final disposition, if applicable)

Specify storage location: 1441 South Park St. Halifax N.S

ATTACHMENTS

Please **check** below all appendices that are attached as part of your application package:

[ ] **Recruitment Materials**: A copy of any poster(s), flyer(s), advertisement(s), letter(s), telephone or other verbal script(s) used to recruit/gain access to participants.

[ ] **Information Letter and Consent Form(s)**. Used in studies involving interaction with participants (e.g. interviews, testing, etc.)
[ ] **Information/Cover Letter(s)**. Used in studies involving surveys or questionnaires.
[ ] Parent Information Letter and Permission Form for studies involving minors.
[X] **Materials**: A copy of all survey(s), questionnaire(s), interview questions, interview themes/sample questions for open-ended interviews, focus group questions, or any standardized tests used to collect data.

SIGNATURES OF RESEARCHERS

_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date

FOR ENVIRONMENTAL PROGRAMMES USE ONLY:

Ethics proposal been checked for eligibility according to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans

_____

Signature Date