Final Draft Report

**PROMOTION OF RENEWABLE ENERGY,
ENERGY EFFICIENCY AND GREENHOUSE GAS ABATEMENT
(PREGA)**

Nepal

TROLLEY BUS DEVELOPMENT IN RING ROAD OF THE KATHMANDU VALLEY

A Pre-Feasibility Study Report[1]

March 2004

[1] Prepared by the PREGA National Technical Expert from Winrock International Nepal, Mr. Ratna Sansar Shrestha.

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List of Abbreviations

ADB	Asian Development Bank
ADB/N	Agriculture Development Bank of Nepal
AEPC	Alternative Energy Promotion Center
ATF	Aviation Turbine Fuel
BOOT	Build, Own, Operate and Transfer
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CES	Center for Energy Studies
COPD	Chronic obstructive pulmonary disease
DOTM	Department of Transport Management
EV	Electric Vehicle
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Giga gram (kilo ton)
GHG	Greenhouse Gas
GJ	Giga Joule
GWP	Global Warming Potential
HDI	Human Development Index
HMG/N	His Majesty's Government of Nepal
KEVA	Kathmandu Electric Vehicle Alliance
KMC	Kathmandu Metropolitan City
kW	Kilowatt
kWh	Kilowatt hour
LCC	Lifecycle cost
LPG	Liquefied Petroleum Gas
MOICS	Ministry of Industry, Commerce and Supplies
MOF	Ministry of Finance
MOLT	Ministry of Labour and Transport Management
MOPE	Ministry of Population and Environment
MW	Megawatt
NEA	Nepal Electricity Authority
NEPAP	Nepal Environmental Policy and Action Plan
NIC	National Implementation Committee
NGO	Non-governmental Organization
NPC	National Planning Commission
NPV	Net Present Value
O&M	Operation and Maintenance
PM10	Particulate Matter with diameter equal or less than 10 micrometer
PREGA	Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement Technologies
REGA	Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement

NRs	Nepali Rupees
NTE	National Technical Expert
SDAN	Sustainable Development Agenda for Nepal
TSP	Total Suspended Particle
TU	Tribhuvan University
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCC	United Nations Framework Convention on Climate Change
WB	The World Bank
WI	Winrock International
WMO	World Meteorological Organization

Executive Summary

Rapid and unplanned urbanization and migration of rural people in Nepal has resulted in a rapid growth in the demand for transport in the urban areas over the past few years, especially in the capital city Kathmandu. The number of vehicles registered in Kathmandu alone in the past 10 years has increased by 211 percent. Needless to say, the increase in vehicles is putting immense pressure on the existing infrastructure and triggering numerous adverse effects. The environmental impact of these vehicles is mainly felt in terms of air pollution, primarily Greenhouse Gases (GHGs), from tail pipe exhausts and noise pollution. GHGs not only cause global warming but also impact the health of the local populace adversely. The adverse health impact from the air pollution includes increased incidence of chronic bronchitis and acute respiratory illnesses, exacerbation of asthma, and impairment of lung function. Chronic bronchitis and asthma lead to chronic obstructive pulmonary disease (COPD). Different studies have indicated that the air quality in Kathmandu, especially the PM10 (particulate matter less than 10 microns) has a major impact on respiratory diseases leading to COPD. Various studies indicate that transport sector contributes the highest CO_2 emissions in Nepal. In addition, as most of these vehicles are fossil fuel based, the government is spending the scarce foreign currency reserve to import fuel for these vehicles. Pollution can also be detrimental to our cultural heritage and can also have severe effects on the tourism industry. Electric based vehicles have a convincing potential to counter escalating pollution levels and adverse impacts thereof, and are currently being promoted in the country, especially in the mass transport system. The fleet of about 600 battery-powered three wheelers, called “Safa Tempos”, in the country is testimony to this newfound public awareness of the benefits of clean energy. The concept of electric public transportation is not new to Nepal. In 1975, Chinese support enabled the operation of a 32 fleet trolley bus system between Tripureshwor in the city center (in Kathmandu) and Suryabinayak in the town of Bhaktapur in the Kathmandu Valley. Although an amalgam of problems led to the termination of Nepal’s one and only trolley service in late 2001, the system has recently been partially revived by a consortium of three municipalities: Kathmandu, Thimi and Bhaktapur.

In an effort to address the current transport related problems in the Kathmandu valley, a pre-feasibility study for the development of a trolley bus system in the Kathmandu valley Ring Road has been undertaken under the PREGA project. The project is being initiated at a time when the government policy is favorable for electric vehicles; this has the potential to contribute to the overall sustainable development of the Nepali economy. The project is expected to make a positive impact on poverty reduction through employment generation, support the tourism sector, and promote environment protection, positive health impact etc.

As an immediate 100% replacement of all diesel buses from the Ring Road is an unrealistic target, the trolleybuses are planned to be introduced in phases over three different periods during the project life. It is proposed that 50 trolleybuses will be introduced in the initial stage; followed by 25 trolley buses introduced in three, five-year intervals. This would mean that an additional 75 buses would be added in the system during 2011, 2016 and 2021, resulting in a total of 125 trolley buses on the Ring Road by 2021.

In terms of replacing diesel buses, the 50 trolleybuses introduced in 2005 would replace about 34 diesel buses and 33 diesel minibuses. Ultimately, introduction of the total 125-trolleybus fleet during the project period (2005-2025) would replace about 85 diesel buses and 83 diesel minibuses from the Ring Road. Apart from other benefits, implementation of the trolleybus transportation system in the Ring Road would ultimately help reduce about 128,927 tons of CO_2 equivalent emissions during the project period alone.

The project investment scheme will also be staggered over the project period. Investments are required at different intervals as additional numbers of trolleybuses are introduced over the project period 2005-2025. The initial investment, amounting to NRs 522.49 million (US$ 6.97 million) will be made in 2005 for the 50 trolley buses. The additional 75 trolleybuses, to be introduced at three five year intervals, require an additional investment of NRs 211.56, NRs 185.41 and NRs 211.56 million (US$ 2.82, 2.47 and 2.82 million) during the years 2011, 2016 and 2021 respectively. The total investment required for the infrastructure needed to implement the trolley bus project along the Ring Road amounts to about NRs 1,131 million (US$ 15.08 million). However, this cost can be reduced to NRs. 969.5 million (US$ 12.93 million) if the trolleybuses are assembled locally with imported components i.e., chassis from India and electrical components from China. The estimated cost of an imported trolleybus is NRs 5.5 million (US$ 0.073 million) whereas the cost of a locally manufactured trolleybus is estimated at NRs 4.2 million (US$ 0.056 million). As the cost of imported trolley buses is substantially higher, the assembly of trolleybuses locally has been found as a cost effective option besides the appurtenant benefits thereto in the form of backward linkage. In addition, an annual operation cost of NRs. 1.18 million (US$ 0.015 million) per trolleybus per year has been estimated.

The project can be financed in two ways: one time lump sum payment for the abatement during the life usually through Global Environment Facility (GEF) or payment each year upon delivery of abatement through the Clean Development Mechanism (CDM). CDM is a mechanism within the Kyoto Protocol that allows industrialized Annex I countries to implement projects that reduce emissions in non-Annex I countries (developing countries) and get credits for meeting their commitments to reduce emissions. In order to make the project commercially feasible and attract private investors, the FIRR needs to be at least 14%. Calculations suggest an incremental cost of about NRs 155 million (US$ 2.06 million) for imported trolleybuses, and NRs 63 million (US$ 0.84 million) for locally assembled ones. If the lifecycle costs of baseline and project case are considered, the incremental cost becomes Rs. 427.02 million (US$ 5.69 million) for imported trolley bus and Rs. 207.48 million (US$ 2.77 million) for locally assembled. However, the economic analysis indicates that the project will be beneficial to the society if implemented. But the financial calculation suggest that additional income like sell of CERs would be needed on top of the revenue from passenger service to be financially viable.

The abatement cost of CO_2 varies depending upon the funding mechanism. Receipt of payment for the total GHG abatement during the life time of the project at the beginning of the project through one time lump sum payment makes the abatement cost of CO_2 more economical compared to the abatement cost through CERs paid annually. If the project were to be implemented with imported trolleybuses, then the abatement cost would be US $ 16 per ton of CO_2 eq mitigated. For locally assembled trolleybuses, this would be around US $ 6.5.

On the other hand, if the project were to be paid for CERs generated each upon delivery, the cost of CO_2eq would be around US $ 57 per ton of CO_2eq mitigated for imported trolleybuses, while the cost of CO_2eq would be around US $ 23 for locally assembled trolleybuses. Similarly, the abatement cost is US$ 44 per ton of CO_2eq for imported trolleybuses, and US$ 21.5 per ton of CO_2eq for locally assembled if the incremental cost computed on the basis of through lifecycle analysis. From the above results it is evident that the cost of CO_2eq is higher if the payment for the generated CERs is to be made annually, and that, the project would be even more attractive if the trolleybuses could be manufactured locally.

On the other hand, a detailed monitoring plan needs to be developed for CDM funded projects. For certain projects, monitoring the performance and GHG impacts can be an important component of a project's total transaction costs. The latest draft simplified baseline and monitoring methodologies for selected small-scale CDM project categories, which also includes "Emission Reductions in the Transport Sector", requires monitoring to track the number of trolley buses operated and the annual units of service for a sample of the vehicles. An effective and efficient record keeping system can be established in the company based on the overall kilometers covered, total passengers traveled, the total number of trolleybuses as well as diesel buses in operation etc. This data can be reported on an annual basis and can be electronically archived.

A half-day workshop to gather stakeholder comments regarding the draft report was held on November 3, 2003 in Kathmandu. The overall consensus was that the project should be investigated further by conducting a detailed feasibility study. Questions pertaining to how the local costs would compare to the initial investments, how to raise the preliminary capital, the need to incorporate health impacts to strengthen the study, development of a concrete substantiation of benefits in order for EVs to be eligible to claim subsidies, involvement of the private sector in future trolleybus operations, and the need for a strong management system were suggested by workshop participants to further substantiate the study.

1.0 Project Summary

Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA) was initiated in April 2001 with the goal to promote investments in renewable energy, energy efficiency and greenhouse gas abatement to increase access to energy services by the poor, help reduce greenhouse gas emissions and realize other strategic development objectives of the developing ADB member countries. This three-year project is co-financed by the Royal Government of The Netherlands on a grant-basis and is being implemented by the Asian Development Bank (ADB). Nepal is one of the 15 PREGA countries. The Ministry of Population and Environment (MOPE) hosts the National Implementation Committee (NIC) in Nepal and Mr. Ratna Sansar Shrestha, Senior Advisor of Winrock International Nepal has been selected as the National Technical Expert (NTE) for Nepal. The NTE has been assigned two tasks: a Country Study Review and a Pre-feasibility Study of the Trolley Bus in the Kathmandu Valley Ring Road. This report is the outcome of the Pre-feasibility study. The study was initiated in April 2003 and the preliminary draft was completed in November. A workshop was held in November 3, 2003 to collect comments from the stakeholders on the preliminary draft. The pre-feasibility report was submitted in January 2004 after incorporating comments received from the stakeholders.

1.1 Salient Points

Transportation is the major source of CO_2 emissions in Nepal. This study concentrates on carrying out a pre-feasibility study to replace some of the diesel vehicles operating in the 28 km Ring Road in the Kathmandu Valley with trolley buses which use electricity generated by a non-GHG emitting source: hydropower. The study approximates that a total of 128,927 ton equivalent CO_2 can be reduced by the utilization of trolley buses in the total project lifetime alone (2005 – 2025).

The total investment for the whole period from the 2005 to 2025 will be: NRs. 1,131 million (US$ 15.08 million) for imported trolleybuses. If locally assembled ones are to be used instead, then the total investment will be reduced to NRs. 969.5 million (US$ 12.93 million). The total operation cost in both cases is NRs. 2,131.29 million (US$ 28.41 million).

The financial internal rate of return (FIRR) of the project is only 8.9% with the negative FNPV of NRs. 38.89 million in the case of imported trolley buses without considering any GHG mitigation credit/benefits. If the trolley buses are to be locally assembled, then the FIRR becomes 11.7% and FNPV NRs. 53.1 million. The project would require an incremental cost of NRs. 155 million (US$ 2.06 million) as an initial lump sum grant in the case of imported trolley bus, and NRs. 63 million (US$ 0.84 million) in case of locally assembled buses to maintain a minimum financial return of 14%. This translates to US$ 16 per ton CO_2 for imported buses, and US$ 6.5/ton CO_2 in case of locally assembled ones.

If the project is to be paid for the CERs it generates upon delivery each year, the CO_2 will have to be traded at least for US$ 57 per ton CO_2 for imported buses, and US$ 23 per ton CO_2 for locally assembled ones. On the other hand, if the lifecycle costs of baseline and project case are considered, the incremental cost becomes Rs. 427.02 million (US$ 5.69 million) for imported trolley bus and Rs. 207.48 million (US$ 2.77 million) for locally assembled. This translates to the abatement cost of US$ 44 per ton of CO_2eq for imported, and US$ 21.5 per ton of CO_2eq for locally assembled trolleybuses. It is, however, very unlikely that the prices for carbon credits will reach to these levels within the first crediting period. If the economic costs are considered, the project is beneficial to the society but would require additional income through selling of CERs to be financially feasible.

1.2 Map of the project

The project site is the Kathmandu Valley Ring Road. The Ring Road is 28 km long and is an important bypass for Kathmandu city traffic. The development of a sound mass transit system along this road would certainly ease the traffic congestion and reduce GHG emissions within the valley. The Ring Road area is illustrated in the map below:

Figure 1: The Kathmandu Ring Road Periphery

Source: *http://www.asiatravel.com/kathmap.html*

The Ring Road has wide curvature radius and low gradient making it ideal for the operation of the trolley bus system. All bridges also have the necessary width and load bearing capacity to allow smooth operation of the trolley bus system. An added advantage is that the Ring Road also has easy access to the required Nepal Electricity Authority (NEA) 11 kV electricity lines.

2.0 Project Background

2.1 Sector Description

Nepal is a South Asian country with China to the North, and India to the East, West and South. Nepal has three distinct ecological regions along the length of the country. All of the three regions, namely the mountainous region, the hilly region and the Terai region, run parallel from east to west. The mountainous and hilly regions are least accessible as compared to the Terai region due to their rugged and difficult terrain. For administrative purposes, the country is politically divided into 14 zones and 75 districts.

Nepal is a low-income country with an annual Gross National Income per capita of US$ 230 in 2002 against US$ 250 in 2001 (World Bank, 2003). Nepal is ranked 143rd in the 2003 Human Development Report, with the Human Development Index (HDI) value of 0.499 (UNDP, 2003). The country has an area of 147,181 square km with an estimated population of about 23.1 million in 2001. The annual population growth rate was 2.2 percent during 1991-2001. About 14.2 percent of the population lives in urban areas (CBS, 2002). The population density of the country is 165 persons per square kilometer. The GDP growth rate of the country was 4.8 percent during the year 2000-2001. About 42% of the population lives below the poverty line (World Bank, 2003). However, the 10th five-year plan states that this percentage has come down to 38% at the end of 9th plan (2001).

The Kathmandu, Patan and Bhaktapur cities together constitute the major part of the Kathmandu Valley. Kathmandu is the capital city of the country. The population of the valley is about 1.6 million (MOPE, 2000). About 33 percent of the population of the valley lives in Kathmandu city, 10 percent in Patan and 7 percent in Bhaktapur.

The above-mentioned ecological regions have highly uneven spatial distribution of roads and transport facilities. The prime reasons for uneven distribution of these facilities are rugged terrain, low and sparse population density in rural areas, high cost of development of such facilities, etc. However, the Terai region has better roads and transport facilities as compared to those of the other regions. Most of the large cities have reasonable roads and transport facilities. The longest highway in the country, the East West Highway, is 1,024 km. The total road network in the country as of mid March 2003 is 16,000 km (MOF, 2003) of which 28.9 % is black topped, while in the Kathmandu Valley about 55% of the 1,260 km network is black topped (CEMAT, 1999). Table 1 presents the statistics on the extension of road facilities, black-topped roads and graveled roads in the country from the period 1974/75 to 2001/02. There were only 1,575 km of blacktopped roads and 416 km of graveled roads in the Fiscal Year 1974/75. The length of blacktopped roads increased by almost 200% while that of graveled roads increased by more than 800% during this period.

Table 1: Extension of Road Facilities in Nepal, 1974-2001

Fiscal Year	Black Topped (km)	Growth (%)	Graveled (km)	Growth (%)
74/75	1575		416	
75/76	1579	0.25	310	-25.48
76/77	1751	10.89	556	79.35
77/78	1851	5.71	593	6.65
78/79	1916	3.51	685	15.51
79/80	2044	6.68	564	-17.66
80/81	2167	6.02	703	24.65
81/82	2322	7.15	719	2.28
82/83	2484	6.98	830	15.44
83/84	2645	6.48	815	-1.81
84/85	2724	2.99	918	12.64
85/86	2757	1.21	946	3.05
86/87	2794	1.34	1180	24.74
87/88	2822	1.00	1348	14.24
88/89	2837	0.53	1477	9.57
89/90	2821	-0.56	1542	4.40
90/91	3083	9.29	2181	41.44
91/92	3164	2.63	2243	2.84
92/93	3404	7.59	2373	5.80
93/94	3451	1.38	2396	0.97
94/95	3533	2.38	2662	11.10
95/96	3609	2.15	2867	7.70
96/97	3655	1.27	3011	5.02
97/98	4080	11.63	3489	15.88
98/99	4148	1.67	3710	6.33
99/00	4522	9.02	3646	-1.73
00/01	4566	0.97	3786	3.84
01/02	4617	1.12	3878	2.43

Source: TRUST, 2000, P. 14; MOF, 2003

Apart from the Ring Road in Kathmandu, some other sites for expansion of Trolley bus have caught the attention of the government and other private sectors. These are: Sunauli – Butwal, Biratnagar – Dharan, Birgunj – Hetauda, Nepalgunj – Kohalpur, and within Pokhara valley. The approximately 50 km long Janakpur–Jayanagar railway line, which is presently operated by diesel-powered engines, can also potentially be replaced by electric vehicles. Presently, over 100,000 passengers benefit from the services provided by over 600 battery-powered 'Safa Tempos' each day in Kathmandu and Pokhara, Bhairahwa, Narayanghat, Hetauda, Birgunj and

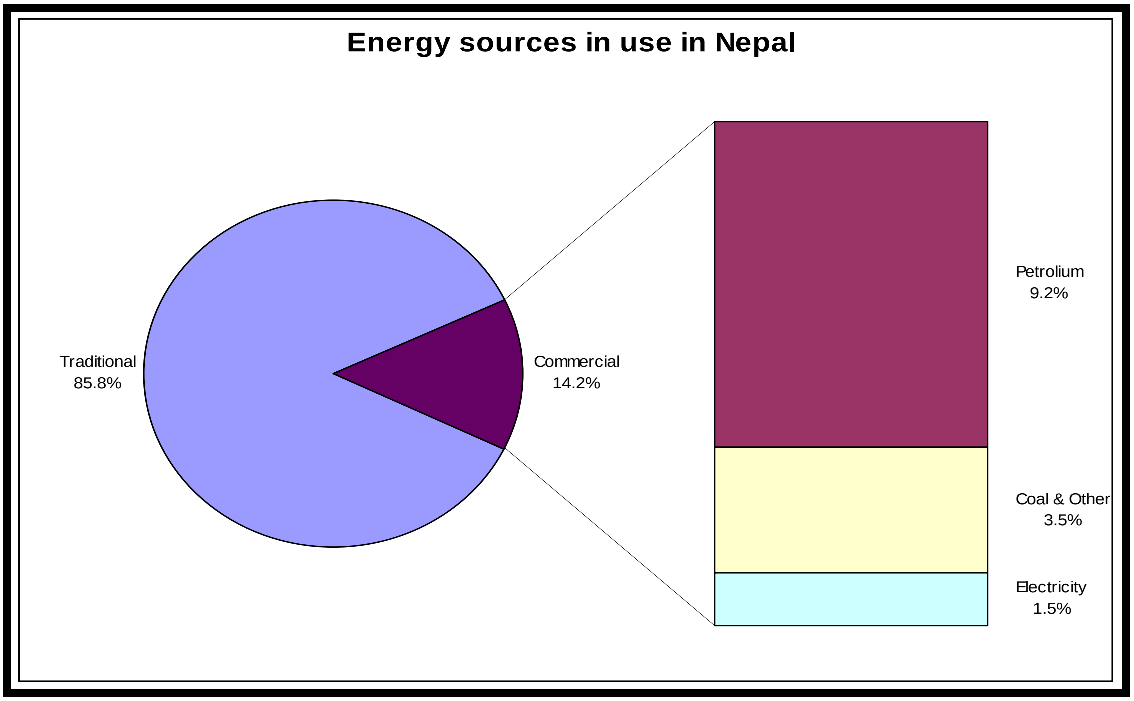
Biratnagar are other cities where Safa Tempos can be operated. These sub-metropolitan cities have been identified for operating Safa Tempos, as these cities are located in the plains area with wider roads and low gradient. In line with the Government's policy to encourage private sector participation in the development of the transport system, a cable car service between Kuringhat of Chitwan district and Manakamana of Gorkha district is now in operation. The other such successful example is Bhatte Danda ropeway at Lalitpur. There is a tremendous potential for such ropeways and cable cars in many hilly and mountainous regions where other modes of transportation are financially not feasible.

2.2 Constraints and issues

As in most cities in developing nations, Nepali cities are also subjected to immense strain due to overwhelming migrations of people from rural areas. The scale of migration can be attributed to the lack of career enhancing opportunities such as jobs, education, and healthcare in rural areas. In addition, Maoist activities have also induced migration among the rural mass. This influx of people to Kathmandu has already over taxed infrastructures such as the road network and its capacity, the water supply system etc. In the transport sector, the marked impact has been the rapid increase in the number of vehicles in the valley, and the resultant adverse effects on the valley environment. The environmental impact of these vehicles is mainly felt in terms of air pollution due to emissions, mainly Greenhouse Gases (GHGs), from tail pipe exhausts and noise pollution. In addition, as most of these vehicles are fossil fuel based, the economy is spending scarce foreign currency reserve on the import of fuel for these vehicles. Efforts have been made to promote electricity-based vehicles such as electric three wheelers, however only a negligible percentage of electric three wheelers operate in the valley. It is estimated in this proposed project that around 1.8 million liters of diesel can be reduced from total fuel imports by replacing 67 diesel buses in 2005 alone.

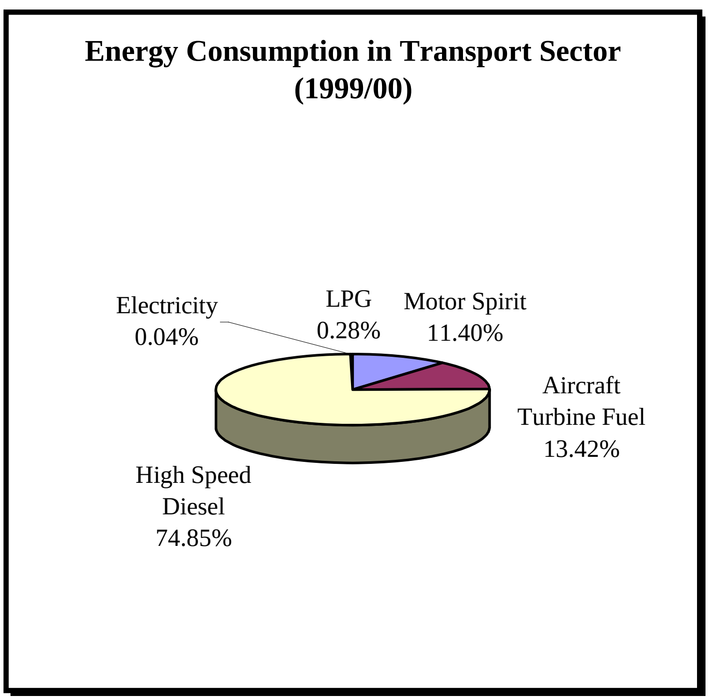
Nepal relies heavily on traditional energy sources to meet its energy requirements. During the year 2001/02, 85.8 percent of Nepal’s energy requirement was supplied from traditional sources like fuel wood (75.78%), animal waste (5.74%), agricultural residue (3.75%), others (0.48%); and the remaining 14.2 percent from commercial energy sources such as petroleum, coal and electricity. Out of the 14.2 percent of the energy supplied through commercial energy sources, 9.2 percent was from petroleum, 3.5 percent was from coal and about 1.5 percent from electricity (MOF, 2003). The 10^{th} five-year plan states that a total of 40% of the Nepali population has access to electricity.

Figure 2: Energy Sources in Nepal



Source: MOF, 2003

Figure 3: Energy Consumption in the Transport Sector (1999-00)



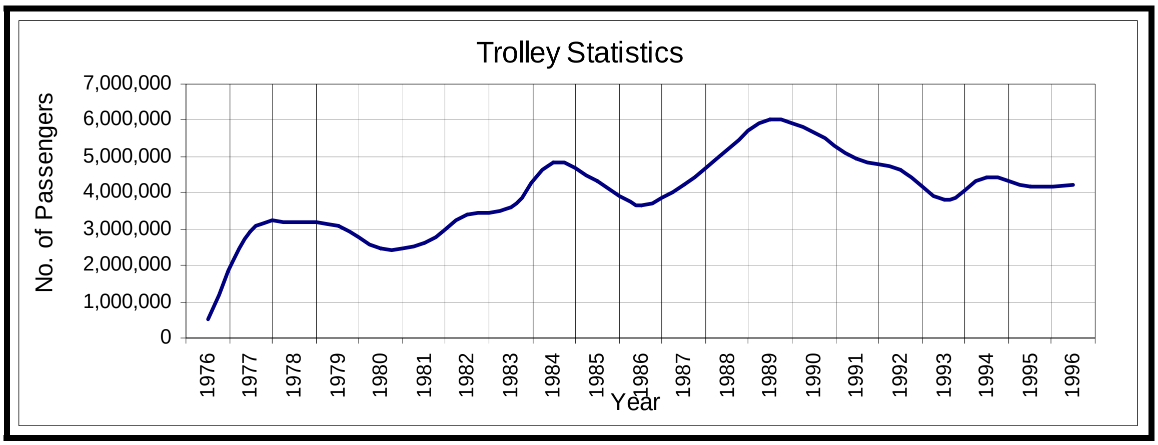
The detailed breakdown of different sources of energy in the transport sector for 2001/02 is not available. However, the share of electricity was only 0.04% in 1999/00 from the total of 15,529,010 GJ. The remaining energy demand is met by imported fossil fuels, of with diesel takes the maximum share. The average annual growth rate of the total transport energy consumption in the last 20 years (1980/81 – 1999/00) is 7.8% and for diesel, it is 8.77% (TRUST, 2000, P. 58). Diesel has replaced coal in the railway sub-sector and LPG has recently been introduced for road transportation.

Source: TRUST, 2000, P. 58

Nepal has the advantage of abundant hydropower resources which may be used to produce electricity to operate the electric trolley bus system in the major cities of Nepal, replacing as well as reducing the number of polluting fossil fuel driven vehicles that have high global warming potential and contribute to climate change. Promoting the trolley bus system in major cities would conserve the natural environment, reduce pollution, and ultimately contribute positively to global climate change by lowering GHG emissions.

Nepal's one and only trolleybus system was commissioned in 1975 with the grant assistance of NRs. 40 million from the Chinese government. The 32-bus trolley fleet plied between Tripureshwor in Kathmandu city and Suryabinayak in Bhaktapur for 27 years before it was suspended in 2001 (CEMAT, 1999, P. 7). The Chart below shows the number of passengers using the trolley bus during the period between 1976 and 1996. The passenger flow is seen to decrease during the 1990s.

Figure 4: Number of passengers using the trolley bus (1976 – 1996)



Source: TRUST, 2000, P. 33 - 34

The drop in number of passengers in the '90s clearly depicts the performance of the trolley bus system. Poor management could be the main explanation for this failure. Ultimately, the system stopped operations when the government dismantled the Nepal Transport Corporation (NTC) on December 16, 2001. At present Kathmandu Metropolitan City and, Thimi and Bhaktapur Municipalities are managing the trolley bus system jointly.

Implementing trolley bus services along the Ring Road in the Kathmandu Valley and in other cities outside the Valley would depend largely on the availability of government funds if they were to be developed by the government. However, budgetary constraints and the collapse of Nepal Transport Corporation (NTC) have left the government with very few options apart from implementation of such services through the private sector. The failure of NTC and thus the trolley bus system is mainly attributed to the weak management, overstaffing, corruption, and poor maintenance.

As the private sector is generally profit oriented and, therefore, relatively more efficient, effective and economic, the decision to involve them in implementing transport infrastructure and services in general, and the trolley bus system in particular, would primarily revolve on the premise that the projects or the schemes are able to generate enough revenue for them. One of the prime concerns of a prospective lender for the projects is servicing of the debt, which is directly related to the revenue from the project.

As maximization of profits for a given scope of work is one of the objectives of the private sector, its involvement would naturally tend to have a very efficient management by hiring an efficient and small group of manpower able to sustain good maintenance of vehicles. In addition, there is almost no scope for corruption in well-managed private ventures. The electricity tariff, availability of electrical energy and quality of energy and incentives are also important factors in the successful implementation of transportation infrastructure projects. The private sector's participation generally relieves the government from funding expensive infrastructure projects. This allows the government to concentrate on social sectors.

2.3 Project sustainable development objectives

The trolley project is expected to contribute to the economic development of the country and thus impact the GDP and GNP favorably. As the energy source for the trolley bus system is electric energy and Nepal has huge hydropower potential, promotion of a trolley bus system would establish a reliable market for hydropower. Smaller hydropower projects can also be developed to meet increasing electricity demand. This would also provide opportunities for local independent power producers to gain experience of developing hydropower projects. Nepal, in search of a consistent market, has long harboured an ambition to sell electricity to India. However, even the authorities agree that much needs to be done before Nepali electricity can be exported either to India or other neighbouring countries.

Once a trolleybus system is in place, it would provide emission and noise free mobility to the public, thus contributing to the government's efforts to reduce air and noise pollution. In addition, all forms of transport infrastructure and services, including trolleybus systems, would help contribute positively towards increasing economic activities in the area, and help reduce poverty, generate employment and improve health conditions. Of crucial importance is that the trolley bus systems would help increase the country's foreign exchange reserves by using electric energy as fuel, and thereby reducing the quantity of fossil fuels imported. This would help in providing improved standards of living and easier access to public services. In addition, as rural agricultural products and cottage industries would also have easy access to the urban market, they could, in turn, further pave the way for the establishment of new cottage and small industries in rural areas.

2.4 Government policy and strategies

So far, government efforts towards the promotion of an electric based transport system have been fragmented. Inconsistencies of various consecutive governments in decisions regarding EVs are causing prospective EV investors to lose confidence in the government. Rules and polices of government bodies responsible for the development of the transportation sector are not coherent. As a result, the policy objectives have not been achieved. For example, the traffic police regulate emission levels of vehicles, the Department of Transport Management (DOTM) allocates specific routes to the vehicles, and the Ministry of Finance determines the taxes and import policies for vehicles. It would be much more comprehensive for all policies to be streamlined into a single act covering all aspects of the electric based transportation system. An integrated approach would be more conducive to bring all players behind the promotion of the electric based transportation system in Nepal together.

Nepal lacks adequate Research and Development (R&D) work in the promotion of electric vehicles. The government as well as the private sector has invested only minimally in R&D related to electric based transportation systems.

HMG/N made public its transport policy in 2001 as the "National Transport Policy, 2001" (NTP2001). In addition to NTP2001, the following policies and legislative framework promulgated by the HMGN are relevant to the energy and transport sector of Nepal.

- Five year plans (1992- 2007)
- Vehicle Transport Management Act, 1993
- Vehicle Transport Management Regulation, 1997
- Environmental Protection Act, 1996
- Environmental Protection Regulation, 1997
- Local Governance Act, 1999
- Industrial Enterprise Act, 1993
- Hydropower Development Policy, 2001
- Privatisation Act, 1994
- Foreign Investment and Technology Transfer Act, 1992
- BOOT Act 2003
- Fiscal Act, 2003

The 8th five-year plan (1992-1997) policy document stressed on minimizing consumption of imported fuel through the extension of trolley bus services to Tripureshwor-Kirtipur and Thapathali-Patan Gate-Pulchowk during the 8th plan period. It further stressed that operating trolley bus along Ring Road between Teenkune-Chabahil-Maharajgun (15 km) would make an important contribution in reducing vehicular pressure on the roads of Kathmandu. Similarly, it also envisaged the establishment of a 22 km trolley bus service between Itahari and Biratnagar in the eastern part of Nepal during the plan period.

The 9th five-year plan (1998-2002) also envisaged extension of the Kathmandu-Bhaktapur trolley bus service along the Ring Road, and initiation of its privatisation during the plan period. After 5 years of unfulfilled commitment to extend trolley bus services in the Valley and to establish new services in Itahari-Biratnagar, the government reiterated its earlier commitments though with a greatly reduced scope. It planned to conduct detailed study to extend trolley bus services to Tirpureshwor-Kirtipur, Thapathali-Patan Gate-Pulchwok and Tripureshwor-Maharajgunj-Ring Road junction within Kathmandu Valley and to gradually construct the infrastructure necessary to extend its services. Similarly, it planned to conduct a feasibility study to operate a trolley bus service in the Biratnagar-Ithari-Dharan sector in the Eastern Region, and the Bhairahawa-Butwal sector in the Western region and to construct necessary infrastructures.

The 10th five-year plan (2003-2007) stresses on making the traffic and transport system systematic and sound by making transport services reliable, safe, pollution free, and service-oriented, and to increase the quality of the transport service. It emphasizes on reduction of pollution including air pollution (due to traffic) through effective enforcement of Nepal Traffic Pollution Standards 1992 (2056). The long-term strategy for the expansion of the transport sector includes development of a sustainable, reliable, low-cost, safe, comfortable, pollution free and self-reliant transport system that contributes to the overall economic, social, cultural, tourism etc development in the kingdom of Nepal.

The expansion of trolley bus services is under the high priority for development and has been allocated a budget of NRs 10 million (US$ 0.13 million) for five years (2003 - 2007) in the 10th Plan document. This is the first time that HMG/N has expressed its commitment to the expansion of trolley bus services by allocating a budget for it. The Plan also mentions an increase in the involvement of the private sector in the operation and management of railway, ropeway, and trolleybus services. However HMG/N's other commitments to provide trolley bus services outside the valley have not been mentioned in this plan period. The plan also expects to increase the involvement of the private sector in the operation and management of the railway, ropeway, and trolley bus services during the 10th five-year plan.

The Nepal Transport Policy (2001) includes the policy of utilizing solar and electric transport throughout the nation; making public transport safe, reliable, convenient, pollution free and easily available; and involving the private sector to the maximum extent possible in the development of transport infrastructure and expansion of services. The policy also states that noise and air-polluting vehicles would be prohibited from plying the urban areas and that solar, electric and gas operated buses, trams and cars would be operated in urban areas. The policy has also stressed the need to attract and involve the private sector in the construction of transport infrastructures and operation under Operate and Transfer (OT), Build, Own and Transfer (BOT) and Build, Own, Operate and Transfer (BOOT) basis.

2.5 Benefits of the Project

The project directly contributes to GHG mitigation and helps control local air and noise pollution. In addition, it also helps alleviate poverty and assists in the sustainable development of the country as it stimulates new business, saves money on healthcare, creates / improves jobs and opportunities for people.

The improved outdoor air pollution will reduce the chances of getting affected by chronic bronchitis and acute respiratory illnesses, exacerbation of asthma and impairment of lung function to the city dwellers. Generally, children, elderly and people with lung and heart diseases are more vulnerable to the health effects of air pollution. This will also lower their medical expenses. Various studies have indicated that urban air pollution, especially the particulate matter, results in major human impacts. A study done by the World Bank in 1997 found that the PM10 in Kathmandu's air has a major impact on respiratory diseases like chronic bronchitis, asthma etc. leading to chronic obstructive pulmonary diseases (COPD) and the number of asthma attacks is particularly high (CEN & ENPHO, 2003).

The project also provides an opportunity to introduce the latest and most efficient electric vehicle technologies in the country. Nepali technicians and laborers would obtain training on various aspects of the technologies. Local entrepreneurs are also given an opportunity to invest more in the electric vehicle industry, decreasing the dependency on imported components and parts. If the trolleybuses are to be assembled locally, this will also bring benefits with other backward linkages.

Replication of this system in other parts of the country is anticipated to play a major role in the industrial development of the country. Developing trolleybus networks throughout the country would create an opportunity to develop more hydropower units as the electricity generated is consumed within the country. Also of significance is the fact that development of power plants would increase the energy security for the country.

Steady operation of non-polluting trolleybuses is expected to persuade the general public to use clean transportation systems. This would help to decrease the traffic density in Kathmandu Valley roads by limiting the use of private vehicles such as motorbikes and cars. The shift from private vehicles to non- polluting public transport would boost better traffic management resulting in speedier movement of people and vehicles within the city. The trolleybus public transportation system could become a backbone for the Nepal tourism industry. This competence will also help develop the eco-tourism sector of the tourism industry.

3.0 General Description of the Project

Project Title:

Pre-feasibility of trolleybus development in the Ring Road of Kathmandu Valley

Host Country:	Nepal
Relevant Contact:	Mr. Ratna Sansar Shrestha, FCA Winrock International Nepal 1103/68 Devkota Sadak Baneswor P. O. Box 1312, Kathmandu, NEPAL Tel: 4467087; Fax: 977-1-4476109 Email: rsansar@mos.com.np
Responsibility:	Senior Adviser

3.1 Goals and objectives

Project rationale:
In view of the deteriorating air quality and associated detrimental effects on public health caused by the present condition of the transport sector in major Nepali cities, an alternative to fossil fuel based transport systems is needed urgently. Therefore, the possibility of extending the trolley bus service along the Ring Road has been analyzed.

Goal:
To reduce environmental air pollution by replacing some of the fossil fuel based transport systems with the electricity based trolleybus system.

Objectives:
To develop a trolleybus network, an electric based transportation system to contribute towards the government's clean air initiatives and to provide additional environment friendly modes of transport to the public.

Expected Results:
A zero emission environment friendly transportation system would be established; this would help the nation conserve its scarce foreign exchange reserves as the quantity of fossil fuel imported is correspondingly reduced. In addition, it would also provide a market for domestically generated hydro-based energy.

3.2 Poverty reduction

During the construction of infrastructure required for the project, local skilled as well as unskilled laborers would get employment opportunities. Once the project has been completed, additional skilled groups such as technicians, administrators, managers, drivers, and conductors would have permanent direct employment opportunities. Employment generation would help promote a better living standard for people, contributing to poverty reduction. The project assists in increasing the mobility of the public, helping to increase economic activities, access to healthcare, education, employment opportunities etc.

The project helps to reduce the dependency on imported expensive fossil fuels, thereby increasing foreign exchange reserves. Curtailing the import of fossil fuels would provide an opportunity to develop the market for locally produced energy from the enormous hydropower resources in the country. This additional saving could be utilized towards poverty reduction in other sectors. Developing electric based transport networks throughout the country would simultaneously create an opportunity to develop hydropower units. Also, utilization of locally produced renewable hydro energy provides some form of energy security with regard to the transportation sector. The impact of unexpected disruption of transportation due to shortage of imported fuels (by sanctions, strikes etc.) has adverse effects on the economy; this project expects to avert such damages to a greater extent.

The increase in the demand for electricity in the transport sector would induce further hydropower project development which would again create employment opportunities in addition to development of associated physical infrastructures such as roads, bridges, schools, hospitals etc in rural areas. Once such facilities are available locally, the migration of people to urban areas would be reduced, ultimately reducing the pressure on the urban economy. Also, development of power projects would increase investment opportunities for the business community and sometimes for the general public as vendors. In addition, it creates favorable environment to attract foreign investors in the development of hydropower projects. Therefore, the above-mentioned reasons are expected to raise the living standards.

3.3 Technology transfer

Introducing trolleybuses is also expected to help transfer the most recent and innovative electric trolleybus technology from our neighboring country. China has been the leader in this technology and it is anticipated that importing trolleybuses from China would help to transfer their new trolleybus technology in Nepal. Initially, the electric transportation system would be highly dependent on imported spare parts, however, local entrepreneurs would gradually seek the opportunity to manufacture and supply them locally. As the number of electric based transportation systems develops in the country, the number of trained mechanics and engineers will also increase correspondingly. Gradually, the vehicles would be modified to use locally manufactured parts. This is evident from the case of electric three wheelers (Safa Tempos) in the Kathmandu Valley. Due to newfound local capability to manufacture various vehicle components and spare parts, maintenance as well as vehicle costs will be greatly reduced. In fact better technology transfer can take place if the trolley buses are to be locally assembled.

3.4 Project partners

The private sector and the government are the most likely partners in this project. Forging partnerships with other stakeholders would enhance the project implementation strategy. A key partner in this project would be the private sector; however, it is too early to identify individual companies and to obtain financial commitments from partners. Moreover, this project would not be financially feasible unless the project is able to trade carbon. The Government, both at the central and municipal levels, could merge with the project, which would improve the successful implementation of the project significantly.

3.5 Product(s) or service(s) generated by the project

Characteristics:
To provide an environment friendly transportation system that contributes to poverty reduction and the sustainable development of Nepal.

Expected annual production:
The trolleybus is anticipated to convey about 150 passengers per trip. It is estimated that about 123 trolleybuses were required to meet the total passenger demand in the Ring Road during the year 2005. This could replace about 83 diesel buses and 82 diesel minibuses from the Ring Road during the year 2005. Practically, without any strong government intervention, it is not possible to replace all diesel vehicles with trolleybuses within a few years. Therefore, it is planned that the trolleybuses be introduced at different intervals. In the initial stage, 50 trolleybuses will be introduced in 2005, and an additional 25 trolleybuses will be introduced in three five-year intervals. During the year 2011, 2016 and 2021 an additional 75 trolleybuses, in total, will be added into the system, resulting in a total of 125 trolleybuses on the Ring Road.

The total fleet of 125 trolleybuses introduced during the planning horizon (2005-2025) would replace about 85 diesel buses and 83 diesel minibuses from the Ring Road. The total CO_2eq mitigation during the planning horizon would be about 128,927 tons.

Expected variability of the annual production:
The demand for trolley services will be relatively higher during peak hours on working days. Similarly, the demand of the service is expected to fall considerably during holidays and weekends. In addition, political unrest in the valley might also affect the anticipated level of emission reduction.

Evidence why the stated annual production / activity level is plausible
The consumption of diesel is one of the main reasons for GHG emissions. Therefore, reduction in the consumption of diesel can be achieved by replacing diesel vehicles by trolleybuses, which is what the proposed project aims for. The initial estimates show that a significant amount (128,927 ton CO_2 equivalent) can be reduced in the project time period alone. These trolley buses will utilize electricity generated by Nepal’s indigenous renewable energy source, hydropower. The ultimate consequence of all this will be mitigation of GHG and improvement of the local air quality.

4.0 Project Implementation Plan

It is difficult to come up with a detailed project implementation plan at this stage. The timeframe required for planning, implementation, and operation, as well as the project commencement time, construction starting and completion date, and project operational lifetime will be stated in the feasibility study. However, it is expected that the project will be completed within a year's time. In this study, the year 2005 is considered as the year of commencement. The operational life of the trolleybus is assumed to be 20 years.

Figure 5: Implementation plan of the trolleybus project

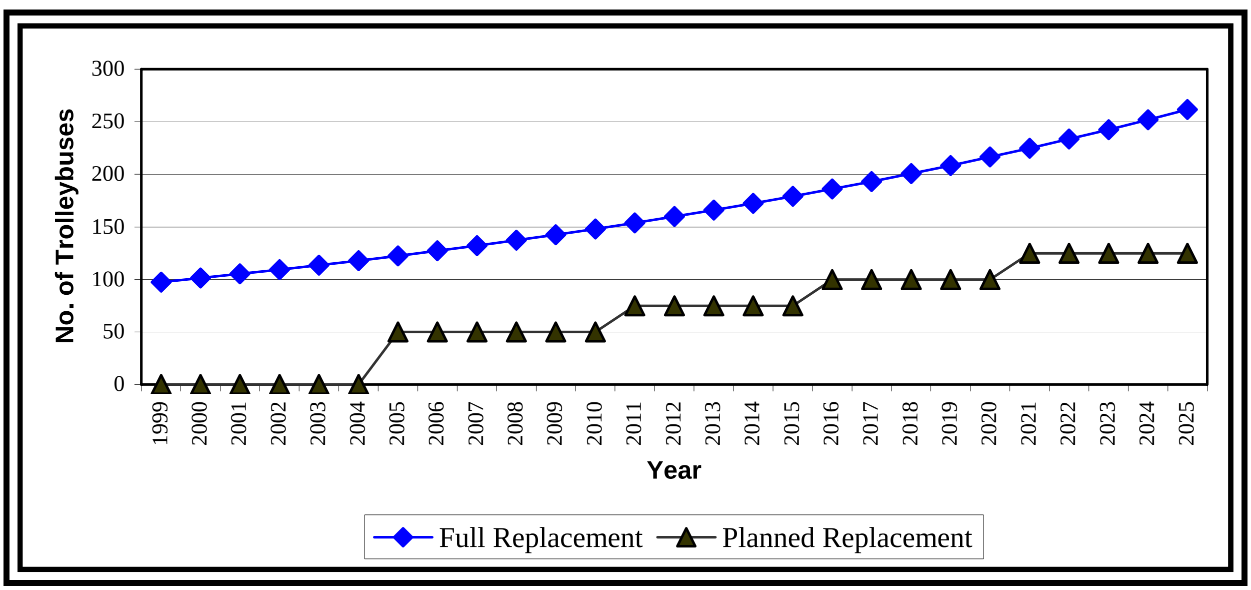


Figure 5 illustrates the implementation plan of the trolleybus project. Complete replacement, which means replacing all the diesel vehicles, is very difficult and improbable; it is therefore proposed that the trolleybuses be introduced at different stages. In the initial stage, 50 trolleybuses will be introduced in 2005, and an additional 25 trolleybuses would be introduced at three equal intervals of five years. During the year 2011, 2016 and 2021 an additional 75 trolleybuses will be added into the system, resulting in a total of 125 trolleybuses on the Ring Road.

5.0 Contribution to sustainable development

All CDM projects must meet the sustainable development criteria set by the host country and must also be implemented without any negative environmental impacts. The Sustainable Development Agenda for Nepal (SDAN) clearly mentions the need for and supports any emissions reduction initiatives including electric vehicles, use of hydropower, reduction in the use of imported fossil fuel etc. There are many examples of non-carbon benefits of this project, and other indirect benefits of reduced GHG emissions that contribute to the sustainable development and are summarized below:

5.1 Benefits

A. Long-term GHG and local emission reductions

The Kathmandu Valley is bowl shaped, which is very conducive to polluted air inversion. Rapid unplanned urbanization and migration of rural people over the past few years has resulted in a rapid growth in the demand for transport in urban areas. As a result, the vehicle population has increased drastically, leading to higher levels of tail pipe emissions. Tail pipe emission from fossil fuel driven vehicles consists of air pollutants carbon monoxide (CO), Hydrocarbon (HC), Sulfur dioxide (SO_2), Oxides of Nitrogen (NOx), Lead (Pb), Total suspended particulates (TSP) and Carbon dioxide (CO_2), which is one of the main greenhouse gases (GHG) imparted from the transport sector. As fossil fuel driven vehicles contribute significantly to air pollution, the transport sector is becoming a major contributor of the rapidly deteriorating air quality at alarming levels.

Major cities in Nepal lack adequate transport infrastructure such as road networks, overhead bridges, subways, toll ways and mass transportation systems etc., and also have not developed in proportion to the increased vehicle population. As the public transportation system is very poor, personal transport systems such as motorbikes and private cars have become a necessity in Nepal. However, this has aggravated the traffic congestion further leading to higher levels of emission from these vehicles.

In the year 1998, the CO_2 emission level in Nepal was 3 million tons, while that of South Asia was 1,194.4 million tons (World Development Report, 2003). The total CO_2 emission from fossil fuel consumption in Nepal is estimated to be 1,465 kilo tons out of which 31% are from the transport sector during the year 1994-1995 (National Climate Change Study Group/TU, 2002, Page 16). Table 2 below shows the CO_2 emissions from various sectors for the year 1994-1995.

Table 2: CO2 Emission from Various Sectors, 1994/95

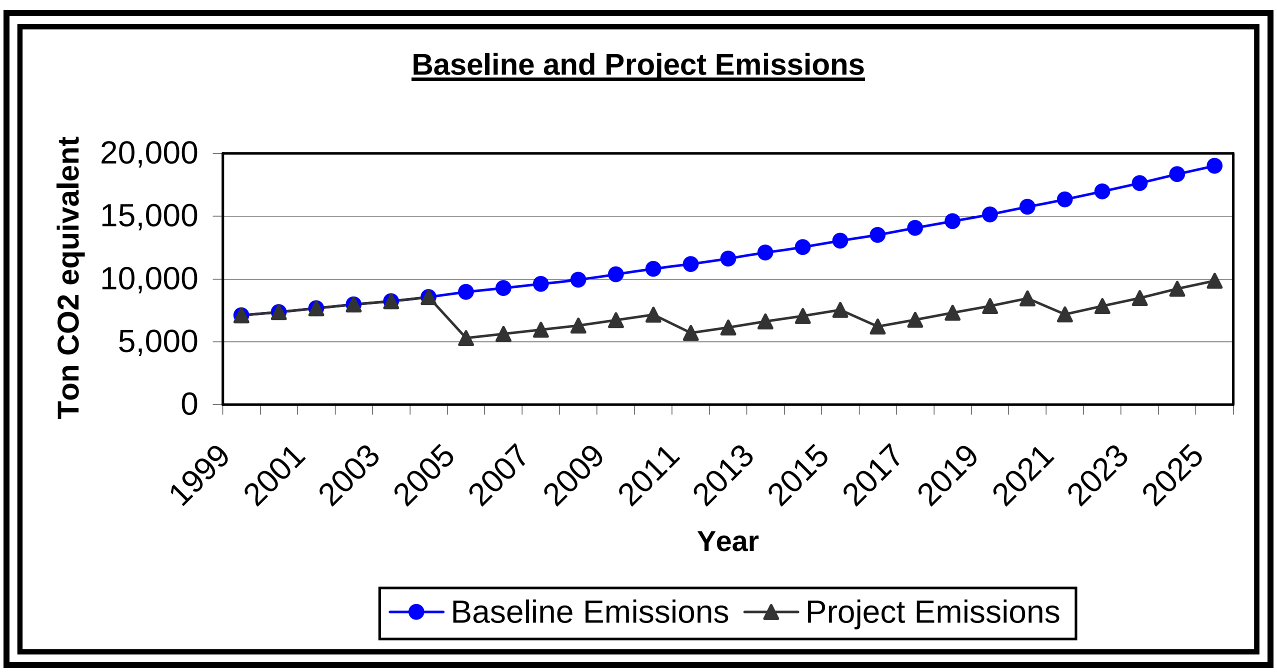
(unit: kilo Ton)

Sectors	**Diesel**	**Kerosene**	**Coal**	**Gasoline**	**LPG**	**Fuel oil**	**Total**
Residential	-	291	2	-	24	-	**317**
Industrial	73	6	233	-	-	79	**391**
Transport	360	19	2	75	-	-	**456**
Agricultural	135	-	-	-	-	-	**135**
Commercial	4	113	26	-	15	8	**166**
TOTAL	**572**	**429**	**236**	**75**	**39**	**87**	**1465**

Source: National Climate Change Study Group/TU, 2002, Page 16 (original unit Gg changed to kilo ton)

Figure 6 illustrates the baseline emissions (without the trolleybus project) and the project emissions (with trolleybus project) and the gap is the reduction in the level of emissions after the implementation of the trolleybus project. Replacement of 34 diesel buses and 33 minibuses would mitigate about 3,647 tons of CO_2eq but would have 71 ton of CO_2eq as the project emissions resulting net emissions reduction of 3,576 CO_2eq. Ultimately, introduction of the entire 125-trolleybus fleet during the project period (2005-2025) would replace about 85 diesel buses and 83 diesel minibuses from the Ring Road. The total CO_2eq mitigation during the planning horizon would be about 128,927 tons. The sharp reduction in the emissions level can be noted during 2005, 2011, 2016 and 2021 where additional trolleybuses are added.

Figure 6: CO2 Emission with and without the Trolleybus Project



Promoting the trolleybus will not only help improve the deteriorating air quality and mitigate GHG but also to reduce noise pollution. Reducing noise pollution will make the city quieter and calmer, which is preferred by everyone.

B. Social Benefit

Promoting an electric based transport system would help to mitigate the health risks brought about by escalating air pollution. Healthy people will naturally be more efficient and able to work better compared to ill people. In addition, medical expenses will be reduced, which would help augment savings not spent on medical facilities. As a result, improved health of the people will reduce the government's healthcare expenses.

Better transport systems will also provide improved access to education facilities. With a sound transportation system, both students and teachers can commute longer distances to their respective education institutions. This is anticipated to reduce the rate of migration of students and the teachers to urban areas.

C. Economic Benefits

Employment generation will have a direct and positive impact on the economy of the country. People can work for longer periods and will have substantial incomes to enhance their economic condition. When they use an efficient trolleybus transportation system, the time that employees save commuting to work can be utilized in production activities in individual professions. Reduction in air quality related health costs will increase the saving potential of the people which will also increase people's productivity due to decrease in absenteeism from work. Also, the proposed assembly of trolleybuses directly stimulates new businesses in the EV sector, which creates/improves job opportunities, and retains local resources in the vicinity. If the trolleybuses are to be locally assembled, there could be appurtenant benefits in the form of backward linkages like more demand for raw materials, skilled and semi-skilled manpower etc.

D. Technological Benefit

The most recent, innovative and efficient electric vehicle technologies would be introduced in the country. Technicians would be trained on various aspects of these technologies. Similarly, the business community would also acquire a better appreciation of the technologies as they begin manufacturing simple spare parts. As the demand for electric transportation systems increases, local entrepreneurs can make use of the opportunity to invest more in the electric vehicle industry. Thus, various electric vehicle industries would emerge in the country and manufacture various components and spare parts. This would decrease the electric vehicle industry's dependence on imported components and parts. If the project is use locally assembled trolleys then higher amount of technological benefit will accrue to the country from technology transfer.

5.2 Other Impacts of the Project

A. Positive Impact

A sound transportation system plays a major role in the industrial development of a country. Industrial areas should have a good transport network in order to bring in raw materials and to distribute the goods produced. Additional industries can be launched at diverse and remote areas, which will ultimately generate employment opportunities. Employment generation will have a positive impact on the country's economy. People can work for longer periods and will gain substantial incomes to enhance their economic conditions. Employees could save and utilize their commuting time in production activities in their respective industries when they take advantage of the efficient trolleybus transportation system.

Various industries could operate for longer hours, which would again increase the consumption and demand of electricity and make use of the spillover energy. This would reduce the price of the electricity. As a result, people would start using electrical energy rather than other forms of energy. This would persuade private investors to invest in hydropower projects in the country. This would increase job opportunities for people in the rural areas and keep people busy and active, leading to decreased crime rates in rural areas. If the trolleybuses are to be locally assembled, there could be other benefits in the form of backward linkage. Followings are the main sectors, which will have positive impacts from the project:

I) Energy security (Power Sector Development)

Nepal has to spend huge amounts of foreign reserves to import fossil fuels from other countries. The supply and price of fuel fluctuates with the changes in the state of affairs of the exporting country. As a result, Nepal lacks energy security. The Table below illustrates the historical trend of petroleum product consumption in the transport sector.

Table 3:Historical Trend of Petroleum Product Consumption in Transport Sector

(Unit: kiloliter)

Fiscal Year	Motor Spirit (MS)	Growth (%)	High speed diesel (HSD)	Growth (%)
1974/75	10231		27111	
1977/78	11097	8.46	36595	34.98
1982/83	15442	39.15	62024	69.49
1985/86	20368	31.90	80425	29.67
1990/91	24283	19.22	139521	73.48
1993/94	31061	27.91	195689	40.26
1994/95	34983	12.63	226622	15.81
1995/96	41193	17.75	250500	10.54
1996/97	44709	8.54	257910	2.96
1997/98	46939	4.99	300604	16.55
1998/99	49994	6.51	315780	5.05

Source: TRUST, 2000, P. 90

Developing a trolleybus network throughout the country would create an opportunity to develop more hydropower units as the electricity generated is consumed in the country. Development of power plants increases the country's energy security. Developing hydropower projects in Nepal eliminates the dependency on other countries and helps to increase foreign currency reserves curtailing the import of fossil fuel.

The country's natural resources could be utilized to fulfill the increasing demand for electricity, which would also, ultimately, create job opportunities for local people. Employment would provide an opportunity for people to uplift their economic standards. In addition, areas hosting hydropower development will, in due course, be developed into urban areas.

ii) Traffic System Management

Systematic operation of the pollution free trolleybuses is expected to convince the general public to use clean transportation systems. This will help reduce the traffic density on Kathmandu Valley roads due to the reduction in the use of private vehicles such as motorbikes and cars. The shift from private vehicles to non-polluting public transport will promote better traffic management resulting in a speedier movement of people and vehicles and also reduce per capita emission by the traffic. The commuting time saved can be diverted to other activities. In addition, there is the basic fact that a reduction in the traffic density will lead to lower emission levels in the city.

iii) Health

Obviously, the rapid increase in vehicular traffic, poor traffic management and ineffective control of emissions have been the major contributors to air pollution in most developing cities in Asian countries. This has resulted in negative health impacts to the residents of these cities, along with the attendant problems of loss of productivity and increased health expenses, as well as an adverse impact to the economy through the negative impacts of pollution on tourism. In order to improve the air quality of these cities, electricity based public transportation needs to be developed. Declining air quality in South Asia is a growing hazard to millions of people. The World Bank's Urban Air Quality Study estimated that health damage costs due to air pollution were NRs. 210 million (US$ 4.4 million) per year due to pollution-related premature deaths and to respiratory problems and other illnesses that restrict work in Kathmandu.

In addition, various analyses have demonstrated that Kathmandu's air, especially in the vicinity of the main thoroughfares, contains unacceptable levels of suspended particulates, lead, sulphurous and nitrous gases and other pollutants posing a significant risk to human health. The increase of pollutant emissions will soon be a major contributing factor in deterioration of public health due to the increase in respiratory and skin diseases. The World Bank report confirms that Nepal is facing increased health costs as a result of environmental degradation. Furthermore, the adverse impact of pollution on public health means that productivity of the valley's populace also significantly on the decline. An additional point against petroleum-based fuels that contribute to the air pollution is that they are bought using hard earned foreign currency.

iv) Rural Economy

There will be some positive indirect impacts to rural economy. The market for rural agricultural products increases as the areas obtain access to the urban market directly through better transportation systems. On the other hand, people living in urban areas are also supplied with fresh and economical products compared to more expensive imported products from neighboring countries. People can also commute to the city for employment from the outskirts if the transportation system is enhanced.

v) Tourism

Air pollution from the transport sector has emerged as a major problem, posing a serious threat to the health and environment of cities. Air pollution is already affecting the tourism industry, a significant contributor to the country's economy, adversely. Some surveys have quoted tourists, as saying that pollution in the Kathmandu Valley would be the number one reason why they may not return to Nepal. Further degradation in the valley's air quality may actually prevent potential visitors coming to Nepal in the future. Pollution can also be detrimental to our cultural heritage. Acid formed by high levels of sulfur and nitrous oxides in the air will damage exterior wooden carvings, marble, and metals that are part of many historical and heritage sites in Nepal. This can further damage the tourism industry, but with proper intervention, Nepal can still become a formidable competitor among tourist destinations. Zero emission trolleybuses have the potential to provide reliable, economical and eco friendly public transportation that could become an integral backbone of the tourism industry. This could also be utilized to develop and share expertise in eco-tourism ventures. Mitigation of noise pollution would make the city quieter and calmer, something highly appreciated by most tourists.

vi) Urbanization

Increased movement of people from one place to another and better accessibility to remote places will lead to urbanization of rural areas as a result of infrastructure development. People can see and learn many things when they are exposed to new places. As local areas become urbanized, migration of the people is expected to decrease.

B. Negative Impact

Most hydropower plants in Nepal are of the run-of river type. During dry years, the supply of electricity on a grid dominated so strongly by hydropower might not meet the demand. This would result in an energy crisis, resulting in a huge economic loss to the country. The trolley bus system, which relies on electricity for its operation, would be susceptible to disruption of power. Operating a backup diesel system over an extended period of time would be expensive and inefficient.

There are concerns that the trolley buses, which are larger than normal buses and mini/micro buses operating in the streets, could obstruct other traffic. This could increase emissions from those vehicles. Stops for the trolley buses have to be clearly marked and need to be placed such as not to obstruct traffic.

6.0 Project Baseline and GHG Abatement Calculations

The project baseline in this study is taken as the emissions from only those diesel vehicles on the Ring Road that would be replaced by the project (trolley buses). The total number of diesel vehicles operating on the Ring Road is much larger.

6.1 Traffic Forecast on the Ring Road

In the year 1999, about 66 and 65 diesel buses and minibuses are estimated to be plying the Ring Road. CEMAT has estimated that 51,980 and 50,505 passengers traveled per day by bus and minibus respectively in the Kathmandu Valley Ring Road. This estimation was based on the carrying capacity of 113 and 111 passengers per trip for buses and minibuses respectively. Diesel buses are estimated to make a total of 460 trips per day and minibuses about 455 trips per day. CEMAT Consultants based total numbers of trips and passengers on the review of previous traffic studies and actual traffic flow survey & passenger count survey at different points in the Ring Road in 1999. This study also took into consideration the passengers during peak hour and slack hour as well as during working days and holidays during survey and while calculating the number of trips and passengers[2]. An average population growth of 3.9% in three districts namely Kathmandu, Lalitpur and Bhaktapur has been assumed in the study to forecast the number of passengers traveling by diesel buses and minibuses in the Ring Road in the coming years. Even though there is increasing trend in the number of private vehicles in Kathmandu Valley, it is assumed that it will not have significant impacts on the number of trips in the Ring Road and the passengers growth rate will be maintained at around 3.9% (CBS 2003) so does the number of trips. The number of diesel buses and minibuses can be extrapolated till the year 2025 based upon the passenger demand forecast. Under the 'business as usual' scenario, there will be then 83 diesel buses and 82 mini buses in 2005 and this will increase to 176 buses and 174 mini buses in 2025. In the proposed trolley bus project, total of 50 trolley buses will be introduced in 2005, and an additional 25 trolley buses would be introduced at three equal intervals of five years. The year 1999 has been considered as the base year in this study[3].

Table 4 below presents the estimated total number of passengers that traveled by diesel buses and minibuses per day in the Ring Road during the year 1999 and the numbers of vehicles used to carry them.

[2] Winrock International Nepal supported this study on "Pre-feasibility Study for Extending Trolley Bus Services within Kathmandu Valley" to the CEMAT Consultants (P) Ltd. in June 1999 and the final report is available at Winrock Nepal Office for more information.

[3] The available resources for this pre-feasibility study did not permit to carry out another detailed actual traffic survey in the Ring Road in 2003 and thus the most recent study carried out by CEMAT Consultants (supported by Winrock International Nepal) in 1999 was considered as the base year for this pre-feasibility study and relevant data were extrapolated for this project period but it is highly recommended that the detailed traffic study be conducted during the feasibility study phase.

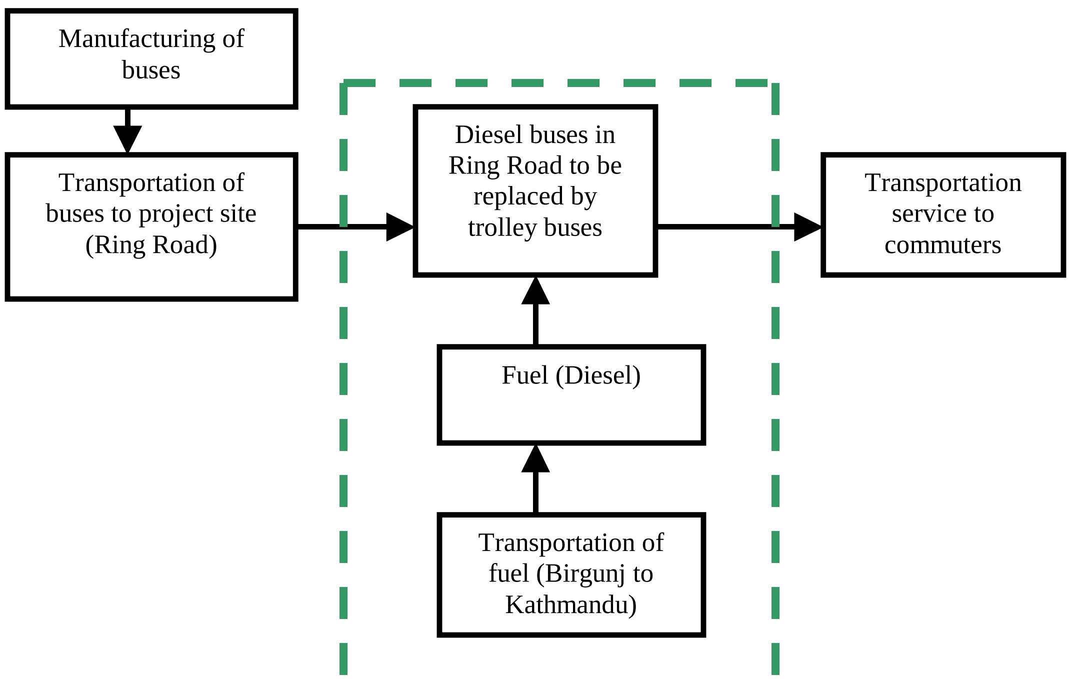
Table 4: Number of Passengers Traveling per Day

Type of vehicle	No. of passenger per trip	Trips per day	Number of passenger per day	Number of vehicles
Bus	113	460	51,980	66
Minibus	111	455	50,505	65

Source: CEMAT, 1999

The current delivery system with the main components is presented below.

Figure 7 : Flowchart of the current delivery system



The diesel necessary for buses/mini-buses is transported from Birgunj to Kathmandu (almost 300 km away) by tankers. The dotted lines show the boundary of the project baseline excluding manufacturing and transportation of buses etc., which are beyond the project's control or influence.

Figure 8: Demand of Diesel buses and Minibuses during 1999-2025

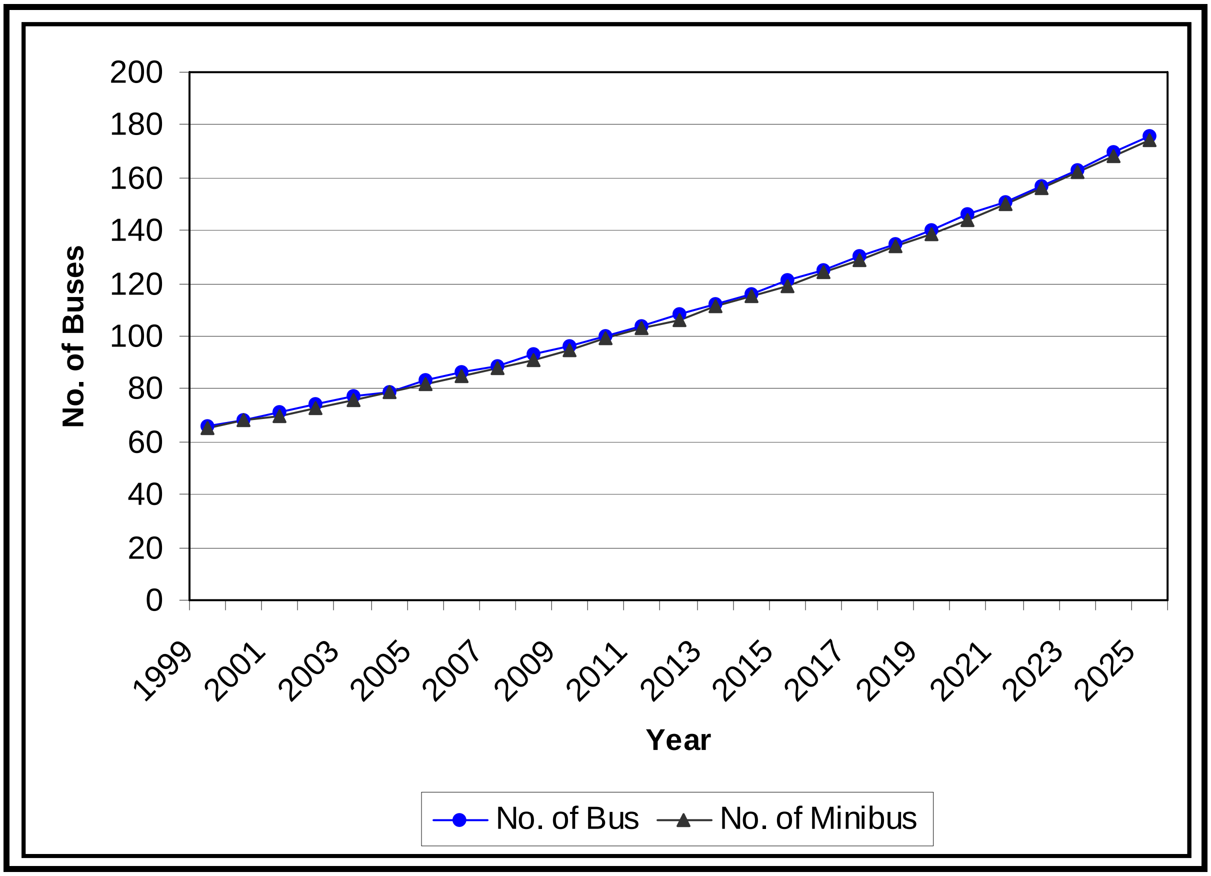


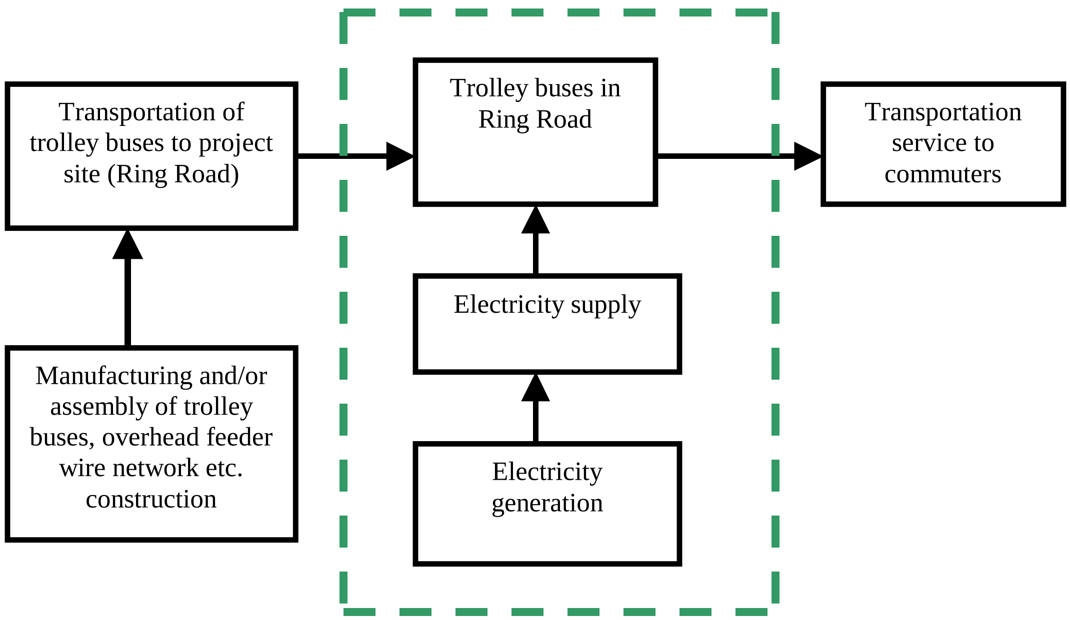
Figure 8 shows the demand for diesel buses and minibuses during the year 1999-2025. The demand for diesel buses and minibuses is found to increase till the year 2025. The 66 and 65 diesel buses and minibuses in 1999 are anticipated to multiply to 176 and 174 respectively by the year 2025.

The project flow chart and its main components and connections are presented below (Figure 9). A portion of the total diesel buses will be replaced by trolley buses but the project case in this study considers only the trolley buses. The power generation system in Nepal is mostly hydro based with only 0.8% share of thermal (diesel) energy in 2002[4]. However, a conservative value of 2% of the electricity supplied is considered to have been generated from diesel when calculating project emissions in this pre-feasibility study. This also takes into account possible diesel backup of the Trolley Bus system when the grid is down. The dotted lines represent the boundary of the project, again excluding processes beyond the control or influence of the project, including trolley bus manufacturing and/or assembly, construction of overhead feeder wire

[4] The share of thermal energy (diesel) is already very small in Nepal and is in the decreasing trend. The share of thermal energy was 1.45% in 2001, 0.8% in 2002 and NEA estimates that this would be only 0.2% in 2003 and most likely it will be negligible (if not zero) during the first crediting period of this project if it follows the same trend.

network and other infrastructure necessary for the operation of the trolley bus. The diesel used for the national grid is also considered in the project delivery system even if it is very small.

Figure 9: Flowchart of the project delivery system



6.2 Baseline methodology and calculation of the baseline emissions

The baseline emissions are estimated using the general formula used to estimate the emissions from fuel consumption. The emissions are estimated using an annual average distance covered by buses and minibuses individually and the average fuel efficiency and CO_2 emission factor for diesel buses and minibuses. Mathematically, it can be expressed as:

Baseline Emission = Average distance (km/veh/year) * average sp. fuel consumption (l/km) * emission factor (kg/liter) * no. of diesel vehicles replaced

The estimated baseline emissions are based upon the future number of diesel buses and minibuses that will be replaced by the trolley buses starting from 2005. The following table depicts the baseline emissions from 2005 to 2025:

Table 5: Baseline Emissions considering only the to be displaced buses and mini-buses

Year	No. of bus displaced	No. of minibus displaced	Direct emissions		Total Emissions
			On-site	Off-site	
2005	34	33	3,615	33	3,647
2006	34	33	3,615	33	3,647
2007	34	33	3,615	33	3,647
2008	34	33	3,615	33	3,647
2009	34	33	3,615	33	3,647
2010	34	33	3,615	33	3,647
2011	51	50	5,441	49	5,490
2012	51	50	5,441	49	5,490
2013	51	50	5,441	49	5,490
2014	51	50	5,441	49	5,490
2015	51	50	5,441	49	5,490
2016	68	66	7,229	65	7,294
2017	68	66	7,229	65	7,294
2018	68	66	7,229	65	7,294
2019	68	66	7,229	65	7,294
2020	68	66	7,229	65	7,294
2021	85	83	9,056	82	9,137
2022	85	83	9,056	82	9,137
2023	85	83	9,056	82	9,137
2024	85	83	9,056	82	9,137
2025	85	83	9,056	82	9,137
		TOTAL	**130,316**	**1,174**	**131,490**

The CO_2 emissions from 34 and 33 diesel buses and minibuses are found to be 2,328 and 1,238 tons per year in 2005. This result indicates that approximately 3,566 tons of CO_2 will be emitted from diesel vehicles on the Ring Road in the year 2005. The emissions estimation is based upon the average distance of 70,000 km covered by bus and minibus individually as estimated by CEMAT and an average fuel efficiency of 0.365 liter per km for bus and 0.2 liter per km for minibus based on a small survey carried out in year 2000 by Winrock International Nepal with CEMAT. The emission factor for CO_2 emissions for diesel[5] buses and minibuses is taken as 2.68 kg CO_2/liter of diesel**.** In addition to the CO_2 emissions, there will also be other GHGs namely N_2O and CH_4 emissions resulting from fuel consumption. The total CO_2 equivalent emissions from N_2O and CH_4 will be around 42.39 tons and 5.94 tons respectively from 34 buses and 33

[5] http://www.defra.gov.uk/environment/envrp/gas/10.htm

mini-buses, considering the emission factor as given in the IPCC[6] for N_2O emissions as 0.032 kg CO_2 equiv. per liter of diesel with global warming potential (GWP) of 300 and 0.004 kg CO_2 equiv. per liter of diesel for CH_4 emissions with GWP of 21 and with the average fuel economy of 0.28 liter per km. Therefore, the total direct on-site baseline emission would be around 3,615 ton CO_2 equivalent in 2005.

The direct off-site emissions in the baseline are the emissions while transporting the fuel from Birgunj to Kathmandu. For the year 2005, a tanker would need to make around 72 trips in total to supply the total diesel requirements on the Ring Road, taking the average capacity of a tanker at around 18,500 liters. Considering the average fuel efficiency and emission factors etc. as above, the total direct off-site emissions in 2005 would be 33 ton CO_2 equivalent.

This illustrates that the total CO_2 equivalent baseline emissions from 2005 to 2025 will be 131,490 tons. The off-site emissions and emissions during fuel transportation to Kathmandu are also quite significant, i.e., 1,174 ton CO_2 equivalent in the total time period. The total baseline emissions estimated will be increased from 3,647 tons in 2005 to almost 9,137 in the year 2025.

6.3 Calculation of the total project GHG emissions

In order to reduce the emissions from diesel vehicles, the effect of non-polluting trolley buses is analyzed in the study. Practically, it is very difficult to displace all diesel vehicles from the Ring Road. Therefore, it is assumed that some of the passengers will be diverted to trolleybuses when they are introduced in the Ring Road. The project case thus considers only the trolley buses, and not other diesel buses, which will still be plying on the Ring Road.

The number of trolleybuses required to replace the diesel buses and minibus are based upon the average speed of the trolleybus and the number of passengers per trip. A trolleybus is expected to carry about 150 passengers per trip (CEMAT, 1999). As a 100% replacement of the diesel buses is not realistic, the trolley buses have been introduced at three different periods during the project life. At the first instance, 50 trolleybuses would be introduced on the road in 2005, and an additional 25 trolleybuses would be introduced at three equal intervals of five years. During the year 2011, 2016 and 2021 additional 75 trolleybuses, in total, would be added in the system, resulting in a total of 125 trolleybuses in the Ring Road.

As explained in the earlier section, the share of thermal energy in the national grid was only 0.8% in 2002. Taking into account the diesel use in the grid, and the possibility of diesel backup in case of grid failure, a conservative amount of 2% of the electricity supplied to the trolley buses is considered to have been generated from diesel when calculating project emissions in this pre-feasibility study.

According to the CEMAT study, the operational energy required on the Ring Road is 1.2 kWh per km which gives 235.2 kWh per trolley bus per day and 77,380.8 kWh per trolley bus per year for the 28 km long Ring Road with 7 trips per day and 329 days a year. Considering 15% transmission loss, total electricity generation needed would be 88,988 kWh per trolley bus per year at the power plant. Now, the share of thermal power would be 1,780 kWh, which is the 2%

[6] http://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php

of total electricity consumed as explained above. The following table shows the project emissions taking the emission factor of 0.8 kg CO_2 eq/kWh as given in the Appendix B of the simplified modalities and procedures for small-scale CDM project activities (in Table I. D.1):

Table 6: Project emissions considering only trolley buses

Year	No. of Trolley bus	Project Emissions (ton CO2 eq)
2005	50	71
2006	50	71
2007	50	71
2008	50	71
2009	50	71
2010	50	71
2011	75	107
2012	75	107
2013	75	107
2014	75	107
2015	75	107
2016	100	142
2017	100	142
2018	100	142
2019	100	142
2020	100	142
2021	125	178
2022	125	178
2023	125	178
2024	125	178
2025	125	178
	TOTAL	**2,563**

The project emissions are found to be 2,563 ton CO_2 equivalent in the 2005 to 2025 period.

Another area to be considered in the project emissions is the emissions during cement productions; cement is used for constructing poles to provide support for the trolley feeder wire network along the route of operation of the trolley buses on the Ring Road in the project case. CEMAT report estimates that around 530 tons cement would be required to erect a total of 1,772 reinforced concrete poles. This would give CO_2 emissions of around 265 ton and about 13 tons per year if distributed over the lifetime of 20 years of the project, which is about 0.01% of total

CO_2 emissions[7]. Thus, this fraction being too small has been excluded from the project emissions.

6.4 Net emission reduction

The reduction of emissions from the project can be calculated simply by subtracting the total project emissions from the baseline emissions. The emission reduction figures for all years have been given in the table below.

Table 7: Emission reduction figures (2005-2025)

Year	Baseline Emissions	Project Emissions	Net Emission Reduction (ton CO2 eq.)
2005	3,647	71	3,576
2006	3,647	71	3,576
2007	3,647	71	3,576
2008	3,647	71	3,576
2009	3,647	71	3,576
2010	3,647	71	3,576
2011	5,490	107	5,383
2012	5,490	107	5,383
2013	5,490	107	5,383
2014	5,490	107	5,383
2015	5,490	107	5,383
2016	7,294	142	7,152
2017	7,294	142	7,152
2018	7,294	142	7,152
2019	7,294	142	7,152
2020	7,294	142	7,152
2021	9,137	178	8,959
2022	9,137	178	8,959
2023	9,137	178	8,959
2024	9,137	178	8,959
2025	9,137	178	8,959
TOTAL	**131,490**	**2,563**	**128,927**

[7] Emission factor of 0.499 ton CO2 per ton of cement has been used. (Asia Least-cost Greenhouse Gas Abatement Strategies, India, Asian Development Bank, Global Environment Facility, United Nations Development Programme, Manila Philippines, 1998).

As illustrated, the net emission reduction from the project is around 128,927 ton CO_2 equivalent in the total project period.

Leakage calculations are not required for small-scale CDM projects. To be eligible for small-scale CDM projects under emissions reduction in the transport sector by low greenhouse emission vehicles, the project activity must reduce anthropogenic emissions by sources and directly emit less than 15 kilotons of carbon dioxide equivalent annually. The proposed trolley bus in Ring Road will use electricity from hydropower plants and considering the project emissions level compared to the baseline as given above, the project activity can reduce the emissions up to 128,927 ton CO_2 equivalent in the total project period of 2005 - 2025. This brings the annual emissions reductions to around 6.5 kilotons, which is well within the criterion for a small-scale transportation CDM project. Being eligible under small-scale CDM would mean being able to use simplified methodology with no need to calculate leakage. Regarding the initially displaced diesel buses, they will be used in other parts of the country where buses are required. Because of their small number (34 buses and 33 minibuses in 2005), they will meet the need for new diesel buses, which would have been required in those areas. As mentioned earlier, a more detailed feasibility study is required to come up with the more detailed information.

Under the current CDM framework, the crediting period can be either a period of seven years, with the potential for renewal for maximum 2 additional periods; or a period of ten years. In this project, renewable crediting period has been suggested so that the emissions reduction during the whole life period can also be captured. The crediting period can start from 2005 and will be renewed after every seven years for 2 more times until the lifetime of the project comes to an end.

7.0 Monitoring Plan

If the project is going to be a CDM project, then a detailed monitoring plan needs to be developed during the feasibility study. The Marrakech Accords calls for a monitoring plan that collects and archives all data relevant to determining the project's baseline, monitoring its performance and determining the benefits of GHG reduction benefits of the project. Monitoring the performance and GHG impacts of a project can be an important component of a project's total transaction costs for some projects. Small CDM projects, like trolley buses on the Ring Road, are less able to absorb transaction costs, including those associated with project monitoring. So, reducing the monitoring burden for small-scale CDM projects would obviously reduce the transaction costs associated with such projects. The Marrakech Accords specifically includes the possibility of developing simplified monitoring methodologies for small-scale CDM projects. The latest draft simplified baseline and monitoring methodologies for selected small-scale CDM project categories, which also includes "Emission Reductions in the Transport Sector", requires the monitoring to track the number of trolley buses operated and the annual units of service for a sample of the vehicles. In addition to that, emissions from the electricity generation must also be taken into account for electric vehicles, which obviously includes trolley bus. The following factors are thus important for monitoring:

- Identification of data needs and quality regarding accuracy, comparability, completeness and validity. For instance: the total kilometers covered in a year by each trolley bus, number of days of operation, number of buses in operation, etc.;

- Methodology for data collection and monitoring - an effective and efficient record keeping system can be established in the company and data can be reported in an annual basis and archived electronically;
- Quality assurance and quality control provisions for monitoring, collecting and reporting – a random sampling and annual monitoring by externals could be carried out;
- An organization after careful selection may be designated to collect data, calculate real GHG emission reduction and report progress etc.

The detailed monitoring plan will be the integral part of the project design document for a CDM project.

7.1 Data to be monitored

Even if the electricity in Nepal is mostly hydropower based but it is not fully hydro. Therefore, electricity generated from the thermal (diesel) power plants need to be monitored to see their share in total energy supply to the national grid. Some other important sources of data needed and the possible methodology for collection considering the small-scale CDM project monitoring purpose are summarized below:

- *Number of trolley bus in operation*: This can be monitored from the daily logbook together with the total distance covered;
- *Annual number of passengers riding the trolley bus*: This can be monitored through ticket receipts;
- *Number of diesel buses and mini buses in operation*: This can be obtained from the Department of Transport Management, which issues the road permit. The local bus entrepreneurs can also be contacted. This will demonstrate the reduction in the number of diesel buses and mini-buses;
- *Diesel consumption*: This can be monitored through some sample diesel buses and mini buses operating in the Ring Road;
- *Electricity generation from diesel power plants*: This can be monitored easily from the total energy supplied to the national grid from the diesel power plants and can be easily obtained from the Nepal Electricity Authority. In addition to this, energy produced from diesel back up if required need to be monitored.

7.2 Frequency of monitoring

The frequency of project monitoring can influence the accuracy or emission mitigation estimates as well as the frequency with which project operators receive emission credits. It is fundamental to bear in mind the frequency of monitoring that will give an accurate picture of project performance and with what frequency the credits are needed from the project. Considering the cost involved in monitoring and time delay between verification and issuance of certified emission reductions (CERs), it seems appropriate that the proposed trolley bus system should have an annual monitoring and reporting mechanism. It is essential that the management system should be efficient and data are kept electronically.

7.3 Cost of monitoring

Monitoring-related costs occur up-front, even before a project has been registered, as well as during a project's operation as the Marrakech Accords indicate that the monitoring plan has to be set up as part of the project design document. The cost for monitoring and verification is not accurately known yet for this project but can be significant and thus needs to be further scrutinized during detailed study. The costs associated with developing a monitoring or monitoring/verification plan can be $20,000 or even more for a "first-of-a-kind" project but also reduces significantly for subsequent projects (Ellis, 2002). Simplifying the monitoring process especially for small-scale CDM projects that are less able to bear high transaction costs can reduce the monitoring costs. The simplifications as suggested in this project include the use of sample populations, reducing the frequency of monitoring/verification and calculating project benefits by using easy-to-monitor data, default emission factors and narrow project boundaries.

8.0 Financial Analysis of the Project

It is obvious that investors would want to invest in projects that give them adequate returns. It is thus imperative to carry out financial analysis of trolley bus system in Ring Road to determine if the project is feasible. However, it should be noted that the following financial analysis is only to provide an approximate result, which naturally needs to be analyzed in greater detail during the feasibility study. The financial analysis is based on the available of secondary data; efforts have also been made to collect and update market prices while estimating the cost. A study carried out by CEMAT Consultants for Winrock International on extending trolley bus services within Kathmandu Valley has been widely referred to and is the main source (unless specified) while carrying out this analysis.

8.1 Cost estimates

Costs are divided into two main categories: investment cost and operation cost.
The investment cost includes:

- Cost of land;
- Cost of construction;
- Cost of vehicles (trolley bus);
- Cost of electrical infrastructure;
- Other costs (furniture, office vehicles, spare parts etc.)

Whereas the operation cost includes:

- Basic operating cost;
- Overhead and crew cost;
- Taxes, permits, test costs etc.

The detailed cost estimates have been included in the Annex. The following table summarizes the investment cost required per trolley bus based on the CEMAT study and the NTE's own findings to operate in Ring Road:

Table 8: Investment cost required per trolley bus

	Imported	Locally assembled	Land	Construction	Other costs
Cost per Trolley bus (NRs)	5,500,000	4,200,000	557,619	551,510	807,333
Cost per Trolley bus (US$)	73,330	56,000	7,435	7,354	10,765

Source: CEMAT, 1999 and NTE's own survey

The estimated cost of electrical infrastructure (transaction system includes high tension connection to substation and the substation equipment) for the whole system is presented below (Source: CEMAT 1999):

- RCC Pole – NRs.21.26 million
- High Tension connection to substation – NRs. 3.9 million
- Substation electric equipment – NRs.20.29 million
- Feeder wire network – NRs.104.28 million
- Electrification of main station – NRs.1.282 million

TOTAL – NRs. 151.66 million (US$ 2.02 million)

So, a sum total of NRs. 151.66 million would be required for electrical infrastructure in 2005. Additional capital cost for electrification of traction stations (high-tension connection to sub-station and substation electric equipment) needs to be invested in 2011 and in 2021 to accommodate additional trolley buses. The improvement in infrastructure in 2011 can also accommodate additional buses in 2016.

The total operation cost per trolley bus per year is as follows (Source: CEMAT, 1999 and the NTE's own estimate):

- Total basic operation cost – NRs. 933,800
- Total overhead and crew cost – NRs. 232,400 and
- Total tax, permits, tests – NRs. 17,850

TOTAL – NRs. 1.184 million (US$ 0.015 million)

The investment to cover the cost of land, construction, vehicle, electrical infrastructure and other costs needs to be made at different intervals as additional trolleybuses are introduced during the project period 2005-2025. The operation cost is on the annual basis.

Based on the cost per trolley bus as given above, the total investment requirement has been estimated. The following table summarizes the total investment and operation costs requirement in different time periods.

Table 9: Estimation of total costs for imported trolley bus

(Unit: Million)

	2005		2011		2016		2021	
	Rs.	**US$**	**Rs.**	**US$**	**Rs.**	**US$**	**Rs.**	**US$**
Land	27.88	0.37	13.94	0.19	13.94	0.19	13.94	0.19
Construction	27.58	0.37	13.79	0.18	13.79	0.18	13.79	0.18
Other costs	40.37	0.54	20.18	0.27	20.18	0.27	20.18	0.27
Vehicle costs	275.00	3.67	137.50	1.83	137.50	1.83	137.50	1.83
Elec. Infrastructure	151.66	2.02	26.15	0.35	0.00	0.00	26.15	0.35
Annual Operation cost	59.20	0.79	88.80	1.18	118.41	1.58	148.01	1.97
TOTAL	**581.69**	**7.76**	**300.37**	**4.00**	**303.82**	**4.05**	**359.57**	**4.79**

Major investments are required in 2005 and in the three five year intervals as per the plan. The table shows that approximately NRs. 581.69 million (US$ 7.76 million) would be required in 2005 for 50 trolley buses, which includes the operation cost as well. The operation cost will be the same up to the year 2010 when additional buses will be added into the fleet and the operation cost in 2011 will be same until 2015 and so on. So, the total investment (including operation cost) for the whole period from 2005 to 2025 will be: NRs. 3,262.3 million (US$ 43.5 million) considering imported trolleybuses. If locally assembled ones replace the imported trolleybuses, then the total investment (again including operation cost) will be reduced to NRs. 3,100 million (US$ 41.33 million). The total operation cost in both cases is NRs. 2,131.29 million (US$ 28.417 million).

It should be noted here that the cost of monitoring and reporting needs to be included should the project be considered for CDM funding.

8.2 Project Financial Analysis

Financial analysis takes the view of the individual project participants rather than society as a whole. The financial costs associated with a project are based on normal accounting conventions. Thus, assets are valued in terms of their historic costs and are depreciated over their normal life. One of the reasons of performing financial analysis is the need to assess the financial implications of the project. The analysis uses market prices and therefore includes any taxes or royalties, which will be levied on the equipments, and other factors of production. Financial internal rates of return and net present values of the project have been presented below taking a discount rate of 10%.

FIRR, NPV without the benefits of CO_2 Credits

The investment in the project can be made only if it gives satisfactory returns. In order to consider the project commercially feasible and be attractive to them, most investors in Nepal require the FIRR to be at least 14%[8]. The revenue generated from a trolley bus in a year is about NRs. 2.23 million (US$ 29,800) considering that the trolley bus makes 7 trips a day in 329 days a year with 150 passengers per trip and NRs. 6.48 per passenger per trip (CEMAT, 1999). This gives the annual revenue of almost NRs. 112 million with 50 trolley buses and so on.

The following table shows the annual costs and revenue for the entire project period:

Table 10: Annual costs and revenue without carbon credit

Unit: NRs. in Million

Year	No of trolley	Capital cost	Operation	Revenue	Sum
1999	0		0	0	0
2000	0		0	0	0
2001	0		0	0	0
2002	0		0	0	0
2003	0		0	0	0
2004	0		0	0	0
2005	50	-522	-59	112	-470
2006	50	0	-59	112	53
2007	50	0	-59	112	53
2008	50	0	-59	112	53
2009	50	0	-59	112	53
2010	50	0	-59	112	53
2011	75	-212	-89	168	-133
2012	75	0	-89	168	79
2013	75	0	-89	168	79
2014	75	0	-89	168	79
2015	75	0	-89	168	79
2016	100	-185	-118	224	-80
2017	100	0	-118	224	105
2018	100	0	-118	224	105
2019	100	0	-118	224	105
2020	100	0	-118	224	105
2021	125	-212	-148	279	-80
2022	125	0	-148	279	131
2023	125	0	-148	279	131
2024	125	0	-148	279	131
2025	125	0	-148	279	131
				FIRR	**8.9%**

[8] The cost of fund in the current bank deposit is around 5% or less whereas hard currency devaluation is around 6 - 7% and inflation is in the range of 3 - 4% in the last couple of years. In order for investors to invest in risky businesses, the financial internal rate of return must be at least 14% so that it can cover the risk of high currency devaluation and inflation. In Nepal, projects giving FIRR 14 - 16 % are considered attractive to the investors.

The table clearly indicates that the FIRR is only 8.9%, which is lower than the minimum expectation of the investors. The FNPV is negative NRs. 38.89 million. The benefits of the project will be started only from 2005.

If the trolley buses are locally assembled then the costs will go down. In the case of locally assembled buses, then the FIRR would be 11.7% and FNPV would be NRs. 53.1 million. This is again not particularly worthy of note for investors.

FIRR, NPV with the benefits of CO_2 Credits

The next and the promising option is the carbon financing. The first case presents the scenario for one time lump sum payment for the total GHG abatement if available at the beginning of the project, as might be possible in the case of Global Environment Facility (GEF) financing for the project to provide the incremental cost of the project. The second case analyses the payment for CERs upon delivery per year as a CDM project. These two options are presented below:

Table 11: Case I: One time up front lump sum payment for the total CO2 eq abatement

Year	No of trolleys	Capital cost	Operation	Revenue	CO2 revenue	Sum	Total CO2eq offset
2005	50	-522	-59	112	155	-315	3,576
2006	50	0	-59	112	0	53	3,576
2007	50	0	-59	112	0	53	3,576
2008	50	0	-59	112	0	53	3,576
2009	50	0	-59	112	0	53	3,576
2010	50	0	-59	112	0	53	3,576
2011	75	-212	-89	168	0	-133	5,383
2012	75	0	-89	168	0	79	5,383
2013	75	0	-89	168	0	79	5,383
2014	75	0	-89	168	0	79	5,383
2015	75	0	-89	168	0	79	5,383
2016	100	-185	-118	224	0	-80	7,152
2017	100	0	-118	224	0	105	7,152
2018	100	0	-118	224	0	105	7,152
2019	100	0	-118	224	0	105	7,152
2020	100	0	-118	224	0	105	7,152
2021	125	-212	-148	279	0	-80	8,959
2022	125	0	-148	279	0	131	8,959
2023	125	0	-148	279	0	131	8,959
2024	125	0	-148	279	0	131	8,959
2025	125	0	-148	279	0	131	8,959
					FIRR	**14.0%**	**128,927**

In order to make the FIRR at least 14%, the minimum amount of funding required is NRs. 155 million (US$ 2.06 million). The corresponding FNPV will be NRs. 101.76 million. The total CO_2 equivalent emissions reduction is 128,927 tons and this would mean that the cost of CO_2 abatement should be NRs. 1,200 or US$ 16 per ton CO_2. If the trolley buses are to be locally assembled, then the minimum amount of funding required will be only NRs. 63 million (US$

0.84 million) to make the FIRR 14% and the corresponding FNPV would be NRs. 110.23 million. This translates the cost of CO_2 abatement to be NRs. 488 per ton or US$ 6.5 per ton CO_2 abated.

Case II: CDM CO_2 Credit Benefits

In case the payment for the abatement of CO_2 equivalent is to be made annually, the following scenario will emerge:

Table 12: Case II: Payment for CERs upon delivery

Year	No of trolleys	Capital cost	Operation	Revenue	CO2 revenue	Sum	Total CO2eq offset
2005	50	-522	-59	112	15	-455	3,576
2006	50	0	-59	112	15	68	3,576
2007	50	0	-59	112	15	68	3,576
2008	50	0	-59	112	15	68	3,576
2009	50	0	-59	112	15	68	3,576
2010	50	0	-59	112	15	68	3,576
2011	75	-212	-89	168	23	-110	5,383
2012	75	0	-89	168	23	102	5,383
2013	75	0	-89	168	23	102	5,383
2014	75	0	-89	168	23	102	5,383
2015	75	0	-89	168	23	102	5,383
2016	100	-185	-118	224	31	-50	7,152
2017	100	0	-118	224	31	136	7,152
2018	100	0	-118	224	31	136	7,152
2019	100	0	-118	224	31	136	7,152
2020	100	0	-118	224	31	136	7,152
2021	125	-212	-148	279	38	-42	8,959
2022	125	0	-148	279	38	170	8,959
2023	125	0	-148	279	38	170	8,959
2024	125	0	-148	279	38	170	8,959
2025	125	0	-148	279	38	170	8,959
					FIRR	**14.0%**	**128,927**

As shown in the table, in order to maintain FIRR of 14%, the project should be able to sell its CO_2 emissions reduction credit for US$ 57 per ton (NRs. 4,275 per ton CO_2) in case of imported trolley bus. In the case of locally assembled ones, the rate should be US$ 23 per ton CO_2. The following table shows the FIRR and FNPV for two extremes: US$ 2 per ton CO_2 and US$ 25 per ton CO_2 as suggested by ADB to consider while carrying out the pre-feasibility study under PREGA as well as other two more realistic carbon credit prices.

Table 13: FIRR and FNPV Variations for Imported Buses

	FIRR	FNPV
@ US$ 2 per ton CO_2	9.1%	NRs. 32.42 million (negative) (US$ 0.43 million) (negative)
@ US$ 5 per ton CO_2	9.4%	NRs. 22.52 million (negative) (US$ 0.3 million) (negative)
@ US$ 10 per ton CO_2	9.8%	NRs. 6.02 million (negative) (US$ 0.08 million) (negative)
@ US$ 25 per ton CO_2	11.2%	NRs. 43.46 million (US$ 0.58 million)

Similarly, for locally assembled trolley buses:

Table 14: FIRR and FNPV Variations for Locally Assembled Buses

	FIRR	FNPV
@ US$ 2 per ton CO_2	11.9%	NRs. 59.69 million (US$ 0.8 million)
@ US$ 5 per ton CO_2	12.2%	NRs. 69.59 million (US$ 0.92 million)
@ US$ 10 per ton CO_2	12.7%	NRs. 86.09 million (US$ 1.14 million)
@ US$ 25 per ton CO_2	14.2%	NRs. 135.57 million (US$ 1.8 million)

8.3 Incremental Abatement Cost

GHG abatement cost calculated is based on the total investment required to implement the project and the GHG mitigation during the project period. In a general sense, an incremental cost is an additional cost required to implement the project compared to the business-as-usual scenario. Incremental cost calculation based on lifecycle cost analysis has been performed as follows:

$$\text{Lifecycle cost (LCC)} = Cc + \sum_{n=1}^{t} \frac{Cn}{(1+r)^t} - \frac{RV}{(1+r)^t}$$

where:

Cc = Initial capital cost (capital, labor, administration cost)
Cn = Operating cost (operation & maintenance cost, fuel, tax, interest etc.) in year n
n = time period (year)
r = discount rate
t = total life of project
RV = Residual Value

Following inputs have been used in the calculation:

Discount rate	-	10%
RV	-	60% of the trolley bus infrastructure and 10% of the cost of trolley bus and diesel bus
Time period	-	2005 to 2025
Operating cost	-	Rs. 1.184 million per trolley bus per year
	-	Rs. 0.998 million per diesel bus per year (CEMAT 1999)
Cost of bus	-	Rs. 5.5 million for imported trolleybus;
	-	Rs. 4.2 million for locally assembled trolleybus and
	-	Rs. 1.65 million for diesel buses (average)

The LCC of baseline scenario is found to be Rs. 2,241 million (US$ 29.88 million). The LCC of project scenario is Rs. 2,668 million (US$ 35.57 million) considering imported trolleybus and Rs. 2,448 million (US$ 32.64 million) in the case of locally assembled trolleybus. This gives the incremental cost of Rs. 427.02 million (US$ 5.69 million) with imported trolleybus and Rs. 207.48 million (US$ 2.77 million) with locally assembled. This translates that GHG abatement cost is US$ 44 per ton CO_2 equivalent with imported trolleybus and US$ 21.5 per ton CO_2 equivalent considering the abatement potential of 128,927 ton CO_2 equivalent in the entire project period.

It can be safely assumed that the diesel buses that are operating in the baseline case in the project area are maintaining minimum FIRR of 14%. So, another circumstance has also been analyzed in this project to estimate the incremental cost. The incremental cost could also be the extra cost needed to maintain the minimum FIRR of 14%. As explained in Case I (one time lump sum payment) above, the minimum amount required to maintain this FIRR is NRs. 155 million or US$ 2.06 million for the case of imported trolley buses and NRs. 63 million or US$ 0.84 million for locally assembled ones. Just to recap, the total GHG abatement potential by replacing diesel buses by trolley buses from this project is 128,927 ton CO_2 equivalent.

Incremental Abatement Cost = Incremental Cost / CO_2 Mitigation Potential

In the case of imported trolley bus,

Incremental abatement cost = US$ 2.06 million/128,927 ton
= US$ 16 per ton CO_2

In the case of locally assembled trolley bus,

Incremental abatement cost = US$ 0.84 million/128,927 ton
= US$ 6.5 per ton CO_2

8.4 Financing Plan

The total capital cost investment requirement for the entire project is NRs. 1,131 million (US$ 15.08 million) in the case of imported trolley buses and NRs. 969.5 million (US$ 12.93 million) for locally assembled ones. The total operation costs for the whole project lifetime is estimated to be NRs. 2,131.29 million (US$ 28.417 million) in either case as explained above. However, it is not required to make all the investment at once. First major investment of NRs. 522.49 million (US$ 6.96 million) for imported bus and NRs. 457.89 million (US$ 6.1 million) for locally assembled ones is needed for 2005. It is too early to define who will be the financer, proponent, and what the sources of funding etc will be. Locally based environmental organizations like Winrock International Nepal, Kathmandu Electric Vehicles Alliance (KEVA), Clean Energy Nepal, UNDP Nepal etc. are a few examples of organizations lobbying and advocating for environmental protection and clean air, and either one or some of them could facilitate and support the proponent/s of this project. The project can be financed either by one time lump sum payment for the total GHG abatement during the lifetime of the project by GEF or by annual payment for the abatement upon delivery for the CERs under CDM. International financial institutions like The World Bank, Asian Development Bank, and other bi-lateral organizations could also show interest in financing this project. The Kathmandu Metropolitan City, either alone or as a consortium with other neighboring municipalities and other organizations, might be the proponent; some private companies might also come up. The investors can also make additional investments in the year 2011 and 2021 from the revenue generated.

9.0 Economic Analysis

The economic analysis estimates the net economic benefits of a proposed project and tests the sensitivity of that estimate to changes in the basic parameters. An economic analysis is concerned with the broad social impacts of the project, taking into the account the view of society as a whole and not just the impact on the direct project participants. The project must contribute to the development of the total economy and justify against using scarce resources. Taxes, duties etc. have been excluded from the financial calculation in order to carry out economic analysis, as these do not have any impacts on macro-economic of the country. This has primarily affected the operation and cost of vehicles. The economic operation cost now becomes:

- NRs. 35 million for 50 buses,
- NRs. 53 million for 75 buses,
- NRs. 70 million for 100 buses and
- NRs. 88 million for 125 buses.

The details of cost components in the operation cost are given in the Annex. For this analysis, 5% has been deducted from the cost of a trolley bus as custom duty. Therefore, the economic cost of an imported trolley bus is taken as NRs. 5.225 million and for a locally assembled one it becomes NRs. 3.99 million. The following table summarizes the economic costs:

Table 15: Summary of economic costs

Year	No. of Trolley bus	Operation cost (NRs. in million)	Capital cost (with imported trolley) (NRs. in million)	Capital cost (with locally assembled trolley) (NRs. in Million)
2005	50	35.25	508.74	446.99
2011	75	52.87	204.68	173.81
2016	100	70.49	178.53	147.66
2021	125	88.11	204.68	173.81

Following a similar procedure as in financial analysis, the economic internal rate of return (EIRR) and economic net present value (NPV) has been calculated again with a 10% discount rate in the CDM case.

Table 16: Economic internal rate of return (EIRR) calculations

	Type of bus	EIRR	NPV (Rs. in million)
Without carbon credit	Imported bus	17.4%	274.98
	Local bus	21.0%	362.90
At US$ 2 per ton	Imported bus	17.6%	281.58
	Local bus	21.2%	369.50
At US$ 5 per ton	Imported bus	17.9%	291.48
	Local bus	21.5%	379.40
At US$ 10 per ton	Imported bus	18.3%	307.97
	Local bus	22.0%	395.89
At US$ 25 per ton	Imported bus	19.6%	357.46
	Local bus	23.4%	445.38

The project is seen to be beneficial to the society if just the economic costs are considered. This is positive when thinking from the society's point of view. The incremental cost is negative since even without carbon credits; the EIRR is more than 14%. This also depicts that the project has very little risk from the economic viewpoint. On the other hand, the project could make a significant contribution to poverty alleviation and other social sectors through the carbon credits it can attain. Even if the carbon-financing rate is US$ 2 per ton CO_2, it could generate US$ 0.25 million and could generate around US$ 3.22 million if the rate is US$ 25 per ton CO_2.

There are other benefits of this project in terms of health benefits, employment generation, environment protection etc., which if quantified and added to the above calculations would make the EIRR even more attractive for the society.

10.0 Stakeholders' Comments

A half-day workshop on the Pre-feasibility study of trolleybus development in the Kathmandu Valley Ring Road was organized on November 3, 2003 at the Hotel de l'Annapurna, Kathmandu, Nepal. The Ministry of Population and Environment (MOPE), HMG and Winrock International organized the workshop jointly as a part of an assignment - Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA) from the Asian Development Bank (ADB), Manila. The workshop was mainly organized to obtain feedback from the stakeholders on the development of the trolleybus project in the Ring Road, to replace the diesel buses and minibuses. Various organizations including government, semi-government, non-governmental organization (NGOs), private sectors, individuals and media persons participated in the workshop. The list of participants has been attached in the Annex.

Mr. Binod Gyawali, joint secretary at MOPE formally initiated the workshop with a brief welcome speech. Mr. Gyawali highlighted PREGA activities commenced in Nepal in 2002 based on an understanding between MOPE and the ADB and lauded the scheduled workshop as being very conducive in planning future PREGA programs.

Mr. Ranjan P. Shrestha, Research Officer, Winrock International presented the study findings of a pre-feasibility study to develop a trolleybus transportation system in the Ring Road. He mentioned the extension of the trolley bus services in the Ring Road is possible through specialized treaty-linked mechanisms such the Clean Development Mechanism (CDM) defined in Article 12 of the Kyoto Protocol to the United Nations Framework Conventions on Climate Change (UNFCCC). This is expected to help promote non-polluting rapid mass transport systems in Nepal and to bring in investments through the CDM into the renewable energy technologies contributing positively to global climate change by lowering GHG emissions.

Following the PowerPoint presentation, Mr. Ratna Sansar Shrestha highlighted the primary points of the study in Nepali, reiterating the 2 separate options, namely the payment for CERs upon delivery annually and one time lump sum payment for the total GHG abatement during the lifetime of the project and the 2 additional alternatives (imported or locally assembled trolley buses) available within the larger framework. Of this, Mr. Shrestha stressed the possibility of accruing substantial savings by opting for the assembly of imported components within Nepal.

Floor Discussion

The findings of the study and the initiative to introduce the trolleybus transportation system in the Ring Road was highly appreciated as it contributes significantly to the reduction of local air pollution, resulting in the improvement of the heath of valley residents. However, the possibility of project investment through the Clean Development Mechanism (CDM) has been given major importance, as the subject was new to most of the participants. The summary of the comments received is given below:

- It was suggested that other similar studies be carried out in order to claim CO_2 credits through the CDM for electric three-wheelers plying on Kathmandu roads since they have also displaced diesel run three wheelers from the valley;

- The possibility of funding the project simultaneously from ODA as well as CDM was also questioned during the workshop;

- It was mentioned that the CDM processing cost is very high, raising the project costs. Therefore, a recommendation to include CDM processing costs in the proposed plans was made;

- The skills and knowledge of the local technicians and the trolleybus company engineers was questioned to determine whether Nepali technicians have the ability to assemble trolleybuses with parts imported from India and China. The question was raised on the preliminary source of funding and its impact on the initial investment if the local assembly unit is set up to produce trolleybus locally. It was recommended that the capacity of the local technicians and labor have to be investigated further if the trolleybuses are to be assembled locally;

- The health impact should be included in order to strengthen the quality of the study. It is also suggested that the social benefits in monetary terms from the electric based transportation system in the study be incorporated into the study;

- The PREGA scope of work in Nepal was clarified and questions raised about the prerequisites necessary to apply for PREGA by other organizations;

- It was suggested that the private sector be involved in the trolleybus project in the future to ensure smooth operation and to take precautions not repeat the mistakes that lead to the collapse of Nepal's only trolleybus system, which was started in the 70s;

- As the traffic has increased substantially since the base year of 1999, the use of comparatively long-standing data was suggested to offer a more promising result, provided that there is sufficient funding to carry out a survey to collect the most recent data;

- The total energy consumed by the trolleybus transportation system upon implementation of the project was raised. Also, the impact of the electricity tariff on the proposed cost of operating electric trolleybuses in the future was raised as the tariff is very high in Nepal;

- There was also an enquiry about the approximate total electricity (generated by hydropower in Nepal) likely to be consumed upon implementation of the proposed project.

Chief Guest, Joint Secretary of MOPE, Dr Jigbar Joshi outlined PREGA objectives and the promising potential of CDM generated revenue. Dr Joshi acknowledged that PREGA was open for all Renewable Energy Technologies (RETs) and that MOPE was in the process of preparing a national strategy for Renewable Technologies. He stressed the need to adopt technological changes to avert the adverse effects of climate change through essential modes of identification, implementation and expertise, and reiterated HMG/Nepal's dedication to provide a more equitable access of energy by promoting alternative carbon-free energy. He stressed the appropriateness of RETs in Nepal as they are economically viable and user friendly. Mr. Joshi stated that the CDM was market based and market driven promising numerous potential benefits for Nepal and verified that MOPE was in the process of identifying a CDM based climate development strategy.

Mr. Ratna Sansar Shrestha, Senior Advisor Clean Energy Group, Winrock International, and the National Technical Expert, PREGA emphasized that all fuels presently used in public transportation have to be imported. He deliberated over the maximum use of surplus/spilled electricity during the off-peak period. Given the current NEA practice of spilling surplus electricity, Mr. Shrestha pointed out the paradox of having to import fossil fuel while Nepal's vast hydroelectricity potential remains not only untapped but a substantial portion of the energy generated by the commissioned plants is spilled. He advised policymakers to be wary of some of the recently proposed activities regarding national infrastructure development, suggesting the inappropriateness of these activities to the Nepali economy and that the resultant adverse effects would far outweigh any advantages. He also urged the stakeholders and authorities concerned to focus on the many potential avenues for the use of hydropower in the domestic market rather than remaining limited to exploring export strategies of hydropower. He further clarified that the PREGA scope of work for Nepal is presently limited to conducting a review of country study and the pre-feasibility study of Trolleybus system in the Ring Road. He also stated that any institution, local or global, functional on CE technology is eligible for PREGA activities, subject to CDM screening. Regarding the question about the manufacturing capability of parts in Nepal, Mr. Shrestha stressed the assembly, not the manufacture, of imported pre fabricated parts. On the subject of why CDM and ODA are not simultaneously viable, Mr. Shrestha further clarified that carbon trading is not possible on subsidized services. He also made it clear that the study is based on current NEA tariffs and that the prospects would be even better if the tariff was to decrease (which is the stated policy of HMGN[9]).

The study clearly indicates an assortment of environmental, economic and technological benefits, the most relevant of which are opportunities for technology transfer and investment in the domestic scenario; maintenance of foreign currency reserves and the mitigation of atmospheric pollutants.

It was concluded and recommended that the project should be investigated further as a feasibility study. Questions pertaining to how the local costs would compare to the initial investments, how to raise the preliminary capital, the need to incorporate health impacts to strengthen the study, development of a concrete substantiation of benefits in order for EVs to be eligible to claim subsidies, involving the private sector in future Trolley operations, and the imperative for a strong management were also suggested by workshop participants to further substantiate the study.

11.0 Risks and Uncertainties

There are some risks and uncertainties associated with the political, technical, economic, environmental etc. scenario, which can affect the baseline and project activities. At present, the government policy is favorable to electric based transportation and provides many fiscal incentives. However, if the present government policy changes, there is the danger that electricity based transportation systems might not be able to compete with fossil fuel based ones. Therefore, the continuity of the current government policy favoring electric vehicles to at least the current level is required.

The existing local Tripureshwor – Suryabinayak trolley bus system has already established how important internal management is. So, it is especially crucial that the proposed project should have a very efficient and effective management system in order to operate the trolley bus efficiently and also be able to compete with other public transportation systems in terms of passenger fare and time.

[9] HMGN's budget speech for FY 2003/4.

Assembly of the trolley bus in Nepal would accrue enable many forward and backward linkages benefits to Nepal. However, risks and uncertainties about the capability of the local people/companies and the quality of products produced will remain. This could be minimized with appropriate training.

Nepal has been experiencing many ups and downs in recent years because of the Maoist insurgency, political instability etc. There are also frequent *bandhas* (general strike), which also affect the normal functioning of the economy. So far these factors do not pose a great threat to the proposed project; however, certain risks and uncertainties should not be overlooked.

Carbon financing presents the hope to make the project feasible and attractive to investors. In order for this to materialize, Nepal should first ratify the Kyoto Protocol. The country has already shown its commitment towards this but needs to ratify the Protocol at the earliest. There is also some uncertainty as to how effective the Kyoto Protocol will be. There is also no guarantee of the price of CO_2 and will have severe effects if the buyers decrease the rate. The risk factor is also associated with the date by when the project can be made available. The estimation in this study is based on 1999 as the baseline year but costs, passengers, emission level etc. will change if the project is delayed by several years. Also, the emissions forecast might also change slightly due to variations in the passenger demand forecast. The electricity tariff also plays a major role and is a very important factor in ensuring the success of the trolleybus project.

However, it can be concluded that as the pre-feasibility of the study shows the project to be promising under various conditions, a detailed feasibility to assess the cost of the project and the actual revenue from the carbon credits is necessary in the near future.

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Annex

Annex 1: List of Participants in PREGA Stakeholders' Comments

Date: November 3, 2003
Venue: Hotel Annapurna, Kathmandu

S.N.	Name	Designation	Company	Address
1	Dr. Jibgar Joshi	Joint Secretary	MOPE (PREGA Nat. Imp. Agency)	Singha Durbar, Kathmandu
2	Mr. Binod Gyawali	Joint Secretary	MOPE	Singha Durbar, Kathmandu
3	Mr. Stalin M. Pradhan	Joint Secretary	Ministry of Industry and Commerce	Singha Durbar, Kathmandu
4	Dr. M. B. Basnet	Director	AEPC	Dhobighat, Lalitpur
5	Mr. Purushottam Kuwar	Under Secretary	MOPE	Singha Durbar, Kathmandu
6	Mr. J. N. Shrestha	Director	Centre for energy Studies, IOE/TU	Kritipur
7	Mr. Dipesh Bista	Program Officer	Explore Nepal	Kamaladi, Kathmandu
8	Mr. Rajendra Ghimire	Section Officer	MOPE	Singha Durbar, Kathmandu
9	Mr. Narayan Pd Shrestha		Centre for energy Studies, IOE/TU	Kritipur
10	Mr. Ratna Sansar Shrestha	Senior Advisor	Winrock International	Old Baneshwor, Kathmandu
11	Mr. Ranjan P. Shrestha	Research Officer	Winrock International	Old Baneshwor, Kathmandu
12	Ms. Karuna Sharma	Research Officer	Winrock International	Old Baneshwor, Kathmandu
13	Mr. Jiwan Acharya	Research Officer	Winrock International	Old Baneshwor, Kathmandu
14	Mr. Shyam Upadhayay	Senior Research Specialist	Winrock International	Old Baneshwor, Kathmandu
15	Mr. Bibek Chapagain	In-Country Coordinator	KEVA	Old Baneshwor, Kathmandu
16	Mr. Megesh Tiwari	Program Associate	KEVA	Old Baneshwor, Kathmandu
17	Mr. Raj Kumar Bajracharya	Deputy M.D	Nepal Electricity Authority	Ratna Park, Kathmandu
18	Mr. Basanta Ranjitkar	Executive Director	Martin Chautari	Thapathali, Kathmandu
19	Mr. Damodar Lama	Manager	Trolley Bus	Minbhawan, Kathmandu
20	Mr. Arjun Maharjan	Head, overhead network	Trolley Bus	Minbhawan, Kathmandu
21	Mr. Amar B. Karki	head, Workshop	Trolley Bus	Minbhawan, Kathmandu
22	Mr. Kuber Shresthacharya	Incharge, Sub Station	Trolley Bus	Minbhawan, Kathmandu
23	Mr. Hari Shrestha	Technician	Trolley Bus	Minbhawan, Kathmandu
24	Mr. Kiran Raj Joshi	EV Industry Promotor		

25	Mr. Shanti Karanjit	Office Manager	EVAN	Anamnagar, Kathmandu
26	Mr. B.M. Sherchan	Managing Director	CEMAT	Kupondole, Lalitpur
27	Mr. Bhusan Tuladhar	Executive Director	Clean Energy Nepal	Anamnagar, Kathmandu
28	Mr. Bimal Aryal	Executive Director	Martin Chautari	Thapathali, Kathmandu
29	Mr. Shanker N. Rimal			
30	Mr. Lal Bahadur Ghisisng	Chairman	EVAN	Anamnagar, Kathmandu
31	Mr. Surendra Bhatta	Policy analyst	PADCO	
32	Mr. Ben Stoner	Director	PADCO	
33	Mr. Rabindra	Press Photographer		
34	Mr. Gopal Acharya	Reporter	Business Times Weekly	
35	Mr. Ramesh Kafle	Reporter		Putalisadak
36	Mr. Shanker Shah	Media		
37	Mr. Shreedhar Acharya	Reporter	Gorkhapatra	
38	Mr. Bhumi Mainali	Reporter	Public Mirror	
39	Mr. Binod Paudyal	Reporter	Citizen voice	
40	Mr. Krishna Adhikary		Rastriya Samachar Samiti	
41	Mr. Kedarshree Joshi	Reporter	Janaprabhat	
42	Mr. Bhuwan Sharma	Reporter	Kantipur TV	
43	Mr. Subodh Gautam	Reporter	Kantipur Daily	
44	Mr. Nimesh Regmi	Reporter	Samachar Patra	
45	Mr. Bhoj Raj Bhat	Reporter	Space time Dainik	
46	Mr. Abdulla Miya	Reporter	Rajdhani Dainik	
47	Mr. Sanjay Dhakal	Reporter	Spotlight	
48	Mr. Bishnu Budhathoki	Reporter	The Rising Nepal	
49	Mr. Mohan Khanal	Reporter	Valley Mirror Weekly	
50	Mr. Arun Ranjit	Reporter	The Rising Nepal	
51	Mr. Udipt S. Chhetry	Press Photographer	The Himalayan Times	

Annex 2: Cost estimation

(Source: CEMAT, 1999 and the NTE's own study)

Note: Total cost (in CEMAT, 1999) is converted into per vehicle cost and then multiplied by the number of trolley buses in order to get the total cost. 1 US$ = Rs. 75 has been considered in the calculation.

A. Land cost for trolley bus

Description	Unit area (sq. ft per bus)	Cost per bus (Rs.)	Cost per bus (US$)
Land for main station/hanger	374	109,135	
Land for office building	20.4	5959	
Land for stores	20.5	5984	
Land for workshop	150	43,833	
Land for compound	1126	328,748	
Land for traction stations	219	63,960	
Total cost of land per trolley bus		**557,619**	**7,435**

B. Civil Construction cost

Construction cost for Trolleybus (Rs)	Unit cost (Rs/sq. ft)	Cost per Trolley bus (Rs.)	Cost per trolley bus (US$)
Hanger construction cost	500	186,875	
Office building construction cost	1,500	30,612	
Store construction cost	700	14,344	
Workshop construction cost	500	75,056	
Road construction cost (Rs/ sq. ft)	400	135,102	
Traction substation buildings	500	109,520	
Total civil construction cost		**551,509**	**7,353**

C. Other Costs

Trolleybus	(Rs/vehicle)
Furniture and Office Equipment (Rs/veh)	83,333
Workshop equipment	66,667
Vehicles	240,000
Spare Parts	417,333
Total	***807,333***

D. Electrical Infrastructure cost

	Quantity	Rate	Total cost	US$
Electrification of Traction Stations				
HT Connection to Sub-station	3	1.289	3,867,000	
Sub-station electric equipment	3	6.990	20,970,000	
Electrification of Main Station	1	1.282	1,282,000	
Feeder Wire Network	1	104.28	104,280,000	
RCC Poles (Rs./pole)	1772	12,000	21,264,000	
Total Electrical Infrastructure Cost (million)			151.66	2.02

E. Operation Cost

Items	Rs/km/bus
Electricity cost	4.76
Lubricants	0.2
Wear and tear of tyres	0.55
Maintenance of parts	2.2
labour charge	0.75
Depreciation	4.88
Total A	13.34
Total basic operating cost for 70,000 km/yr	933,800

B. Overhead and Crew Costs	
	Rs/vehicle
Basic running cost	0
Vehicle time cost (crew cost)	1.61
Overhead	1.71
Total B	3.32
Total overhead and crew cost for 70,000 km	232,400
C. Permits, Taxes and Tests Costs	Rs/vehicle
Blue book renew	0.005
Road Permit (1-50 km)	0.016
Pollution Test	0.000
Examination Pass (Jach Pass)	0.000
Municipality Tax	0.014
Vehicle income tax	0.199
Yearly tax	0.021
Total C	0.255
Total taxes and permit & test costs (Rs/veh)	17,850
Total Operating cost per trolley bus per year (Rs.)	**1,184,050**