Biofueled Public Transport for sustainable transportation

A Case Study of Stockholm and possibility in Kathmandu

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Master's Thesis in Geography, 30 credits

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Abstract

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Due to the hotly debated issues of global warming and climate change, the world is constantly looking for a replacement for fossil fuels which have less impact on the environment. Biofuels in recent years has been considered a great solution to this problem. The transport sector has been experimented with these biofuels and Sweden is one of the leading nations in using biofuels in transportation sector. The purpose of this study was to study if the Stockholm’s Biofueled public transportation has been able to meet its objectives of sustainable transportation and what lessons can a third world city like Kathmandu learn from the experience of Stockholm’s biofueled public transportation. Semi-structured interviews were used to collect information from the stakeholders both in Stockholm and Kathmandu. The study showed the importance of tax exemption policy and government support for the biofuels industry. Kathmandu can learn to develop a democratic and accountable public transportation system for a sustainable transportation. Study showed that biofuels promotion is a complicated process and needs lots of social and infrastructural changes. Kathmandu needs to develop an effective tax policies, technological experimentation, social awareness and investment. Kathmandu is not in the position of promoting biofuels itself. So, donor assistance can be a great support to promote biofuels in public transportation in Kathmandu and other third world cities to globally reduce the effect of climate change.

Key Words: climate change, biofuels, public transportation, sustainable transportation, tax exemption, Stockholm, Kathmandu
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I want to thank my family who have constantly supported in my endeavors. They have been my constant source of strength and I wouldn’t be the person that I am today without your love and support. Finally, I want to thank all my friends in Sweden who have been part of my life in Sweden for more than two years.

January 2013

Uttam Moktan
Preface

Coming from a developing nation like Nepal whose urban planning and development lags far behind, I was very impressed by the public transportation system of Stockholm. The buses and the rails take you to the every part of the city at any time and the efficiency of the public transportation is very high. My personal experience of living more than two years in the city showed that the number of people enjoying the public transportation is really high. On top of that, the renewable energy use of the city in public transportation is one of the highest in the world. The situation is very much opposite in my home town Kathmandu. The ever increasing population has led to the problem of uncontrolled urbanization in Kathmandu. With this the demand for vehicles, roads and fuels is also increasing. In this scenario, Kathmandu is very much in need of a better transportation system. So, when the time came of writing a thesis, I was drawn to the topic discussed below. I am really interested to know if biofuels can be used in the public transportation in Kathmandu and if not what the hindrances are.
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1 Introduction

1.1 Background

‘Biofuels mainly refers to ethanol from starch and sugar, biodiesel from vegetable (and animal) oils and biogas from organic waste’ (Hillman, 2011).

The issue of biofuel has been a hot topic of discussion for few decades now. With the increasing problem of global warming and rising price of fossil fuels, the world has been looking for an alternative source of energy. Under Kyoto protocol, Annex I countries have negotiated to reduce their greenhouse gas emissions by 5.2% on average for the period 2008-2012 (Jos, Olivier, Janssens-Maenhout, Peters, & Wilson, 2011) and the EU has set the target at 20% by 2020 (European Parliament, 2009). After the first international oil crisis in 1973, there have been extensive work in the field of alternative fuels. This has been the main driving forces which led biofuels to be considered a better way towards sustainable transportation.

1.1.1 Transportation

Transportation is one of the biggest sectors that are responsible for carbon emissions. Transportation is responsible for 25 percent of the world’s greenhouse gas emissions, and this share is rising. In the EU, the transport sector is responsible for 28% of carbon emissions (Amezaga, Boyes, & Harrison, 2010). In 2008, only 3.29% of the EU’s total transport fuel consumption accounted for renewable transport fuels (EUROSTAT European Commission, 2011). This shows that the transport sector is highly dependent on fossil fuels. To reduce this dependency, the use of biofuels in public transportation is gradually increasing. Bio fuels have the potential to significantly reduce GHG emissions, particularly with the development of advanced biomass technologies that rely on agricultural wastes and cellulosic crops such as switch grass’ (Worldwatch institute, 2006).
1.1.2 The EU

The use of biofuels in transportation is very high in the European cities compared to rest of the world. ‘The availability of the biofuels and ease of implementation due to political programs, city dimensions and startling interest from the public has created demand for an environmentally sound solution in city centers.’ (Martin, 2007). There have been efforts on the EU level to formulate plans and policies which can help to promote biofuels in transportation. One of those initiations are the Directive 2003/30/EC passed by the European Parliament ‘on the promotion of the use of biofuels or other renewable fuels for transport’ in May 2003. This directive aimed at increasing the biofuel consumption in the European Union up to 5.75% by 31 December 2010 (Janssen, Rutz, Hofer, Helm, Landahl, & Ericson, 2007). Similarly the ‘European Technology Platforms on Biofuels’ envisions an ambitious target to increase clean and CO₂-efficient biofuels to cover one-fourth of the EU’s transport fuel needs by 2030.

1.1.3 Stockholm

In Europe, Sweden is one of those countries which are successful in increasing its biofuel share in the fuel consumption. Sweden has the highest share of renewable energy in terms of total energy consumption, with 44.4% in 2008 (EUROSTAT European Commission, 2011). The share of renewable energy in transport was 5.4% in 2009 which is one of the highest in the EU (Energimyndighet, 2010). Stockholm has extraordinary objectives for sustainable development. It is considered one of the cleanest cities in the world and the city won the 2010 ‘European Green Capital Award’ by the EU Commission (European Commission, 2010). For more than 15 years bioethanol city buses has been in use in city of Stockholm and it has been expanding all the time with more than 400 bioethanol buses in 2006 (Janssen, Rutz, Hofer, Helm, Landahl, & Ericson, 2007). Now, Stockholm has the world’s largest fleet of ethanol buses (Green Car Congress, 2010). Therefore, I have focused on Stockholm in my study on the use of biofuels for public transportation.
1.1.4 Kathmandu

The public transport in the third world cities are very much characterized by the opposite of sustainable transportation. ‘Public transport faces severe problems in almost all countries of the developing world, although the situation varies from one country to another and even from one city to another.’ (Vasconcellos, 2001). Kathmandu is a third world city with a poor public transport. From the detailed study of the use of biofuels in public transport in Stockholm it will be interesting to see the possibility and practicality of Biofueled public transport for sustainable transportation in Kathmandu.

1.2 Research Outline and Aim

Sweden and especially the city of Stockholm have been very successful in adapting to the use of biofuels in public transportation compared to rest of the European Union. In this context, it will be interesting to study the tools and mechanisms that were implemented in Stockholm to promote biofuels in public transportation. In the first stance, I wanted to study about the impacts of biofuels on economy and environment; but while pursuing some research I also got interested to understand the motives (reasons) behind giving emphasis on biofuels in public transportation. So, I will also try to identify the motives behind pursuing for biofuels in public transportation. With the increasing attention on sustainable transportation, it will be interesting to study the impact of biofuels use to achieve the objective of sustainable transportation in Stockholm. I will also analyze the possibility of using biofuels in public transport of Kathmandu. In this setting, the overall aim of my project is:

‘To discuss the relevancy of the use of biofuels in public transportation to achieve the aim of sustainable transportation in Stockholm and to study the possibility of biofuels use in the third world city like Kathmandu’

The main research questions guiding my project to achieve the above stated aim are:

- What are the tools and mechanisms that guide the use of biofuels in public transportation in Stockholm region?
What are the perspectives of the stakeholders on the use of biofuels in the public transportation in Stockholm region?

What are the challenges and opportunities for Kathmandu to implement biofuel use in the public transportation?

Chapter 2 will give you theoretical and methodological framework of the study. It is followed by the literature review chapter which gives you knowledge on past researches and studies about the topic. Chapter 4 gives you brief information about Swedish energy policies that are mostly related to biofuels. Chapter 5 provides information regarding Stockholm and tools that are used in Stockholm for Biofueled public transport. Chapter 6 will analyze the interviews taken at Stockholm with the help of SWOT analysis. Chapter 7 will analyze the situation of Kathmandu and also presents the interview analysis of Kathmandu. Chapter 8 provides overall discussion from both Stockholm and Kathmandu and the final chapter concludes the research work.


2 Methodology

The chapter discusses about the theoretical and methodological foundation of my study. It will present the methods utilized for the data collection and also describe how different methods were applied in the study.

2.1 Theoretical Perspective and Framework

There has been clash between the interests of environmental conservation and development for a very long time. On the one hand, the robust progress towards economic prosperity and rampant urbanization has a huge impact on environment and on the other hand, the lack of economic prosperity and unplanned urbanization doesn’t fulfill the basic human needs. It was very important to find the middle ground between environmental conservation and development. When the concept of ‘sustainable development’ was first introduced to find this middle ground by the World Conservation Strategy (WCS) (IUCN, 1980), the concept was dominated by conservationist environmentalist standpoint. Brundtland (World Commission on Environment and Development, 1987) provided a definition of sustainable development which is the official definition and most widely quoted and it defines sustainable development as ‘the development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. (Kirkby, O’keefe, & Timberlake, 1995)

This concept of sustainable development is very fitting for my research work. The world is very much focused on finding and understanding alternative sources of energy that leads to sustainability. ‘Sustainability is the term chosen to gulf the bridge between development and environment’ (Rogers, Jalal, & Boyd, 2008). It is very much important to understand the sustainability aspect of the alternative sources of energy.

The concept of sustainable development has become so much popular that it has become an important tool for policy making for major important institutions of the world like the United Nations, and the World Bank. With time, the context of understanding sustainable development
is also changing. ‘Today there are more challenges as well as opportunities for environment and development’ (Elliott, 2006). Two decades ago the issues of climate change and global warming were not the forefront environmental problems. In the twenty-first century, global warming and climate change is the biggest environmental problem and sustainable development is considered the solution for it.

‘The Global Challenge of Sustainability is now understood to lie in the complex interdependencies of environmental, social and economic development’ (Potter, Binns, Elliott, & Smith, 2004). Most definitions of sustainable development encompass the idea that there are three interdependent pillars of sustainable development: environmental, economic and social (Elliott, 2006). That means to reach the goal of sustainable development all three pillars needs to be fulfilled. With the increasing use of alternative sources of energy, it is important to understand sustainability of these sources.

Energy is in the center of debate of global warming and climate change. To achieve sustainable development and to tackle the problem of global warming, new sources of energy are being experimented. The use of alternative source of energy such as biofuels in transportation sector is rising rapidly. With the issue of global warming and fuel crisis taking the main platform of discussion in the world, it is important to take steps to counteract these issues. So, biofuels has been identified as one of the best alternatives for fossil fuels which helps to reduce global warming and can help to overcome fuel crisis. The concept of sustainable transportation addresses this issue very well. This concept came into use as to address the issues of sustainability that are connected with transportation.

‘Sustainable Transportation is defined by the European Union council of ministers into three-fold parts as a system that:

- Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promises equity within and between successive generations
- Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development
• Limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on land and the generation of noise.’ (Goldman & Gorham, 2006)

As the definition shows that three factors i.e. environmental, economic and social factors needs to be addressed to achieve sustainable transportation. In my research, I will study the impacts of biofuels use in public transportation in Stockholm region and try to analyze whether it helps to achieve sustainable transportation or not.

2.2 Research Strategy

This research project is a qualitative study including stakeholder perceptions on the biofuels use in public transport, and study of the tools and policies available. The project is therefore an exploratory study that provides the basis for on-going research or a follow-up study of the use of biofuels and sustainable transportation.

2.3 Methods and Data Collection

The project is an analysis of the effect of biofuels use in public transportation on the objective of sustainable transportation, studying the in-depth study of Stockholm region as an example and probability in third world city like Kathmandu. For This, I have:

- Collected data in order to map out the dominant stakeholders in the public transportation sector in Stockholm and Kathmandu and access the effects of biofuels use
- Processed data using qualitative analysis
- Assessed gift and vulnerability of using biofuels in public transportation using SWOT analysis.

Several sources were used to extract data including semi-structured interviews.
• Policy and Literature Review: Review of policies and related literatures helped me to understand the driving forces that have shaped the biofuel system in Sweden and City of Stockholm. This helped me to understand the public transportation sector in both Stockholm and Kathmandu in detail. This also helped me to identify the major actors who are involved in decision making position and the driving force behind the implementation of the biofuels. I have come across several published reports located through Stockholm University’s online journal database, policy documents from the EU website, Swedish government websites and Nepalese government websites.

• Interviews and questionnaire: Interviews with key stakeholders helped to dig out valuable information. The semi-structured questionnaires were prepared to take the interviews and interviewees were contacted through email. Some interviews were conducted through telephone, some were conducted in person and few respondents replied through email. These interviews were used to determine in detail various impacts of biofuels use in public transportation have had, hurdles and the future perspectives.

• SWOT analysis: This method is basically a strategic planning method which helps to evaluate the strength, weakness, opportunities and threats involved in a business venture (Rutz & Janssen, 2007). In this report SWOT analysis is not used for a specific business venture but to evaluate the Biofueled public transport sector of Stockholm. Strengths (S) and weaknesses (W) are factors that are internal to biofuel technologies whereas opportunities (O) and threats (T) are external factors that affect the Biofueled public transport. By using this analysis, it will help to identify strength, weakness, opportunities and threats of biofuels in Stockholm. This will be a useful tool to analyze results, conclusion and recommendation in a systematic manner.
2.4 Critique of Source

- Interviews were taken by three different methods which are in person, through email and through telephone. The interviews that were taken in person have been more interactive and I felt that I was able to gather more information from these interviews.

- It was comparatively difficult to take interviews in Kathmandu than in Stockholm. It was really difficult to get in contact with concerned authorities and I felt like as if they are trying to avoid the interview in Kathmandu whereas it was very easy to approach the interviewees in Stockholm and most of them replied back as soon as I contacted them through email.

- There were some difficulties while performing literature review mainly for the case of Stockholm. It was difficult for me as the policy documents and many other reports were only available in Swedish. The help from Swedish speaking friends was crucial to understand the Swedish reports and policies.
3 Literature Review

There are researches and studies on the use of biofuels on transportation which are very useful and relevant in my study. So, this chapter presents critical points of current knowledge on the field of biofuels and public transportation.

‘If the biofuels industry is to expand then production costs and prices for biofuels need to compete with petrol and diesel.’ (Bomb, McCormick, Deurwaarder, & Kåberger, 2007)

The fossil fuel has been the dominating technology in the transport sector for a long time and to replace such a dominating technology needs a lot of infrastructural changes and society needs to adapt to these changes. In Germany and the UK, regulatory framework especially in the form of economic support was provided to biofuels industry to compete with the price of petrol and diesel and make society willing to use it. Germany implemented excise duty exemption while the UK used excise duty reduction to promote biofuels. In Germany, the National Government has been supportive of biofuels industry and most of the political parties are also positive which have had a huge positive impact on the biofuels industry but in the UK, there is uncertainty if the government will support in the future which has slowed down the growth of biofuels industry as oil companies are hesitating to invest in biofuels. (Bomb, McCormick, Deurwaarder, & Kåberger, 2007)

So, to promote biofuels use in transportation is a very complex process as it needs many infrastructural changes and society needs to adapt to these changes. The role of National Governments and regulatory frameworks to initiate the adaptation process is very important.

‘In recent years, the role of cities in climate governance has gained more attention. For one thing, many climate change-related problems stem from the activities of urban individuals, communities, governments and industries (Collier, 1997).

European cities like Berlin, London, Milan and Helsinki have used biofuels in their transportation fleet and play important role in EU’s Greenhouse gas reduction objective. At the national level for all the cities, the EU biofuels directive began with an economic instrument of tax reduction. The comparison between the countries shows that the higher the tax reduction,
higher the biofuels consumption. Due to full tax exemption in Germany, the biofuels consumption is the highest while in Finland there is no tax reduction and the biofuels consumption is the lowest. So, the instruments like tax reduction play a vital role for the development of biofuels industry. At local level, voluntary measures are applied by cities to promote biofuels which may be in line with the EU biofuels directive or not. For every city, there is varied national support. Helsinki gets direct national support in terms of economic instrument to promote biofuels. Berlin on the other hand is highly autonomous and powerful and the local level biofuels development goals are totally independent of national goals and the city has not received national support after the initial help. In London, the national government did not provide financial support for biofuels development but has funded green car initiative and in the case of Milan there has been no support from the national government what so ever. The study of four cities didn’t show any correlation of biofuels development with the national level support nor with the local self-autonomy (Silvestrini, o.a., 2010)

So, the study shows that it is hard to establish relationship between development of biofuels industry in cities and the support of national government and local self-governance of cities. For Berlin, the biofuels industry is comparatively developed and they have high local self-autonomy but there is no direct economic support from national government. For Helsinki, the national government has direct economic support but the commitment towards biofuel is minimal and the biofuels industry is in an initial phase and for London and Milan also there is no financial support from the national government. Even though there is weak support from national fund in London, there are many trials on transport biofuels compared to other cities.

‘The biofuel producers showed particular concern about the overall economic sustainability of liquid biofuel production- but indicating that their survival depends on the economic governance of the tax laws more than Renewable Energy Directive (RED)” (Morris, 2011).

The main concern for biofuel producers in Sweden is if they can compete with petrol and diesel. The tax laws have helped them to establish the industry but for a long-run, they want a detailed study on economic governance in biofuels industry. The environmental sustainability concern for biofuels industry is the land use pattern. If energy crops are grown in degraded lands and waste products are used to produce biofuels, which are the main issues raised by stakeholders regarding environmental sustainability under RED in Sweden. The issue of social sustainability such as the
issue of food vs. fuel debate and land use was not given as much priority as economic and environmental sustainability by RED. The social sustainability issue also wasn’t raised in the interviews and the stakeholders didn’t show any hint of interest towards it. (Morris, 2011)

The study by J. Morris shows that RED in Sweden needs to put priority on social sustainability issues and economic issues to promote sustainability in biofuels industry and to satisfy the concerns of important stakeholders in the biofuels industry.

There is a huge potential for biofuels production and consumption in transport sector for developing countries by adopting commercially available or near-commercial technologies. Biofuels industry can be a source to stimulate agricultural development, create jobs and save foreign exchange for developing countries. The developing countries are also motivated to promote biofuels industry to reduce dependency and vulnerability on international oil market, reduce air pollution, and promote rural development and greenhouse gas reduction. Brazil’s sugarcane based ethanol industry can be a source of motivation for other developing nations. In the case of Brazil, the development of biofuels has had a direct relation with the low cost of production of sugarcane. The development of new cane variety for the purpose of biofuels generation has had positive impact. The most important factors that can be learned from Brazil’s case study are favorable climatic condition for biomass production which will help to reduce the cost of production. Similarly, deep agricultural research needs to be done to analyze the mass production and its impact on society and environment. Farmers education and training is very important as in developing countries, farmers are often lacking technical know-how. The use of products like wood wastes, crop residues, forest products and energy crops for biofuels generation has a high potential for developing nations. This is due to the widespread availability, prospect of low production costs, and significant lifecycle GHG emission reductions. (Kojima & Johnson, 2006)

The potential of biofuel production in developing countries like Indonesia, Malaysia, Brazil, Philippines, Argentina, Thailand, India, Pakistan, Paraguay and China from the use of raw materials like palm oil, sugarcane, coconut oil, soybean oil and jatropha plant is huge. But these countries are not utilizing their full potential in biofuels industry. Brazil is the only country that stands out. The energy giants like India and China are gradually working on the field of biofuels and if they can reduce their fossil-fuel dependency then the GHG emission will have drastic
reduction in the global scale. Other developing countries are far from establishing biofuel industry (Liaquat, Kalam, Masjuki, & Jayed, 2010).

In the case of Nepal, it is very much dependent on fossil fuels as it imports its petroleum products from India. Government of Nepal has agreed on policies to blend ethanol with petrol. There are well established sugar mills in Nepal which are waiting to be explored to extract ethanol (Khatiwada & Silveira, 2009).

There have been lots of study on the EU directives and regulatory frameworks of biofuels industry in transport. The studies have highlighted the importance of tax policies, national support and EU directives to promote biofuels industry. In this research, I will try to study the role of biofuels industry to promote sustainable transport. I didn’t find researches that study the relationship between biofuels industry and sustainable transport. Even more the study of biofuels use in public transport in Stockholm will narrow down my study area which will give me a clear view. I will also study the applicability of biofuels in Kathmandu. Researches need to be carried out on how applicable biofuels are on cities in third world.
4 Swedish Energy Policies

Sweden is Europe’s largest consumer of biofuels, which account for 17% of the national energy supply. Biofuels constitute 3% of Sweden’s transport fuels, surpassing the EU biofuel Directive’s 2005 target of 2% (Rothkopf, 2007). The energy policies of Sweden are comparatively biofuels friendly than rest of the Europe. Sweden is net importer of biofuels. The majority of Sweden’s imports of both ethanol and biodiesel come from other EU countries. However, it is not necessarily, the case that the country of export is the country of production. The Netherlands, for example is a major importer of ethanol from countries outside the EU. The ethanol is then sold within the EU, to Sweden for example, and is registered in Sweden’s trade statistics as imports from the Netherlands.

Figure 4.1: Import of undenatured and denatured ethanol, in total 243,253 m3 in 2010, by country, in per cent. Source: (Energimyndighet, 2011)
**Long term and sustainable energy policies**

Swedish energy policies are driven towards cleaner and sustainable energy sector which can be observed by the Country’s ambitious goal of reducing the oil dependency heavily by 2020 (Rothkopf, 2007). Sweden is very much active and sincere towards its climate commitments. As a member of the Kyoto protocol, Sweden has implemented different tools and policies to address the issue of climate change. In 2005, the National Climate Policy in Global Cooperation Bill was passed which is one of the important policies. The bill readdressed the target of reducing the greenhouse gas emissions by 4% from the level in 1990 within 2008. The bill also committed to meet the target set by the EU biofuels directive to meet 5.75% of biofuels use by 2010 (Regeringskansliet Ministry of Sustainable development, 2006).

To achieve an ambitious goal of making Sweden oil-independent by 2020, Commission on Oil Independence was formulated in 2005. The main objectives of the commission are:

- Through more efficient use of fuel and new fuels, consumption of oil in road transport shall be reduced by 40-50 percent.
- In principle no oil shall be used for heating residential and commercial buildings.
- Industry shall reduce its consumption of oil by 25-40 percent. (Commission on Oil Independence, 2006).

**Energy tax policy**

Excise tax on diesel in Sweden is 39 €/HL. Biodiesel has full exemption from this tax. The excise tax on gasoline is 53 €/HL and ethanol has full exemption from this tax. This tax exemption will last until December 2013. Excise tax on fuel comprises both carbon tax and energy tax in Sweden (Swedish Tax Agency, 2010). The following table shows the estimated cost of excise tax exemption in Sweden for the year 2007 and 2008.
<table>
<thead>
<tr>
<th></th>
<th><strong>Ethanol</strong></th>
<th></th>
<th><strong>Biodiesel</strong></th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Quantities</td>
<td>Exemption</td>
<td>Loss of fiscal</td>
<td>Quantities</td>
<td>Exemption</td>
<td>Loss of fiscal</td>
<td>Total Cost</td>
</tr>
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<td>(L)</td>
<td>(€/L)</td>
<td>revenues (€)</td>
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<td>revenues (€)</td>
<td></td>
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<tr>
<td>2007</td>
<td>360,786,169</td>
<td>0.53</td>
<td>191,216,669</td>
<td>160,097,742</td>
<td>0.39</td>
<td>62,438,119</td>
<td>253,654,789</td>
</tr>
<tr>
<td>2008</td>
<td>423,589,775</td>
<td>0.53</td>
<td>224,502,581</td>
<td>163,947,520</td>
<td>0.39</td>
<td>63,939,533</td>
<td>288,442,114</td>
</tr>
</tbody>
</table>

Table 4.1: Estimated cost of excise tax exemption in Sweden. Sources: (Jung, Dörrenberg, Rauch, & Thöne, 2010)

The Bill and the Commission introduced tools and instruments such as carbon dioxide tax, tax relief system and fuel certificates to increase the share of renewable fuels in transportation. Biofuels are exempted from carbon dioxide and energy taxes (The Swedish National Audit Office, 2011). The biofuels production process is comparatively expensive than oil, so this tax exemption helps biofuels to be competitive with gasoline and diesel in terms of price. Past experience shows that partial or total exemptions from fuel taxes for biofuels were vital in promoting biofuels in the EU. All Member States with a high penetration of biofuels have, or have had; a favorable tax regime in place, e.g. Germany (until the end of 2006), Sweden, Austria, France and Spain (Pelkmans, 2008).
The government also implemented laws to maintain the biofuels market. In 2005, the government passed a law which made gas stations to sell at least one type of biofuel to meet the increasing demand for biofuels (Lexmon, 2006).
5 Stockholm

This chapter provides the information on geographical, environmental and administrative setting of Stockholm. It introduces Stockholm’s governmental structure, public transportation system, and energy policies, analyzes the performance of Biofueled public transportation and finally studies the governing tools and mechanisms used for Biofueled public transportation in Stockholm.

5.1 Introduction to Stockholm

Stockholm County consists of 26 municipalities. The Stockholm County is the most densely populated counties of Sweden with more than two million inhabitants which makes more than one fifth of the Swedish population. The total area of the County is 6,488 sq. km. As of March 2011, the total population of the county was 2,091,473, which makes the population density of the County 322.per sq. km (statistiska Centralbyrån, 2011). The city of Stockholm which is the capital city of Sweden also lies in this County.

Figure 5.1: Stockholm County with 26 municipalities: Source: Redrawn from (Stockholms läns landsting, 2012)
Stockholm County Council (Stockholms läns landsting) is the council of Stockholm County and the council mainly works in the field of public healthcare system and public transport. A county council (Landsting) is a political body/assembly formed through election and consists of 149 members. The election is held every four years parallel to national parliamentary elections. The county council elects its executive committee itself with the representation of both political majority and the opposition in the committee to implement policies approved by the assembly. There are mainly seven political parties that have won the seats in the council in 2006 and 2010 council elections. During the council election of 2010, the Moderate Party had the largest representation with 57 seats. The opposition parties which are social democrats, leftist party and environmental party also won remarkable number of seats. So, it will be interesting to study the impact of political dynamics in the implementation of biofuels in Stockholm.

As I have mentioned before, it is really amazing how much Sweden and Stockholm are investing for the alternative energy and particularly biofuels. I interviewed key persons in decision making at Stockholms Läns Landsting and SL (Storstockholms Lokaltrafik). I also reviewed national level goals and policies to study its impact at Stockholm region. One of the key reasons for Stockholms läns landsting for promoting biofuels is due to the national level policies of Sweden which bounds it. The national level government of Sweden is very much environment friendly which can be proved by the fact that it has surpassed its target set by Kyoto Protocol by a huge margin. ‘Sweden has reduced its emission by 12.7 per cent, more than agreed under the Kyoto Protcol.’ (AFP, 2007)

One of the key factors for this is the drive to become the first country to become a fossil fuel free economy. In 2005, the national level government formed a commission to build up a comprehensive program to reduce the dependency of Sweden on oil. ‘Commission on oil independence’ was formed which produced a report ‘making Sweden an oil-free society’ in 2006 which forwarded four reasons to reduce the oil dependency of Sweden which are;

- The impact of oil prices on Swedish economy
- Oil plays a key role in the peace and security throughout the world
- The Swedish raw materials have a great potential to be used as an alternative to oil
Climate change due to the extensive use of fossil fuels. (Commission on Oil Independence, 2006)

The report proposed a number of ambitious goals for 2020 to reduce the oil dependence which is:

- Consumption of oil in road transport shall be reduced by 40-50 percent by using more efficient fuels.
- Oil consumption in industrial sector shall be reduced by 25-40 percent
- No oil consumption for heating both residential and commercial buildings

Such ambitious targets have inspired national level government as well as county level government to work towards achieving the goals. But the work on national level to reduce oil dependency was going on before the formation of the commission as well.

5.2 Structure of Public Transport in Stockholm

To understand the tools and mechanisms that guide the use of biofuels in public transportation, I will study the whole structure of public transportation system in Stockholm. This will also help me identify the relevant stakeholders for interviews.

Stockholms läns landsting is the Regional Planning Authority for the Stockholm planning and public transportation in the county as per the special legislation’ (Regionplane- och trafiknämnden, 2006). Public transportation mainly consists of bus, metro, rail, tram and archipelago boat in the Stockholm County. The bus and rail transportation is handled by SL and the boat transport is handled by Waxholmsbolaget. Both companies are owned by Stockholm läns landsting. The research basically focuses on public transport that uses biofuels. So, we will mainly focus on the SL and bus transport in this research.

SL’s overall aim is to provide public transport in Stockholm County that is easily accessible and reliable. The transport services for SL are provided by private transport operators through procurement system. The overall objectives established in 2011 by the SL emphasizes on developing public transport solutions that are sustainable in the long term as it helps for the development of Stockholm region and the municipalities. Since 1980s, SL has been looking for renewable fuels for transportation. So, it has worked on environmental issues for many years.
Since the läns landsting owns the SL Company, it is politically governed and the SL board is nominated by the county politicians (AB Storstockholms Lokaltrafik, 2011). So, it will be interesting to study the political motives behind implementing biofuels in public transport. ‘SL receives half of its finance from taxation with the remainder consisting mainly of fare revenues’ (AB Storstockholms Lokaltrafik, 2011).

For bus services, the major service procurements were awarded to three main bus operators in 2010 which are:

- Bus service for Nacka/Värmdö and Huddinge areas was awarded to the operator Keolis I Sverige AB and it relates to around 470 buses
- Bus service for Norrtälje and the Stockholm-Norrtälje route was awarded to the operator Nobina Sverige AB and it relates to around 100 buses
- Bus service for Solna, Sundyberg, Bromma, Sollentuna and Norrort was awarded on autumn 2011 to Arriva and it relates to around 500 buses (AB Storstockholms Lokaltrafik, 2011).

SL’s vision of Sustainable transport is governed mainly by SL’s vision and business concept, County Council’s environmental policy programme for 2007-2011 (environmental Step 5) and UN global compact.
5.3 Biofuel buses performance study for 2009, 2010 and 2011

From the study of annual reports published by SL, I have compared the performance of Biofueled buses for years 2009, 2010 and 2011 with the help of tables in the prevailing pages:

**Biofueled buses in SL Services**

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas buses</td>
<td>103</td>
<td>131</td>
<td>195</td>
</tr>
<tr>
<td>Ethanol buses</td>
<td>418</td>
<td>545</td>
<td>768</td>
</tr>
<tr>
<td>RME-blend Diesel buses</td>
<td>75</td>
<td>69</td>
<td>211</td>
</tr>
<tr>
<td>Diesel buses</td>
<td>1420</td>
<td>1305</td>
<td>994</td>
</tr>
<tr>
<td>Total no. of buses</td>
<td>2016</td>
<td>2050</td>
<td>2168</td>
</tr>
<tr>
<td>% of SL buses running on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>renewable fuel</td>
<td>30%</td>
<td>36.3%</td>
<td>56%</td>
</tr>
</tbody>
</table>

Table 5.1: **Bus services using different fuels**

The table shows that SL has been annually increasing its bus services. At the same time, it has introduced more biofueled buses every year. This means that the target set by ‘environmental policy programme for SLL 2007-2011’ of running at least 50% of the SL bus services on renewable fuel by 2011 has been fulfilled.

**Fuel Consumption from bus services, per cent**

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>26.6</td>
<td>44</td>
</tr>
<tr>
<td>Diesel</td>
<td>63.7</td>
<td>42</td>
</tr>
<tr>
<td>Biogas</td>
<td>6.4</td>
<td>8</td>
</tr>
<tr>
<td>RME</td>
<td>3.4</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 5.2: **Fuel consumption pattern for bus services of SL**
The table shows that from 2010 to 2011, there has been a drastic change in the fuel consumption pattern in bus services. The diesel consumption was reduced remarkably whereas the ethanol, biogas and RME consumption has increased within a year.

**Operational Costs of bus services**

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Costs of bus services</strong></td>
<td>4234</td>
<td>4581</td>
<td>4733</td>
</tr>
<tr>
<td><strong>Total no. of buses</strong></td>
<td>2016</td>
<td>2050</td>
<td>2168</td>
</tr>
<tr>
<td><strong>Operational cost per bus</strong></td>
<td>2.10</td>
<td>2.23</td>
<td>2.18</td>
</tr>
</tbody>
</table>

Table 5.3: Operational costs of bus services for SL

The table shows that the operational cost of the bus services has increased annually. This is due to the overall increase in the bus services as the number of buses has increased as well as investment of SL for the fulfillment of environmental targets set by SL and SLL. The operational cost per bus has decreased though in 2011 compared to 2010 to SL. This shows that the increasing use of renewable fuels may not increase the operational cost of the bus services. This is the operational cost for SL. The data for actual operational cost per bus cannot be received as the bus operators did not provide the data as it is confidential data for them.

**CO₂ emission from bus services**

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fossil CO₂ (tonnes)</strong></td>
<td>127040</td>
<td>127,343</td>
<td>95,500</td>
</tr>
<tr>
<td><strong>Passenger kilometers (millions)</strong></td>
<td>1713</td>
<td>1757</td>
<td>1792</td>
</tr>
<tr>
<td><strong>Fossil CO₂ per passenger kilometers (grams)</strong></td>
<td>74.2</td>
<td>72.5</td>
<td>53</td>
</tr>
</tbody>
</table>

Table 5.4: Annual CO₂ emissions data from bus services
The table shows that there has been drastic decrease in CO\textsubscript{2} emission from 2010 to 2011. Even though SL increased its bus services and passenger kilometers from bus services have increased, the CO\textsubscript{2} emission has been reduced. This data shows that the replacement of diesel fuels by biofuels in public transportation bus services in Stockholm region contributed a lot to reduce the CO\textsubscript{2} emission in this region. The target set by ‘environmental policy programme 2007-2011’ to reduce the fossil CO\textsubscript{2} emissions to less than 55 grams per passenger at the end of 2011 has been achieved.

**Sources:** (AB Storstockholms Lokaltrafik, 2012), (AB Storstockholms Lokaltrafik, 2011), (AB Storstockholms Lokaltrafik, 2010)

The above tables show that the SL has been successful in meeting the targets set by ‘environmental policy programme 2007-2011’ for Biofueled bus services.

SL had specific targets for bus services in the county to be met within 2011 which were:

- At least 50% of SL’s bus services are to be powered by renewable fuels by the end of 2011, rising to 75% in 2016 and 100% at the end of 2025 (AB Storstockholms Lokaltrafik, 2012).
- Fossil CO\textsubscript{2} emissions from SL bus services are to be no more than 55 grams per passenger kilometer at the end of 2011 (interim result in 2010: 72.48 grams per passenger kilometer).
- Emissions of nitrogen oxides and particulates from SL bus services at the end of 2011 are to be 15% and 25% lower than in 2006, in relation to volume of transport (passenger kilometers); interim result in 2010: in relation to the number of passenger kilometers, nitrogen oxides and particulates have decreased by 38% and 53% since 2006. This is due to older buses having been phased out and the share of buses using renewable fuel has increased (AB Storstockholms Lokaltrafik, 2012).

So, at the end of 2011
• 58 percent of all buses were running on renewable fuels namely ethanol, biodiesel and biogas (AB Storstockholms Lokaltrafik, 2012): Sara Anderson, fuel strategist in SL.

• The target of reduced emission of nitrogen oxides from the buses by 15 percent was met: 22 percent reduced.

• The target of reduced emissions of particulate matter from buses by 25 percent was met: reduced by 46 percent.

• The carbon emission level was less than 53 grams per passenger kilometers at the end of 2011 (AB Storstockholms Lokaltrafik, 2012).

5.4 Administration of biofuels and the stakeholders

The table below lists the tools used for biofuels promotion, the aim of these tools and the related bodies with these tools.

<table>
<thead>
<tr>
<th>Authority actors</th>
<th>Tools</th>
<th>Tool’s aim</th>
<th>Associated mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Nations</td>
<td>UN Global Compact Initiative</td>
<td>To adopt sustainable and socially responsible policies and to report on their implementation</td>
<td>Ten principles addressing the issues of human right, labor, environment and anti-corruption.</td>
</tr>
<tr>
<td>European Commission</td>
<td>Renewable Energy Directive (RED)</td>
<td>To promote the use of renewable energy and ultimately reduce the carbon</td>
<td>Tax-exemption</td>
</tr>
<tr>
<td>Swedish Government (Swedish Tax Agency)</td>
<td>Swedish Energy Agency</td>
<td>Hållbarhetskriterier/Sustainability Criteria (HBK)</td>
<td>To ensure that RED’s goal of sustainability is achieved</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-----------------------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Swedish Tax Agency</td>
<td>Energy Tax Law</td>
<td>To implement tax on energy and carbon content</td>
<td></td>
</tr>
<tr>
<td>Stockholm County Council</td>
<td>Environmental Step 5</td>
<td>To promote sustainable development and preserve rich environment of the county</td>
<td>Environmental objectives for transport</td>
</tr>
</tbody>
</table>

Table 5.5: **Various administration tools and mechanisms that bound the biofuels industry in Sweden**

These tools are discussed in detail in relation to Stockholm public transportation below:

**UN Global Compact Initiative**

UN global compact initiative is a strategic policy to formulate businesses all around the world to follow sustainable and socially responsible policies to reach their objectives and report the success of the implementation. There are basically ten principles in the compact which addresses the issues of human rights, labor, environment and anti-corruption. SL is addressing the ten principles of the UN Global Compact initiative when it became the member of compact in 2009. This means that the SL is working to meet these principles and is reporting its progress annually to the UN (AB Storstockholms Lokaltrafik, 2010).

This shows that SL is very much aware of its environmental responsibility. Consumption of biofuels like biogas, ethanol, and biodiesel are increasing rapidly. The environmental objectives of SL are mainly governed by environmental policy programme (Stockholms läns landsting).
**Renewable Energy Directive (RED)**

RED is a directive which mandates the countries within the EU on using renewable energy. Also known as directive 2009/28/EC has set mandatory national targets to be met by 2020 regarding renewable energy sources:

- 20% of total national energy consumption shared by renewable energy (varies by country)
- 10% of the total transport energy shared by renewable energy (same for all countries)

The directive also contains sustainability criteria for biofuels and is mandatory that all the member states fulfill the sustainability criteria regarding renewable energy.

**Hållbarhetskriterier/Sustainability Criteria**

Hållbarhetskriterier is basically the implementation document of RED in Sweden. The Swedish Energy Agency is the responsible authority which sets the guidelines for sustainability criteria of biofuels market. It is mandatory for biofuel producers within Sweden to follow Hållbarhetskriterier and report to Swedish Energy Agency regarding the sustainability criteria of their products.

**Energy Tax Law**

Swedish energy tax laws are aligned with the EU energy taxation directive 2003/96/EC. All energy products are subject to energy tax based on energy content and they are subject to carbon tax based on emission level. Biofuels are exempted from these taxes to promote the use of these fuels and reduce the GHG emissions.

**Environmental Step 5**

Environmental Step 5 is a policy programme implemented by the County Council for the period of 2007-2011. It is designed to minimize environmental impact and prevent ill-health. The main objectives of the policy that are related to environment and sustainability are:

- Strive towards ecological sustainability by being resource-efficient, converting to renewable resource use and reducing emissions from County Council activities
• Take environmental concerns into account in every action and decision
• Procure, order and purchase goods and services that minimize impact on the environment
  (Stockholms läns landsting)

Transport sector objectives of environmental Step 5

The policy has formulated environmental objectives for transport sector. The overall vision of the policy is that the transports shall only be carried out using renewable fuels and not give rise to air pollution or noise that has a negative impact on health or the environment. The policy aimed at achieving following objectives by 2011:

• At least half of the County Council’s passenger and goods transports will operate on renewable fuel.
• Public transport’s emission of particles and nitrous oxides will be substantially reduced and a systematic noise abatement programme will be underway.

The SL also has been a part of multilateral projects that aim at cooperation and coordination between countries and cities to communicate and share knowledge regarding Biofueled public transport. Two main projects are:

• **Baltic Biogas Bus Project:** SL is a member of an initiative called ‘Baltic Biogas Bus’ which is funded by the EU’s Baltic Sea region programme which is a three year programme and is coming to an end by 2012. This programme aims to promote the use of biofuels, make market and support technological development of biogas as a fuel for public transport. Twelve organizations from eight countries around the Baltic Sea region have participated in this project (Baltic Biogas Bus Project, 2009). Biogas is considered one of the cleanest alternative fuels as it utilizes the waste and at the same time is the best option to reduce CO₂ emissions. SL has gradually increased its consumption of biogas in recent years. Study by SL shows that replacing fossil diesel with biogas in SL buses
reduces CO$_2$ emissions by around 10 kg per 10 km travelled (AB Storstocholms Lokaltrafik, 2012).

Biogas for SL is mainly supplied by Stockholm Vatten and the Käppala Association and they are contracted till 2023.

- **BEST Project:** BEST project (BioEthanol for Sustainable Transport) was a four year project (2006-2009) and incorporated nine participating regions from Europe, China and Brazil. The goal of the project was to promote ethanol buses and cars in the participating cities. Stockholm was the coordinating city for the project. The BEST project introduced and installed 127 ED95 buses and five ED95 ethanol fuel stations in Stockholm (BEST, 2010)
6 Stockholm stakeholders’ perspectives

The following chapter provides the analysis of interviews conducted with some of the important stakeholders in the sector of public transportation and biofuels in Stockholm. This chapter will also provide a SWOT analysis on the implementation of Biofueled public transportation in Stockholm on the basis of the interviews conducted.

To get a better knowledge on biofuels market and public transportation in Stockholm, following interviews were conducted with some of the important stakeholders.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Organization</th>
<th>Position</th>
<th>Interview method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yvonne Blomback</td>
<td>Green party leader at Stockholms lans länsting</td>
<td>Transport policy spokesman</td>
<td>In person</td>
</tr>
<tr>
<td>Sara Anderson</td>
<td>AB Storstockholms Lokaltrafik</td>
<td>Biofuels specialist</td>
<td>In person</td>
</tr>
<tr>
<td>Stefan Wallin</td>
<td>AB Storstockholms Lokaltrafik</td>
<td>Section Manager Sustainable development</td>
<td>In person</td>
</tr>
<tr>
<td>Alexander Magny</td>
<td>Keolis Sverige</td>
<td>Fuel Technologies and Onboard Systems</td>
<td>In person</td>
</tr>
<tr>
<td>Sofia Svensson</td>
<td>Nobina Sverige</td>
<td>Environmental manager</td>
<td>Through email</td>
</tr>
<tr>
<td>Annabella Hultman</td>
<td>Käppalaförbundet</td>
<td>Market Developer</td>
<td>Through email</td>
</tr>
<tr>
<td>Sofie Indevall</td>
<td>SEKAB</td>
<td>Product Manager for ED95</td>
<td>Telephone</td>
</tr>
</tbody>
</table>

Table 6.1: List of respondents interviewed in Stockholm

From literature review these stakeholders were identified and they were contacted through emails. As I have mentioned in the earlier chapter, SL is owned by Stockholms läns landsting. Läns landsting is a very important stakeholder in the public transportation sector. To understand
the viewpoint of political parties involved in landsting, two people from two opposing parties namely Yvonne Blomback from Green Party and Stella Fare from Folkpartiet were contacted but only Yvonne Blomback was willing to give interview. Green Party is the biggest supporter of environmental agendas and Yvonne was very much excited to give interview to me. As SL is the sole organization that is directly responsible for the public transportation in Stockholm, two interviews were conducted. Private bus operators namely Keolis Sverige and Nobina Sverige who run buses under contract for SL were interviewed to understand their perspective on the biofuels use. Finally, biofuel producers namely Käppalaförbundet and SEKAB who produce biogas and ethanol respectively were interviewed. From these interviews, I have summarized some of the important aspects as below:

6.1 Support from the national government and Stockholms läns landsting

From the interviews that I conducted in Stockholm, all of the stakeholders agreed that the reason behind the use of biofuels and the success that is achieved in using biofuels in public transportation in Stockholm is due to the support from the national government for biofuels. Commission of Oil Independence’s ambitious goal to make Sweden fossil-fuel free and to reduce the oil consumption in road transportation by 40-50 percent within 2020 has led the country to support biofuels industry. To fulfill this goal, the national government is very supportive of biofuels program in public transportation. Yvonne Blomback added that läns landsting have their own goal for biofuels use in public transportation which accelerated the use of biofuels in public buses. She highlighted the role of Green Party to put forward the objective of 50% of buses running on biofuels by 2011 when the Alliance (Folkpartiet, Moderates, Center and Christian Democrats) were not supporting it. But when the Alliance got majority seat in the parliament in 2006, they accepted the proposal of Green Party. So, Yvonne highlighted that the support of national government and the cooperation between political parties as the motive and reason for biofuels promotion. SEKAB and Käppalaförbundet acknowledged the support from läns landsting and the role landsting played in creating biofuels market in the public transportation. This has boosted the biofuels industry in Stockholm. Stakeholders from SL also praised the political parties for coming together regarding environmental agendas. The Swedish
government’s initiative to promote the use of biofuels in road transportation has led to the development of biofuels market and use of biofuels in public transportation.

### 6.2 Public transportation funding

50% of SL’s funding comes from tax income collected by Stockholms lans landsting and 50% comes from the fares collected by SL. So, the stakeholders were asked if they agree with the use of income tax in public transportation or not. All of the interviewees were happy that the läns landsting is investing tax money in public transportation which has helped to develop the public transportation of the county and Yvonne Blomback was especially vocal in this issue and she quoted that “50% of the funding of SL is too little. We want to have more of the tax money into public transportation because you could see that the car use in the region is too high. So, we have to build more tracks, we have to bring more buses and boats. We think it is also crowded. So, we have to put in more tax money to public transportation to make it work.” The stakeholders believed that the support and investment of läns landsting has led the public transportation sector in Stockholm towards the goal of sustainable system.

### 6.3 Tax exemption for biofuels

All the stakeholders appreciated the impact of tax exemption on biofuels. Yvonne Blomback stated that all the political parties in government and county level felt the need to differ the price between biofuels and fossil fuels and they agreed to charge taxes for fossil fuels. All the interviewees viewed that the tax exemption to biofuels has helped the biofuels to compete with fossil fuels in Stockholm. Yvonne quoted that ‘it’s a pity that tax exemption is so expensive but we have done so much damage to the environment that there is nothing so expensive than environment.’

But tax exemption is a temporary tool. It will end in near future as the government will not want to support it all the time as it costs a lot. The biofuel producers were worried about this.
Especially SEKAB was vocal regarding the risk that it creates for the investors in biofuels market. SEKAB wants the tax exemption to continue for a little longer time so that more private investment can be invited in the biofuels industry and the biofuel market will reach to that state where it will be able act and able to pay for the product.

SL is very happy with the effectiveness of tax exemption as it has brought the price of biofuels in comparable level to fossil fuels but both Stefan and Sara from SL showed little concern about the increasing costs of using biofuels such as changes in the buses and increase in maintenance costs.

The bus operators are also happy with tax exemptions although they are mainly guided by the contracts they have with SL and tax exemptions do not affect them directly. The bus operators are generally paid more for every kilometer they run in biofuels than fossil fuels. Similarly, the vehicle tax for biofuel buses are comparatively lower than for fossil fuel buses. This is the kind of motivation and support that bus operators get from SL and länslänssting.

The Swedish National Audit Office (SNAO) has audited the tax exemption for biofuels. The SNAO studied the period of 1995-2009 where the Government provided tax reliefs for biofuels. The study showed that the tax exemption for biofuels has helped to increase the biofuels consumption and to reach climate objectives but not at a reasonable cost. The study showed that the tax exemption has resulted in increasing loss of tax revenues which amounts to about SEK 2 billion per year. So, the cost for the government to reduce emissions by the use of biofuels is around 3 SEK per kg/CO₂ reduction whereas the carbon dioxide tax costs 1.05 SEK per kg/CO₂ which shows that complete tax exemption for biofuels is an expensive tool to reduce emissions (The Swedish National Audit Office, 2011).

The stakeholders think that tax exemption has been a great tool to promote biofuels in transport sector and some of the stakeholders think that it should continue till the biofuel market is stable though the government expenditure is high for tax exemption.

6.4 Sustainability issue of biofuels

The stakeholders were asked about the measures they take to make sure that the biofuels that they are using are produced in sustainable way. To make sure that the biofuels used are produced
in a sustainable manner, the SL has prepared a questionnaire which the bus operators give to their biofuel providers to fill. The questionnaire basically seeks if the biofuels produced meets the pre-requisites of EU and national legislation. They not only look for environmental issues but labor issues as well. According to Alexander Magny of Keolis bus operator, they ask data related to fuel composition, greenhouse gas factors i.e. how much equivalent of CO$_2$ does the fuel emit per liter of the fuel burnt and energy content. Sofia Svensson of Nobina bus operators mentioned that they ask their biofuel suppliers to send their ‘Hållbarhetsbesked’ the Energimyndigheten issues which biofuel suppliers have to submit to the Swedish Energy Agency. SEKAB are accredited by Swedish Energy Agency and they also follow ‘Hållbarhetsbesked’ the Energimyndigheten issues.

6.5 SWOT analysis of Biofueled public transportation

This chapter analyzes the strength, weakness, opportunity and threats for Biofueled public transportation in Stockholm from the gathered information from the interviews and literature review.

Strengths:

- **Growing biofuels market**: All the stakeholders agreed that the biofuels market is growing in Stockholm and in Sweden as a whole. SL’s annual reports have shown the annual increase in the consumption of biofuels and the increase in number of Biofueled vehicles. This growth in the biofuels market is a source of encouragement for more investments and development.

- **Experience of more than two decades**: The biofuels market of today is not created in just a few years of time. Sara Andersson of SL mentions the experience of using biofuels since 1989. This long experience has helped to create favorable physical and policy infrastructures that are in use today. The bus operators responded that the filling stations for biofuels are easily accessible which has made their operation efficient. Stockholm has been experimenting with technologies and fuels for a long time and this has provided lots
of knowledge to make the biofuels industry stable, environmentally friendly and economic.

- **Ability to fulfill increasing demand:** The growing demand for biofuels is a good sign for biofuels market. Even better scenario is the ability to fulfill this increasing demand. The biofuel producers who were interviewed were very much positive about the growing demand and their ability to fulfill the demand in Stockholm region. SEKAB responded that the supply of raw materials to produce ethanol is in abundance to meet not only the demand of Sweden but the EU at present situation but if the demand for biofuels grows all over the world then fulfilling the demand can be a problem. Similarly, Käppalaförbundet also assured that there is enough supply to meet the growing demand as the production of biogas is also increasing. Increased upgrading of biogas installations and increased waste digestion at existing or planned facilities are seen to increase the production for a short term. Biogas Öst stated about the use of thermal gasification of forest biomass to produce biogas which will make a huge impact on the production. So, the introduction of new technologies and the abundance of raw materials will help to fulfill the increasing demand of Stockholm.

- **Biofuel buses performance:** SL’s Biofueled buses have been able to meet all the environmental objectives set by the läns landsting. Annual report of the SL shows the reduction in carbon emission and other particulate matters. Similarly, SL has been able to meet the target of running more than 50% buses on biofuels. All the stakeholders were confident that by 2016 more than 75% of SL buses will be using biofuels. So, the reduction in carbon emission from the Biofueled buses and the increase in Biofueled buses show a very bright future for these buses in Stockholm.

- **Use of municipal organic wastes:** One of the strength of biofuels is the use of organic wastes for biofuel generation. Biogas is considered one of the best renewable fuels as it
utilizes the waste and at the same time is very environmental friendly. The bus operators believe that biogas has potential to reduce more than 90% of carbon emission.

Weaknesses:

- **Higher maintenance costs**: The two bus operators that were interviewed stated that the biofuel buses have higher maintenance costs. The operators responded that it is confidential matter and they cannot disclose accurate figure about the cost of operating biofuel buses. Keolis Sverige mentioned that the cost of operating biofueled buses is 20-60% higher than diesel buses depending upon the biofuels they use. In case of biodiesel use, some parts of the bus needs change more often than compared to regular diesel bus because biodiesel is more sensitive to contamination which clog the fuel filters. In case of ethanol, different engine is required and the ethanol engine is very expensive to maintain as ethanol is very corrosive and in the case of biogas, the bus modification for biogas and gas maintenance is expensive.

- **Difficulty to store and transport**: The biofuels need special attention while storing. Biodiesel is sensitive to water, temperature and biological contamination. Ethanol is very inflammable and specific installation is required for ethanol fuelling whereas for biogas fuelling, gas compressors are required. Biogas is especially difficult to transport. There are gas pipelines installed in many areas of Stockholm. There are difficulties in transporting biogas in areas with no pipeline networks.

- **Difference in preference**: The bus operators prefer to use biodiesel whereas SL wants the bus operators to use biogas. This is because of the difference in their priority. Biodiesel buses are comparatively economical to bus operators as the biodiesel buses does not require much modification and the maintenance costs is also lower compared to other biofuels. Whereas, SL promotes the biogas use in buses as the biogas is the lowest emitter of greenhouse gas and other pollutants and additionally it uses the waste water of the county to generate biofuels. Sara Andersson of SL quotes, ‘biogas has the potential to
reduce the cost quite a lot in the future as we see now that the repair and maintenance of gas bus is more cost efficient and the price of the biogas is more stable compared to other fuels.’

- **Problem with ethanol:** The bus operators and SL were concerned that there is only one supplier for ethanol in Sweden which is SEKAB. SEKAB holds the patent right for one of the additive on the ethanol fuel which helps in spark ignition. The brighter side is that SEKAB have a limited time for the patent and after that time other producers can also produce the ethanol using that additive. Similarly, there is only one ethanol bus producer in Sweden which is Scania. The SL and bus operators quoted this as the reason why ethanol buses are more expensive than biodiesel and biogas buses.

**Opportunities:**

- **Government and Stockholms länsläns landsting’s support towards Biofueled public transport:** As I have mentioned earlier, the support from the länsläns landsting and national government has been exceptional. The environmental policies and programs that are focused towards increasing biofuels consumption and supporting tax and energy policies has been crucial and will be crucial for the further development of the Biofueled public transport.

- **International cooperation for Biofueled public transport:** It is a great opportunity to be part of projects that incorporate different cities and countries to learn from each other’s experience and knowledge. Stockholm has been involved in BEST project and Baltic biogas project and this has definitely helped to gather knowledge regarding technologies, planning and management of Biofueled public transport. The cooperation and coordination among countries and cities to promote biofuel for public transportation is therefore a great opportunity.

- **To be a fossil-fuel free public transportation:** The Stockholm county has a great opportunity to be the first fossil-fuel free public transportation system in the world. It is
one of the leading regions in sustainable and Biofueled public transportation. The rail way transport runs on 100% renewable energy and by promoting Biofueled bus transport, it has a great opportunity to make a history and stand as an example for the rest of the world.

**Threats:**

- **Termination of tax exemption:** All the stakeholders appreciated tax exemption policy for its contribution in making biofuel industry competitive to fossil fuels. But the tax exemption is slated to end at the end of 2013 and the stakeholders are worried about that. SEKAB responded that this has created uncertainty and people are not willing to invest in the biofuels industry. So, this is a threat that biofuels producer see.

- **Tax exemption burden for state:** The price that state has to suffer to provide tax exemption is huge. Although all the stakeholders interviewed praised tax exemption, there are critics who rise question whether it is worth to put government in so much burden and not invest that money to look for a better solution.

- **Resistance to change:** It is human nature to resist changing. People are used to established system that they don’t want to work within new system. So, it is difficult to make people shift to biofuels when they are already used to fossil fuels. This kind of system requires lots of changes such as technological, policy, social, infrastructural changes so it will take time. SEKAB responded that the end consumers are still not willing to completely shift for biofuels that is why the biofuels business is still not profitable. That is why the government needs to keep supporting the industry till it is stable.
The following chapter provides holistic analysis on the issues related to public transportation and biofuels use so that viewers can have clearer picture on the political, economic, social and environmental realities of Kathmandu. It will also analyze the interviews conducted with major government bodies responsible for public transportation and renewable energy in Kathmandu to understand the challenges and opportunities to implement Biofueled public transportation.

‘The Kathmandu valley, one of the fastest growing cities worldwide, is facing severe socio-economic and environmental threats in the absence of a clear and comprehensive planning and land use policy, according to planners.’ (Shahi, 2012)

Kathmandu is the capital city and it lies in the Kathmandu valley which consists of two other cities Bhaktapur and Lalitpur. The valley covers an area of 220 square miles. The major issues of the valley are air pollution, water pollution, solid waste, road accidents, and traffic congestion. Studies show that the rapid urbanization process had a huge impact on the forest cover and agricultural land. The road transport is the only available transport service within Kathmandu. Varieties of vehicles are used by transport operators to provide services. The most popular vehicles that people travel on are taxi, bus, electric tempos, rickshaws, and microbuses. There were few attempts where the government tried to own and operate the vehicles such as Sajha yatayat and Kathmandu trolleybus but these attempts didn’t succeed due to political and institutional malfunctions. Sajha yatayat which is a cooperative and operates bus services within Kathmandu valley have been unsuccessful to operate is now being revived and is starting its operation again from 2013 (Sajha Yatayat, 2011) while trolleybus which operated since 1975 was formally closed in 2009. Now, there are more than 50 private transport operators within Kathmandu valley only. These transport operators have to receive route permit and a license to operate the public transport services from the department of transport management.

The transportation sector of Kathmandu is unsustainable and is responsible for environmental, social and health related problems in the valley. The number of vehicles is increasing every year at a rate of 15% and private vehicles such as motorcycles and cars are the ones that have escalated every year (ICIMOD, 2007). ‘Although there are many sources of air pollution such as
vehicular emissions, poor infrastructure, brick kilns, and street dust and litter in Kathmandu valley, vehicular emissions have now become the main source of pollution’ (Adhikari, 2012).

![Pie chart showing sources of PM$_{10}$ in Kathmandu valley.](image)

**Figure 7.1: Sources of PM$_{10}$ in Kathmandu valley.** Source: (Gautam, 2006)

This shows the sources of air pollution in Kathmandu valley. The vehicular emissions contribute the most in the air pollution of the valley. Being a valley doesn’t help at all for Kathmandu. It becomes difficult for the particulate matters emitted by vehicles and other sectors to escape and the air pollution becomes intense every day.

The table below shows the rapidly increasing number of vehicles and especially private vehicles such as cars and motorcycle. The number of public vehicles such as bus and micro buses is increasing but comparatively it is very low.
Another important dimension of transport sector in Nepal is the high dependency on the imported petroleum products. Nearly all fossil-derived fuels consumed in the country are imported in a refined form from a neighboring country, India, and the perpetual increase in petroleum imports has adversely impacted the existing fragile economy of the country. The rising fuel price in the international market has worsened the case (K.C., Khanal, Shrestha, & Lamsal, 2011). The demand of petroleum products like petrol, diesel, kerosene, aviation turbine fuel and LP gas is about 1.2 million ton per annum with annual increase by 20%. As the price of petroleum products rises at international market, the government cannot hike the price in proportion due to political vulnerability which causes a huge loss. The estimated total loss for the month of November 2012 is NRs. 31.49 crore (US$3.5 million) (Nepal Oil Corporation, 2012). So, these studies shows that the most important issues that needs to be addressed for a sustainable transportation are dependency on imported fuels, rapidly increasing number of vehicles and air pollution. In this scenario the promotion of public transport and the use of biofuels in transportation sector can be a great solution.
7.1 Biofuels at Present context

Despite a huge potential in harnessing various renewable energy resources such as hydropower, solar power, wind energy and biofuels, these resources have not been sustainably captured due to geographical, technical, political and economic reasons in Nepal. (K.C., Khanal, Shrestha, & Lamsal, 2011)

The concept of biofuel is relatively new to Nepal. Biofuel program was announced by the Government of Nepal in the fiscal year 2008/09 to promote biofuel in Nepal through AEPC. The program focuses particularly on Jatropha Curcas L. as a biofuel feedstock for biodiesel production. Under national biofuel program there are no programs associated with the use of biofuels in transport sector.

In Nepal, biogas is commonly known as gobar gas and animal dung (Gobar in Nepali) and residues are used at local level to generate gas for cooking purpose at household level. The popularity of this kind of biogas plant is increasing as Biogas Support Program of the Netherlands Development Organization-Nepal is technically and financially supporting through Clean Development Mechanism project of Nepal.

Solid waste management is a serious problem of Kathmandu valley. Five municipalities in Kathmandu valley, namely Kathmandu Metropolitan City (KMC), Lalitpur Sub-Metropolitan City (LSMC), Bhaktapur Municipality, Madhyapur Thimi Municipality and Kirtipur Municipality generate nearly 435 dry metric tons of solid waste per day, and 75% of the wastes originate from households and about 65% of the household wastes are reported to be biodegradable (Solid Waste Management and Resource Mobilisation Center, 2004). The biodegradable organic waste has a potential to generate renewable energy like biogas production and this energy generation potential of solid waste is yet to be realized in Nepal.

7.2 Kathmandu Analysis

Public transportation and the use of biofuels is a case study which is interconnected and depended upon social, cultural, political, economic, and environmental factors. So, to have a
deeper knowledge on the prospect of biofuels use in public transportation in Kathmandu I will follow holistic approach of study.

### 7.2.1 India-Nepal relationship

As, I have mentioned earlier, all the petroleum products in Nepal are imported from India. This shows the dependency of Nepal on India. Nepal is closely tied with India in terms of economy, politics and culture. Not only does Nepal depend on India for petroleum products, but almost all the international trade of Nepal is performed through India. ‘Nepal trades over 60 percent of its total imports and total exports with India. However these relations are lopsided with Nepal facing a huge trade deficit and attracting very little investment. The two countries share a 1,800 km long open border and the port of Kolkata in India serves as Nepal’s access to the sea and major transit point for Nepal’s third-country trade’ (Afram & Del Pero, 2012). India in the past has used this trade dependency as a tool to manipulate Nepal’s political tie with China. The disagreement between two countries on trade and transit treaties on 1989 led to an Indian economic blockade of Nepal which lasted for a year. Though the conflict was due to economic disagreement, it was fueled by Nepal’s procurement of weaponry from China. At the end, the economic blockade was too hard to handle for Nepal and had to compromise with India.

India will want to keep Nepal under its control all the time. In this scenario, it will be interesting to study the reaction of India regarding Nepal’s interest towards biofuels. If and when Nepal will move towards the position to replace or even reduce its oil dependency from biofuels promotion, how will this be affected by the relationship between the two countries?

### 7.2.2 Vulnerability of Government in regards to price of Petroleum Products

The case study of Stockholm shows that for biofuels market to prosper, the price of biofuels needs to compete with the price of fossil fuels. One of the obstacles for Nepal is its vulnerability to price of petroleum products. With the rising price of petroleum products in the international
market, the Nepal Oil Corporation (NOC) is not able to raise the price as well. Whenever, the
government and NOC try to raise the price; the opposition, student unions and other civil
societies conduct demonstrations, transportation strikes which most of the time create violence
and chaos and forces them not to raise the price. Nepal imports all petroleum products from India
and the interesting thing is the price of petroleum products is higher in India. Due to the open
border between two countries this has led to black market for petroleum products. The NOC
suffers monthly losses. In this context, it is a big challenge in Nepal for biofuels to compete with
the price of fossil fuels. The inability of government to raise the price of fossil fuels is a big
hurdle if it wants to promote biofuels market.

7.2.3 Governance

Nepal’s transport sector is governed by ‘Vehicle Transport Management Guideline’ which was
implemented in the Tenth Five Year National Plan (2002-2007) of Nepal. The three year interim
plan (2007/08-2009/10) puts forward the long-term vision for transport sector as ‘to make the
transport system safe, affordable, organized, non-polluting and service-oriented, through
qualitative increase in vehicle and transport services, thereby making a contribution towards the
overall development and prosperity of the country’ (National Planning commission, 2007). The
objectives of the three-year interim plan is to make the transport sector efficient, transparent,
efficient less expensive and equipped with new technologies and facilities. This shows the
differences in priority between Nepal and Sweden in transport sector. Nepal’s priority is to get
the basics right and let the people enjoy the services more efficiently and effectively whereas
Sweden’s priority is far broader. Sweden’s objective is to be the first country to be fossil-fuel
free.

In this context I have interviewed two people from department of transport management and
Alternative Energy Promotion Center to get a clearer idea on what vision they have on
sustainable transportation, whether they see biofuels as a solution to the problems of transport
sector and what can be the obstacles to promote biofuels in Kathmandu transport sector.
7.3 Interview Analysis

The following chapter provides the analysis of interviews conducted with two important stakeholders in the sector of public transportation and biofuels in Kathmandu. The interviews were conducted with Chandra Prasad Phuyal who holds the position of Director at the Department of Transport Management (DoTM) and Resa Piya who holds the position of Senior Energy Officer at Alternative Energy Promotion Center (AEPC). Interview at DoTM was conducted with the help of a research assistant in Kathmandu who conducted the interview in person and interview at AEPC was a telephone interview. Similarly, Kathmandu Metropolitan City Office was also contacted for an interview but they didn’t want to participate and replied that the office doesn’t have any information regarding use of biofuels in public transportation in Kathmandu.

The interviews were conducted to have a better understanding on the issues of public transportation and biofuels and to understand the role of these organizations regarding these issues. DoTM works under Ministry of Physical Planning, Works and Transport management and is responsible for transport management in Nepal. According to the DoTM, the government plays three main roles to manage and plan the public transportation sector in Nepal. They are:

- Issuance of route permit to public transport operators
- Setting rules regarding which vehicles to be used for public transportation and which vehicles to be banned
- Conducting routine examination of vehicles to maintain the standard of public transportation

DoTM is responsible for policy making for transport sector in Nepal. With regards to public transportation, DoTM prepares policies keeping in mind the above three responsibilities.

AEPC is a government institution which works under the Ministry of Environment, Science and Technology. AEPC was established with the mission of promoting renewable energy in the country to ultimately improve the living conditions of people. The main objectives of AEPC are:

- To popularize and promote the use of alternative/renewable energy technology
• To raise the living standard of the rural people
• To protect the environment
• To develop the commercially viable alternative energy industries in the country
  (Alternative Energy Promotion Center, 2008).

National biofuel program was implemented since the fiscal year 2008/09 under AEPC in Nepal and the program was focused mainly in promoting Jatropha Curcas for biofuel production. The main activities under this program are formulating strategy for biofuel promotion, preparation of modern nurseries for Jatropha plantation, capacity building of farmers for Jatropha plantation, establishing biofuel processing plants and carrying out pilot projects and related researches on biofuels. (Dhakal & Dhakal, 2009)

Regarding biofuels sector in Nepal, AEPC responded that biofuels sector is in a preliminary stage and there is no National Biofuel Policy as of now in the country. The policy will be drafted in 2-3 months. So, both institutions responded that for now they cannot say whether transport sector will be prioritized for biofuels use in Nepal. AEPC is mainly focused in jatropha production because study has shown great potential of jatropha cultivation. AEPC is prioritizing barren lands that are not used for agricultural products for jatropha. Ms. Resa Piya stated that the global debate of food vs. fuel is very important for countries like Nepal as the country is struggling to meet the demand for food products. So, plants like Jatropha which doesn’t need fertile land to cultivate can be a great way of promoting renewable energy.

Both interviewees responded that biofuels can be a great solution in the case of Nepal. Ms Piya said that for a country whose 20-25% of the budget is allocated to import fossil fuel, biofuels can help to reduce government expenditure. Similarly, Mr. Phuyal from DoTM said that Government has been suffering loss from petroleum products annually, in this scenario if the country can produce biofuels and the transportation sector can utilize domestic biofuels then that is a very good thing. But both responded that they don’t think biofuels industry will flourish in Nepal in near future. They think that there is no necessary infrastructure and preparation which will promote biofuels in Nepal.

AEPC sees great potential in generating biogas from solid wastes and waste water in Nepal and said that there is a project under NRREP (National Rural and Renewable energy Programme) in
pipeline to generate biogas from solid waste in Kathmandu for electrification and heating purpose. The project will come into action only after the implementation of national biofuel policy. Mr. Phuyal from DoTM responded that he doesn’t have much knowledge about production of biofuels from waste. But if it is possible to produce biofuels from waste then that is a very good thing. Kathmandu has been suffering from solid waste management problem for such a long time, if the waste from Kathmandu can be used for this then it is a win-win situation.

Both respondents said that there is no project or policy under pipeline to implement biofuels in transportation sector. The project ‘Kathmandu Sustainable Urban transport Project’ which was implemented recently under DoTM doesn’t have any objectives related to biofuels use. Similarly, the national biofuel program of AEPC doesn’t have any objectives regarding promoting biofuels in transport sector.

Both respondents said that the most important thing is government policies. If the government can implement biofuels friendly policies then biofuels industry can grow. Ms. Piya said that the price needs to be competitive with fossil fuels and government needs to implement tax policies and subsidies which will help to do that. This will help to make the biofuels industry market-driven. Both respondents said that the promotion of biofuels use in public transport is impossible in near future in Nepal. The major obstacles according to AEPC are the lack of awareness about biofuels or in case of Nepal, climate change. People have little knowledge about biofuels, climate change and other environmental problems and they don’t have environment friendly habits which will be hard to change. Similarly, the lack of new technologies is a huge obstacle for Nepal. In Nepal there are mainly diesel and petrol engines in vehicle and there is lack of biofuels friendly engines. Mr. Phuyal said that the main problem is the lack of stable government which can give priority to environmental issues and promote biofuels industry.

DoTM said that to promote sustainable transportation in Kathmandu, more investment is required and projects like ‘Kathmandu Sustainable Urban Transport’ needs to be implemented. Similarly, AEPC said that the Nepalese Government cannot do it alone so the support from donors is important to promote sustainable transportation in Kathmandu. AEPC gave the example of a successful project called ‘Biogas Support Program’ which is donor supported project under clean development mechanism that AEPC launched which is a huge success. So, to
promote sustainable transportation, donor support can help a lot in terms of funding, technical know-how and new knowledge.
8 Discussion

From the interview analysis of both Kathmandu and Stockholm and the literature reviews, I have found interesting comparative issues between these two places. The differences are obviously immense between these two places as one belongs to Least Developed Country and other being in the developed country. Some of the interesting issues are discussed below.

**Difference in priority:** There is a huge difference between Stockholm and Kathmandu’s priorities for public transport sector. Stockholm has ambitious goal of drastically reducing the fossil fuel use in transportation sector and ultimately becoming fossil-fuel free. The priority is to set an example of a public transport service in the world. In contrast, Kathmandu’s priority is to fulfill the basic objectives of public transport such as efficiency and transparency in transport sector. The objectives for transport sector as defined by the three year interim plan 2007-2010 are:

- To develop the transport system so as to make it less expensive, safe, non-polluting, equipped with facilities, competitive and self-dependent
- To make the transport sector, efficient, transparent, service-oriented and effective (National Planning commission, 2007).

The planning and management to provide effective and efficient service and to target sustainable transportation is praiseworthy in Stockholm. Sustainability is not the top priority of Kathmandu’s transport sector; it is to provide the basic service in effective and efficient manner.

**Issue of Accountability:** As I am talking about effectiveness and efficiency on transport sector, the issue of accountability is also important to mention. For any sector to be successful, an accountable governing body is required who is responsible for the success or the failure of the sector. The study of Stockholm and Kathmandu shows the importance of such governing body. In Stockholm, Stockholms läns landsting is the governing body who is accountable for the public transport sector. The landsting is responsible for planning, managing and delivering the public transport service. The structure of public transport sector is very simple in Stockholm. The SL is
owned by Stockholms läns landsting and it delivers the transport services to all 26 municipalities. The landsting is formed through the process of election by the public. So, the people have the ultimate power to decide the future of public transportation and the läns landsting is compelled to hear the voice of the people. There are few governing bodies, it is very easy to understand the roles and responsibilities of all the bodies and to check and balance the transactions which make the transport sector transparent. SL produces annual reports for the public where it puts forward its financial transactions, effectiveness, efficiency, and whether they were able to meet the objectives set by Stockholms Landstinget. This has increased the accountability in public transport sector of Stockholm.

In the case of Kathmandu, Department of transport management is a governing body who is responsible for the management of whole transport sector. The public transport sector is also governed by DoTM. From the interview in DoTM it was found that the main responsibilities that the department of transport management does for public transport are to issue route permit to public transport operators, to decide vehicle tax rates, to decide public vehicle fare and to routinely examine the vehicles. Kathmandu Metropolitan City Office is responsible to maintain and promote infrastructure development within Kathmandu Metropolitan. It is mostly involved in repairing roads, maintaining road lamps but it does not play any role on managing public transportation sector. The private transport operators provide public transport service after getting license from department of transport management. There are more than 50 private operators within Kathmandu valley only. So, with so many private transport operators, it is hard to manage and look for accountability and transparency in Kathmandu. There is no rational planning on how many or how the private transport operators be managed.

**Difference in Technology:** Technology can bring simplicity and effectiveness in service delivery. Such is the case in Stockholm. Stockholm is experimenting with new technologies to use the best technology for sustainable transportation. Now, the second generation biofuels are being tested in the public transportation. SL is constantly experimenting with new technologies and new fuels to find out environmentally, socially and economically sustainable transport technologies. The current public transport of Stockholm is well equipped with advanced renewable technologies that are available till date.
Kathmandu doesn’t have access to new technologies. Kathmandu was still relying on vehicles that are more than 20 years old and two stroke engine vehicles which were considered major source of air pollution and carbon emission. But recently these vehicles have been banned. The use of environmental friendly technologies is not in the priority list. The interviews at DoTM and AEPC in Kathmandu show that the authorities are concerned that the lack of biofuel friendly technologies can be a hindrance in promoting biofuels in transport sector.

**Investment and support from national government:** The support from the national government in Stockholm regarding use of biofuels has been explained in 6.1. The role of environmental friendly policies and investment towards the clean technologies by the government in Stockholm has helped to create a Biofueled public transport sector. More than 50% of the income tax is invested in the public transport sector by the Stockholms lans Landsting. This demonstrates the commitment of Stockholm towards building a sustainable transport system.

The situation is totally different in Kathmandu. The political instability, lack of funds and lack of government support are the reasons for the unsustainable situation of the public transportation. Since the declaration of a democratic republican country in Nepal in 2008, there have already been five governments under five different prime ministers. This shows the reality of Nepal and answers why public transportation is never in the priority list of government. There is no enthusiastic support for biofuels from the government. The government has shown some interest in the last five years and there have been some progress like implementing national biofuel program and formation of AEPC. But still there is no clear-cut policy which governs the biofuel sector in Nepal like in other renewable energy sector such as solar energy and micro-hydro. Both DoTM and AEPC respondents didn’t see the use of biofuels in public transport in near future in Kathmandu.
9 Conclusion

In the present context of energy crisis and global warming, the role of Biofueled public transport is very important. In Stockholm, the bus services have increased its biofuel consumption annually which has led to significant reduction in carbon emission. The most important lesson that Kathmandu can learn is to think about future and focus on sustainable transportation. Transportation is an integral part of an urban life and the use of renewable energy like biofuels in transport is very important especially for city like Kathmandu which is very much dependent on fossil fuels. Energy crisis and fossil fuel dependency has crippled not only the transport system of Kathmandu but also the economy and environment of the whole nation. So, renewable energy like biofuels can be a great solution. Least developed countries like Nepal are the most vulnerable from global warming and these countries cannot depend solely upon developed countries to make efforts. So, it is very important to make efforts to reduce carbon emissions.

The study shows that there is a huge difference in scenario between Stockholm and Kathmandu. Stockholm is a leading example in the world on Biofueled public transport. The Biofueled bus services have led Stockholm towards sustainable transportation. Kathmandu can learn so much from the experience of Stockholm.

The study of Stockholm shows that the Biofueled public transport has been a success. This success has been possible due to detailed planning and implementation of policy tools to promote Biofueled public transport. Tax exemption policy is a very important tool which has helped to establish the biofuels market in Stockholm. It helps biofuels to compete with the price of fossil fuels. Similarly, the role of government is also very important. It is very important for Kathmandu to prepare a planned public transport system which is accountable and effective. The public transport system in Stockholm is efficient and effective and it is due to the presence of accountable institution like Stockholms läns landsting. A single organization looks over the public transportation of all the 26 municipalities of the county which makes it easier to manage as well. So, Kathmandu can learn that for a better service delivery to the public, an effective public transport system must be prepared.
The government needs to give priority to public transportation and invest towards sustainable transport system. It is not easy to shift from a system that depends on fossil fuels to biofuels easily. So, many things are connected with this issue such as technology, fuelling stations, policies, habit and so on. Stockholm is still in the process of shifting and the road is not easy yet. The stakeholders in Stockholm are still worried that biofuels cannot compete with the price of fossil fuels and end consumers may not be willing to pay higher price. To develop Biofueled transport system, it is very important to think about fuel tax system. It is a big challenge for countries like Nepal to make the price of biofuels competitive with fossil fuels. The government of Sweden is investing a lot to cover the burden of tax exemption and comparatively the economy of Nepal will not be able to handle that burden. Lots of investment in policy and physical infrastructure development is needed which is a huge challenge in the case of Kathmandu.

Since, economically it is very difficult to develop Biofueled public transport, the developed countries like Sweden can support countries like Nepal. The use of clean development mechanism as defined by Kyoto protocol to promote Biofueled public transport can lead to a win-win situation for both the parties. This is an emission reduction project so, the Annex I countries can generate certified emission reduction units form these projects which they can use to fulfill the emission reduction target as stated by the protocol.
10 Bibliography


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## Appendix

### Interviews in Stockholm

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<td>Sara Anderson</td>
<td>AB Storstockholms Lokaltrafik</td>
<td>Biofuels specialist</td>
<td>In person</td>
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<td>Stefan Wallin</td>
<td>AB Storstockholms Lokaltrafik</td>
<td>Section Manager Sustainable development</td>
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<td>Keolis Sverige</td>
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<td>Sofia Svensson</td>
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<td>Environmental manager</td>
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<td>Annabella Hultman</td>
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<tr>
<td>Sofie Indevall</td>
<td>SEKAB</td>
<td>Product Manager for ED95</td>
<td>Telephone</td>
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### Interviews in Kathmandu

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<td>Resha Piya</td>
<td>AEPC</td>
<td>Senior energy Officer</td>
<td>Telephone</td>
<td>December 2012</td>
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<tr>
<td>Chandra Prasad Phuyal</td>
<td>DoTM</td>
<td>Director</td>
<td>In Person (interview taken by research assistant)</td>
<td>December 2012</td>
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Interview Guides (Semi-structured interview)

Interview guide for SL

Questionnaire

Thank you very much for this opportunity- is it ok if this is like an informal interview? So, of course, you may decline to answer any of the questions I ask. First of all, I want to make sure I do this right, so I’ll start with some privacy rights questions:

- Would you like to remain anonymous, or would it be ok for me to acknowledge in my report that the information comes from you or from your company?
- Would it be ok if I record this conversation, so that I can be sure to capture everything that was said properly? It’s perfectly alright if you would rather not have it recorded.
- Why does Stockholm County and SL promote biofuels in transport so much? Is sustainable development the only reason?
- Stockholm County is politically governed. How have the political forces influenced the decision of SL to promote or not to promote the biofuels?
- The use of biofuels is mainly shaped by the Renewable Energy Directive and the Environmental Policy of Stockholm County. Are there any specific tools that are used to promote biofuels use in public transport?
- From the annual report of SL, I saw that SL has been able to reach its entire target related to emissions. How did SL calculated the carbon emissions that came only from bus operations?
- DO you have target for carbon emission for 2016?
- How has tax exemption for biofuels influenced the use of biofuels in public transport?
- There is debate that tax exemption maybe is not the best solution to increase biofuels consumption. So, what do you think maybe the alternative options to increase biofuels consumption?
- For a single biofuel bus, how much more or less is the expense of SL in comparison to a diesel bus?
- Which biofuel does SL prefer? And how does SL cope with the biofuel preference of bus operators?
- What do you think about the implementation of higher import tariff of biofuels from non-
  EU countries? How have this affected the price in Stockholm?
- What measures do you follow to make sure the biofuels that are used are sustainable?
  How do you check sustainability issue in ethanol imported from Brazil?
- Should you advice other countries to introduce biofuels in public transportation?
- Have these biofuel buses come up to expectations?
- If there is any, what has been the missing point regarding biofuels promotion by SL?
- Do you think Stockholm will meet its target of more than 75 percent buses running in
  renewable fuels within 2016?
- SL had tested ethanol hybrid buses. Will that bus come into use in the future? What other
  technologies are SL looking in future to use biofuels?

Interview Guide for Green Party

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- Why does Stockholm County and SL promote biofuels in transport so much? Is
  sustainable development the only reason?
- Stockholm County is politically governed. How have the political forces influenced the
  decision of SL to promote or not to promote the biofuels?
- At least half of the county’s public transportation is financed by taxation. Do you think
  this is too much or do you think more should be financed through taxation?
- How does your party think about the increasing investment on the use of biofuels in
  public transportation?
- Do you think that the tax exemption for biofuels is a good way to increase biofuels consumption?
- What other ways do you think can be implemented to increase biofuels use in public transportation?
- Do you think Stockholm will meet its target of more than 75 percent buses running in renewable fuels within 2016?
- What are Green Party’s future agendas regarding use of biofuels in public transportation?

Is there anything you would like to add that the questions didn’t cover? Thank you very much for your time. Would it be ok, if I contact you again in few weeks for short follow up questions, if it is necessary?

**Interview guide for bus operators**

Thank you very much for this opportunity- is it ok if this is like an informal interview? So, of course, you may decline to answer any of the questions I ask. First of all, I want to make sure I do this right, so I’ll start with some privacy rights questions:

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Basic information:

- How many buses do you operate for SL?
- Which biofuels do you use and how much biofuels do you consume per year?

Sustainability issues:

- There are rumors of technical problems on biofuel fed buses. How are you dealing with these problems?
- In terms of economy, is biofuel fed bus more expensive to operate than diesel bus?
- How has tax exemption for biofuels influenced your operations?
- What do you think about the increasing use of biofuels for public transport?
- Are there easily accessible biofuel filling stations in Stockholm?
- What measures do you follow to make sure the biofuels that you use are sustainable?

Regarding Stockholm:

- Do you think Stockholm will meet its target of more than 75 percent buses running in renewable fuels within 2016?
- Have you experienced that the biofuels market is expanding in Stockholm?
- How does SL or SLL support you in terms of operating biofuel buses?
- Do you plan to increase the number of buses running on biofuels? What are your future plans in terms of biofuels use?
- Is there anything you would like to add that the questions didn’t cover? Thank you very much for your time. Would it be ok, if I contact you again in few weeks for short follow up questions, if it is necessary?

**Interview guide for biofuel producers**

Thank you very much for this opportunity- is it ok if this is like an informal interview? So, of course, you may decline to answer any of the questions I ask. First of all, I want to make sure I do this right, so I’ll start with some privacy rights questions:

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- Would it be ok if I record this conversation, so that I can be sure to capture everything that was said properly? It’s perfectly alright if you would rather not have it recorded.

Basic information questions:

- How much biofuel do you produce annually, on average?
- Do you import/export much, in terms of raw materials and final product? (e.g. importing feedstock, exporting biogas)
- Where do you get your raw materials for biofuels?
- Is SEKAB privately owned or a public company?
- Who do you sell your biofuels to? Private companies, or to filling stations?
- What are your targets and plans for future development in Stockholm?

Sustainability issues:
- What measures do you implement so that the biofuel produced is sustainable?
- What are the challenges that you face to make sustainable biofuels?
- How do you see the market of biofuels in Stockholm?
- With the increasing use of biofuels in buses by SL, how are you managing with the increasing demand?
- How has tax exemption for biofuels affected you?

Regarding Stockholm:
- Do you think Stockholm will meet its target of more than 75 percent buses running in renewable fuels within 2016?
- Have you experienced that the biofuels market is expanding?
- How does SL or SLL support you in terms of creating market?
- Is there network between biofuel producers to work towards sustainable production? If there is a network, how does it work?
- How profitable is the biofuel business? Is the biofuels business really profitable for you?
- Do you think that biofuels can really compete with the fossil fuels?

Interview guide for DoTM in Kathmandu

- सार्वजनिक सवारी साधन च्यात्र लाई नियन्त्रन गर्न सरकार को के के प्रावधान छ?
  What are the major government policies that govern the public transport sector of Kathmandu?
- यो संस्थान ले सार्वजनिक सवारी च्यात्र म कस्तो भूमिका निर्धार गर्छ?
  How is this organization involved to provide service of public transport to the public?
- नेपालमा सवारी साधन मा जबिक इन्धन को प्रयोग क्षेत्र एको उघाड्न छ?
  How profitable is the biofuel business? Is the biofuels business really profitable for you?
Are there any cases where biofuels are used to run public transport or any other form of transport in Kathmandu or any other place? If yes, can you describe about the case?

- काठमाडौं मा महत्वपूर्ण पालिका को फोहोर बात जैविक इन्थन उत्पादन गर्ने कती को सम्भावना छ?

if there is any study carried out?

Regarding solid waste management problem in Kathmandu, do you think there is possibility to produce biofuels for transport fuel from this waste?

- पेट्रोलियम पद्धति (petroleum products) र सवारी साधन को बद्धो (badhdo) माघ र सरकारले यो माघ पुरागर्ने नसकी रहेको अवस्था मा, नेपाल को सवारी क्षेत्र (sector) मा जैविक इन्थन (biofuel) को महत्त्व कती र कस्तो हुन सक्छ?

With the increasing demand for fossil fuel and vehicles and Government's inability to fulfill this demand, how relevant do you think biofuel can be?

- Kathmandu Sustainable Urban Transport Project भर्जिर कार्जन्यय भयो | त्यो प्रोजेक्ट मा जैविक इन्थन साँग सम्भन्धित केहि कार्यक्रम छ?

Kathmandu Sustainable Urban Transport Project has been implemented recently. So, are there any objectives in the project regarding biofuels use?

- नेपालमा जैविक इन्थन को सवारी साधन चेत्र मा प्रयोग मा त्याउनलाई के कस्तो कार्यक्रम को आवश्यकता पत्री ? (Maybe clean development mechanism?)

What do you think can be done to promote biofuels in transportation sector in Kathmandu? (E.g. through clean development mechanism)

- निकात भविष्य मा काठमाडौ (Kathmandu) को सवारी साधन मा जैविक इन्थन प्रयोग हुने सम्भावना कती कहो देखनुहुँनछ?

Do you see any possibility in near future of using biofuels instead of fossil fuels in public transportation in Kathmandu?

- नेपाल र काठमाडौं म जैविक इन्थन को प्रयोग र प्रबंधन मा मुख्य बाधा-अद्वधन के हुन सक्छ?

What do you think can be the major obstacles to promote biofuels in Kathmandu and Nepal?
What do you think needs to be done to achieve sustainable transportation in Kathmandu?

Interview guide for AEPC in Kathmandu

- खानभाड़ी माता स्वाभाबिक भांधु तर्कारी साधन देने लाई के के गर्नु पर्छ जस्तो लागछ?

With the increasing demand for fossil fuel and vehicles and Government’s inability to fulfill this demand, how relevant do you think biofuel (Jaibik Indhan) can be for transport sector in Nepal?

- कृषि योग्य जामन मा जात्रोक जर्वक्स (Jatropha Curcas) जस्ता जैविक इन्धन मूलक बाली लगाएर, खान्ध्य पद्धार्थ (Food Products) उत्पादन मा असार पन्ने सक्छ। खान्ध्य पद्धार्थ र जैविक इन्धन पद्धार्थ उत्पादन बाट व्यापेन्स राखने के उपाय अपनाउँछ यो सक्छ?

By using agricultural land to produce plants like Jatropha curcas, food production can get affected. What measures do you take to make sure that there is balance between food production and energy plants production? (AEPC)

- नेपालमा जैविक इन्धन उत्पादन को लागि जात्रोक जर्वक्स बाहेक अरु कुन बाली र कक्ष पद्धार्थ (raw materials) को रामो भविष्य छ?

What other raw materials in Nepal have a great potential to produce biofuels?

- काठभाडौं मा महानगरपालिका को फोहोर बाट जैविक इन्धन उत्पादन गर्ने कक्ष को सम्भाब्य छ?

if there is any study carried out?

Regarding solid waste management problem in Kathmandu, do you think there is possibility to produce biofuels for transport fuel from this waste?

- जैविक इन्धन को सवारी साधन चेत्र मा प्रयोग गर्ने कार्यक्रम छ यो सन्नयान को? if yes please elaborate

Does AEPC have any program related to use of biofuels in transportation sector?
- What do you think can be done to promote biofuels in transportation sector in Kathmandu? (E.g. through clean development mechanism?)

- Do you see any possibility in near future of using biofuels instead of fossil fuels in public transportation in Kathmandu?

- What do you think can be the major obstacles to promote biofuels use in Kathmandu and Nepal?

- What do you think needs to be done to achieve sustainable transportation in Kathmandu?

- Is there a pilot project for using biodiesel in vehicles in Nepal?