A Cost Benefit Analysis of Two Alternative Traffic Lights Systems for the Colourful City of Zamzam

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ABSTRACT

Zamzam Infrastructure Bank has been approached by the country's third largest city to finance the upgrading and expansion of its traffic lights system. Since the project is social in nature, the Bank intends to justify the borrowing on the basis of Colourful City's ability to service the loan from its consolidated cash flows. A pre-requisite however, is the need to confirm the project's socio-economic viability through economic cost benefit analysis. The Bank assessed and is satisfied with council's ability to pay the loan.

This thesis examines the merits of undertaking project on the basis of its economic and social impacts as well as choosing a cost effective option of procuring it. The project can be procured through Solar Powered or Alternative Current (AC) Powered traffic lights both with twelve hour battery backup. In undertaking cost benefit analysis reliance was placed on, amongst other information sources, traffic studies, traffic counts, accident statistics, power outage statistics and cloud cover statistics obtained from relevant institutions as well as case studies on BLEG Electricity Project and Kampala Hilton Hotel Project. The economic analysis showed that the AC powered option is more cost effective as it has a higher Economic Net Present Value of $5.1 million when compared to $4.7 million for solar power option. All road users, heavy vehicles users, light vehicles users and Government benefit from project in that ranking order. Risk analysis shows that project is not sensitive to power cuts, cloud cover and battery life. Although sensitive to annual growth in traffic and minimum wage rate, the risk parameters do not pose a significant threat to the economic viability of the project.

Keywords: Colourful city, traffic lights project, stakeholders, risks.

ÖZ

Zamzam altyapı bankasına ülkenin en büyük üçüncü şehri tarafından trafik ışıkları sisteminin yenilenmesi ve genişletilmesi için yaklaşılmıştır. Bu sosyal bir proje olmasına rağmen banka bu renkli şehrin konsolide nakit akımlarının aldıkları krediyi karşılamada yeterli olduğunu doğrulamak istemiştir. Bu nedenle öncelik, fayda-maliyet analiziyle projenin geçerliliğini onaylamaktır. Banka, konseyin krediyi geri ödeyebilirliğini değerlendirip, yeterli buldu.

Bu tez projenin sosyal ve ekonomik etkilerine bakarak uygun maliyetli seçeneklerle uygulanmasını inceler. Bu proje 12 saat yedek güç destekli güneş enerjili veya güçlü alternatif akımlı trafik ışıklarıyla uygulanabilir. Fayda-maliyet analizleri yapılırken kullanılan kaynaklar, trafik çalışmaları, kaza statistikleri, elektrik kesintisi statistikleri ve bulut statistikleri ilgili kurumlardan elde edilmiştir. Ekonomik analizler güçlü alternatif akım seçeneğinin güneş enerjisi seçeneğinden daha faydalı olduğunu ekonomik net bugünkü değerlerini karşılaştırarak ortaya koymuştur. Güçlü alternatif akımın ekonomik net bugünkü değeri $5.1 milyon Dolar'ken güneş enerjisinin ekonomik net bugünkü değeri $4.7 milyon bulunmuştur. Risk analizleri projenin elektrik kesintilerine, bulutlara ve pil ömrüne duyarlı olmadığını göstermiştir. Proje trafikteki yıllık gelişmeye ve minimum ücrete duyarlı olmasına rağmen risk faktörleri projenin ekonomik geçerliliğine tehdit oluşturmamaktadır.

Anahtar Kelimeler: Renkli Şehir, trafik ışıkları projesi, paydaşlar, riskler

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LIST OF ABBREVIATIONS

ADCR	Annual Debt Coverage Ratio
C	Cash flow in year t
CIF	Cost, Insurance and Freight
CSCF	Commodity Specific Conversion Factor
d*	Average effective rate of Indirect Taxes
DSCR	Debt Service Capacity Ratio
ED	Exercise Duty
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
EOCK	Economic Opportunity Cost of Capital
EOCL	Economic Opportunity Cost of Labor
Ext	Externalities
FEP	Foreign Exchange Premium
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
ID	Import Duty
IRR	Internal Rate of Return
NPV	Net Present Value
Pi	Market price of input
Pj	Market price of input j
Pm	Market Price
PV	Present Value

r	Discount rate
SPNTO	Shadow Price of Non-Tradable Outlays
VAT	Value Added Tax

Chapter 1

INTRODUCTION

1.1 Zamzam Economy Overview

Since the turn of the century, Zamzam's Gross Domestic Product (GDP) fell by a cumulative 40% between 2000 and 2007 and plunged a further 14% in 2008. Inflation is estimated to have peaked at 500 billion percent in September 2009, while foreign currency reserves amounted to $6 million against a foreign debt of $6 billion. Humanitarian aid for 2008 amounted to $490 million against a background of estimated 90% unemployment levels. The freefall in economic performance was largely attributed to political challenges, poor policy environment, government controls, droughts and measures to address social inequalities through the provision of basic and social services at the expense of production.

The signing of a political agreement amongst previously antagonistic parties and the formational of a Government of National Unity (GNU) in 2009 ushered in a new era of political stability. The new government introduced a multicurrency system where the local currency was replaced with the United States dollar, the British Pound and the Euro. Government also instituted an economic revival plan which, amongst other things, introduced cash budgeting. A return to macro-economic stability was characterized by a halt in the hyper inflationary trend, increased capacity utilization and positive growth in GDP. Inflation fell to -7.7% in 2009, closed at xxx and is expected to reach 4.5% in December 2011. Capacity utilization increased from 10-

30% to 30-50% for the period 2009/2010. Real GDP grew by 5.7% in 2009, 8.1% in 2010 and is projected to increase to 9.3% in 2011. In its Medium Term Plan (2010-2015) and other policy pronouncements, Government identified and prioritized infrastructure maintenance, rehabilitation and expansion as a critical enabler to economic development.

1.2 Infrastructure and Transport Sector Overview

1.2.1 Infrastructure Sector

Calderon and Leipziger in their study of "The Effects of Infrastructure Development on Growth and Income Distribution in Chile" concluded that GDP growth is positively affected by the stock of infrastructure assets, and income inequality declines with higher infrastructure quantity and quality. The World Bank asserts that an adequate supply of infrastructure services is an essential ingredient for productivity and growth.

Infrastructure development give rise to new investment opportunities and so pave the way to further economic development. Therefore, infrastructure investments lead to mobilization of latent resources and promotion of general economic development. The role of infrastructure in economic development is epitomized by the fact that in China the massive infrastructure investment is contributing directly to the overall improvement of national competitiveness and business investment climate. The recent emergence of China as the world factory would not be possible without a range of new economic infrastructure services in place. This shows that infrastructure development improves the country's competitiveness aiding local industry and attracting foreign direct investment. Infrastructure development is an integral part of China's export-led growth strategy.

1.2.1.1 Status of Infrastructure in Zamzam

According to the UNDP (2009), in the 1980s and into the 1990s, it was viewed that there was adequate investment in Zamzam's infrastructure and that it was well maintained. The supply of infrastructure services was therefore considered adequate to support productive sector investments and provide relatively high coverage of the needs of, at least, the urban dwellers. However there were some gaps with regards to Information Communication Technology (ICT) infrastructure. The infrastructure has however significantly deteriorated over the past decade.

1.3 Transport Infrastructure in Colourful City

Colourful City, the capital and administrative centre of Wasu Province, is located in the eastern part of Zamzam. The city lies a few kilometres from the Zamzam border with Mapata, approximately 262 kilometres south-east of Hasleep, the capital city of Zamzam. The national census conducted in 1992 gave a population of 131 000 and 1 600 000 for the city and province respectively. The current population for Colourful City is estimated at anything between 180 000 and 250 000.

In 2010, Colourful City engaged ABC Engineering Consultants to identify the transport infrastructure development requirements of the City as part of its greater integrated development plan. The scope of the study included but was not limited to conduction a condition assessment of current transport infrastructure, road network master planning to facilitate and ensure future mobility in the city by considering the current 1992-2001 master plan as well as envisaged future developments, traffic modeling to assess both the current traffic conditions, as well as predicted future traffic conditions, a needs assessment based on discussions with City officials and omnibus operators, comments on proposed bypass road, project identification and prioritisation and high level cost estimate for the proposed projects.

1.3.1 General Condition Assessment of Roads

Surfaced roads in the older part of the city show distress in the form of excessive cracking, local deformation, edge deformation, edge breaks and in some instances the formation of potholes. Some of the surfaced roads in the newer part of the City such as Silver Avenue are in total disrepair and will have to be completed reconstructed. Insufficient drainage and block drainage is a huge concern while some of the surfaced roads were constructed too narrow and need to be widened. In most instances the road markings on the surfaced road are not visible any more. Directional and road signage is very limited and not standard and speed humps are not property marked by means of road markings and road signs.

1.3.2 Signalized Intersections

The condition of 7 signalized intersections is summarized in the table 1 below. The table shows that 3 signalised intersection are not operational while the remaining 4 are working but with visually poor conditions. The study also showed that traffic on 16 additional intersections justifies installing traffic lights.

Table 1: Existing Signalized Intersections

Signalized Intersection	**Condition**
Blue & Green Street	Not operational
Red & Blue Street	Working, but is visually in a poor condition
White & Black Road	Working, but is visually in a poor condition
Brown Road & Yellow Street	Working, but is visually in a poor condition
White & Blue Street	Working, but is visually in a poor condition
White Street & Orange Avenue	Not operational
Brown Road & Yellow Road	Not operational

1.4 Concept of the Project

1.4.1 The Project

The traffic lights project is one of the short term quick-hit projects aimed at kick starting a programme to maintain, rehabilitate and expand Colourful City's dilapidated transport infrastructure after years of under investment and neglect. The project entails replacing malfunctioning traffic lights at 7 existing intersections and installing new lights at 16 additional intersections.

1.4.2 The Sponsor

Colourful City is Zamzam's third largest city and gateway to the nearest port in Baura, Mapata. The City Council is the promoter and owner of the project and has approached Zamzam Infrastructure Bank to finance the capital requirements of the project whilst it will meet the operational and other costs required. Council has pledged to meet loan repayments from its consolidated revenues as well as leverage on its balance sheet.

1.4.3 The Financier

Zamzam Infrastructure Bank was set up by Government in 2005 to mobilize financial and other resources for infrastructure development in Zamzam. The Bank is owned by Government and multilateral development agencies such as European Investment Bank, DEG of Germany and AfDB amongst others. The DFI's enabling act stipulates that it should lend to commercially viable projects with demonstrable development impact. For this reason, the DFI has traditionally shied away from social projects, including those with perceived significant development impact. Over the years the institution has been roundly criticised for this approach on the basis that it was not being relevant to its mandate. As a result, the Board and management recently decided to consider financing social projects in those cases where borrowing entities are able to service debt from their consolidated revenues and have a balance sheet strong enough to give comfort to the lenders. In this regard special arrangements such as ring fencing specific revenue streams and/or requesting real estate security would be entered into with the borrowing entities. This approach was endorsed by shareholders on the understanding that investment justification would be based on economic and social impacts of chosen projects. Since this project is of a social nature and does not generate cash inflows, lending will be based on strength of the city's balance sheet as well as its consolidated cash flows. The DFI has assessed and is satisfied with council's ability to pay the loan.

From the point of view of the DFI, this cost benefits analysis is meant to justify implementing the project on basis of net economic benefits to be realised; compare suitability of two alternative technologies proposed for project procurement; use resultant economic cost benefit analysis model to assist the City adjudicate tenders for the assignment. In this regard analysis results will also be used to advise the City on technical and financial specification to form part of Request for Proposal (RFP) documents.

Although this is beyond the scope of this study, the Bank also intends to use the model to assess the impact of the traffic lights project on other related transport projects for the city as well as to assist with timing of implementation of these projects so as to avoid economic and social costs associated with traffic delays. This is particularly important to obtain the sign off from the Board as the traffic lights project should not be looked at in isolation of the City's overall transport and traffic management challenges. The analysis will assist the Council and the DFI to plan their project preparation and packing as well as resource mobilisation work for related projects. Please note however, that the impacts of related projects are not factored in the economic resource flow statements.

Chapter 2

INVESTMENT RATIONALE AND PROJECT SCOPE

2.1 Project Objectives

To reduce economic and social costs associated with the malfunctioning and inadequate traffic lights by rehabilitating and installing new traffic lights in and around Colourful City's central business district (CBD).

2.2 Investment Rationale

Traffic in the city is expected to increase significantly due to a combination of factors. Firstly, the city plans to increase the current land bank area of 16 700 hectares (ha) to 101 150ha to provide for an estimated population of 800 000 in 2045. Over 100 000 housing units will have to be constructed to support the increase in population of which approximately 20 000 have already been planned for in suburbs which include, but are not limited to, Borderline East, Flora Extension, Mount Hill, Mountain Rise, Alex Estate, Chinya Gejo North & South, Danga, and Mhuru amongst others. Secondly the FBC border post with Mapata is located in a freight zone which links routes between countries in Central Africa and the port of Baura. The port has recently been upgraded and is expected to attract freight movement that previously used other harbours such as Duba. Based on this and plans to make the border a One Stop Border Post (OSBP), it is anticipated that freight movement will increase significantly in future. According to traffic studies conducted by ABC Engineers in 2010, seventy (70%) of heavy vehicles crossing the border post are heading for (and coming from) Hasleep. In the absence of a bypass road to the border post, it is interesting to note that these trucks have to pass through the central business district. Thirdly, huge deposits of diamonds were recently discovered in the Ngoda area of Wasu province resulting in increased mining and related activities. This, coupled with a recovering economy which grew 8% in 2010 and is projected to grow by 9.3% in 2011, is expected to result in increased commercial and related traffic in the City. The traffic is therefore projected to grow by a conservative 6% per annum which is the regional average for central and southern Africa countries.

The City's road transport infrastructure is, however, currently run down and failing to cope with increasing traffic due to years of under investment. For instance, its traffic lights system (over 30 years old) is way past its economic life of fifteen (15) years and is more often than not down. In addition, the system no longer enjoys back up spares support, uses energy consuming incandescent lights, is not centrally controlled and each control unit (at each traffic light controlled intersection) requires reprogramming after every power outage. Only seven intersections have installed traffic lights whilst a traffic study recently concluded by ABC Engineering Consultants indicates that sixteen additional intersections are overdue for traffic lights installation. Historic records of power cuts obtain from Zamzam Power Utility indicate that power outages occur in thirty two (32) percent of the days of the year and average nine (9.2) hours each.

The constant malfunctioning of traffic lights system is costly to the City Council, industry and the motoring public in terms of increased fuel consumption, repairs and maintenance costs and potential revenue lost through traffic flow delays and accidents. Residents of Colourful City have raised their concerns about traffic delays during council's consultative meetings and in writing. Key stakeholders such as the Commuter Omnibus Association and the police have expressed their displeasure with the current state of the city council's traffic management system. The Association operates thirteen (13) urban routes and four (4) peri-urban routes. Major urban routes include City to Saku, City to Chikan (1,2 and 3), City to Flora, City to Mary , City to Fern Valley, City to Danga, and City to FBP whilst peri-urban routes include City to Chigodo, City to Zimu, City to Penha and City to Colourful University. Members of the association were not only experiencing time delays at traffic controlled intersections but also deliberately avoiding roads where traffic lights are malfunctioning, a situation which increases the distance covered by each bus on any given day and congestion on alternative routes. The effect of the route diversion is increased operational costs due to motor vehicle wear and tear. Expert opinion from the Automobile Association indicates that vehicles consistently exposed to traffic delays (moving at idling to stop speed) are subject to increased maintenance costs of approximately twenty (20%) percent. In addition a stationary vehicle at a traffic controlled intersection consumes an average of 100 milliliters of fuel per minute. Senior police officials interviewed confirmed that officers are deployed to man intersections when traffic lights malfunction and increased accidents on intersections where there are no traffic lights and those where traffic lights are not functioning.

The wide gap between current and projected traffic on the one hand and existing inadequate and malfunctioning traffic lights infrastructure on the other gives rise to high economic and social costs associated with time delays at intersections. This project aims to reduce these costs.

2.3 Project Scope

The project entails replacing existing incandescent traffic light signals at seven (7) intersections with solar powered Light Emitting Diode (LED) traffic lights as well as installing additional traffic lights of the same technology at sixteen (16) new intersections over a period of three years. The incandescent traffic lights currently in use, at thirty years, are not only way past their useful life of fifteen years and outdated in terms of technology but also pose a great challenge in terms of maintenance due to lack of replacement parts. As a result, the traffic lights are out of order most of the time, a challenge exacerbated by intermittent power outages. Each time there is a power blackout, the traffic lights have to be manually re-programmed when electricity supply is restored thereby increasing maintenance costs. The project is expected to cost US$1.7 million. This amount will be used for dismantling old structures ($50,000), Civil Works ($47,061), Cabling & Fitting Accessories ($440,500), purchase of new traffic heads ($1,071,338), transportation & installation ($78,813) and contingency ($12, 289). The Project will take three years to complete.

2.4 Project Roll Out Plan

2.4.1 Technology Choice

Colourful City proposes to install solar powered hybrid traffic lights system that utilises LED (Light Emitting Diodes) in place of electric bulbs. The traffic lights use solar power backed by batteries. Electrical power will enhance reliability through continuous supply of power in the event of total loss of solar and battery power. The solar powered hybrid traffic lights components include underground AC cables, concrete cast bases/foundations, signal poles, signal heads, panels and controllers.

Each system operates independently and is controlled by a Programmable Logic Controller (PLC). Remote monitoring is provided via a GPRS link, and various forms of alarms exist, for instance an alarm SMS is sent to designated cell phone number as well as a web application from which the module can be monitored. The expected service life of this technology is twenty five (25) years. Spare parts can be obtained at short notice from vendors in South Africa. The three main advantages of LED's are improved visibility, longer shelf life and lower energy costs.

The City, however, wishes to determine whether it is cost effective to use solar powered traffic lights with battery backup as compared to AC powered with battery backup.

2.4.2 Financing and Procurement

Based on quotations received by the City from interested suppliers, the project will require approximately US$1.7 million. Financing and procurement are however subject to tender and cost variations are therefore expected. After securing finance from the Bank, the City plans to issue a tender for bids from interested suppliers. Council procurements do not go through the State Procurement Board and in this regard, no undue delays are expected. Tenders of a similar nature take up to sixty (60) days. The economic cost benefit analysis model is expected to inform some of the tender specifications to be included in the Request for Proposals (RFP) such as maintenance cost, power usage of the traffic system, back up service, training of city engineers and life of backup battery amongst others. It is also anticipated that the economic cost benefit model will be used to evaluate the tenders.

2.4.3 Installation of Traffic Lights

A total of twenty three (23) programmed LED traffic light signals will be installed by the City's electrical department which will also be responsible for maintaining them. Actual works for the seven intersections with existing traffic lights entail dismantling old structures and replacement of traffic heads and controllers. With respect to the sixteen new intersections, civil works will be undertaken, cables and accessories laid and LED matrix signal heads as well as the controller installed. The project will take three years to complete.

Chapter 3

METHODOLOGY

3.1 Integrated Investment Appraisal

This thesis is based on the investment appraisal methodology developed by Jenkins and Harberger (Jenkins & Harbereger, 2002). The methodology entails the financial, economic, distributive and risk analysis of the traffic lights project in order to not only assess the long term viability and sustainability of economic and social benefits associated with the project but also choose between two competing technologies for procuring the project. The integrated investment appraisal technique simplifies the decision making as it reconciles the financial performance, the economic outcome and the distributive impacts of the project in one analytical framework in a consistent and logical manner. Another distinct advantage of this tool is its ability to accommodate a cost benefit analysis of two competing technologies in the same analytical framework.

The first building block of the integrated analysis, financial analysis, normally seeks to determine the financial viability of the project from the investor and lenders points of view. It projects the annual financial cash flows of the traffic lights project denominated in default domestic (United States Dollars) currency over the life of the project and determines whether the resultant net cash flows discounted at the opportunity cost of capital yield positive financial net present values for the investor and acceptable debt service ratios for the lender(s). In this particular case, it is known that the project does not generate direct revenue inflows for debt service and that lending will be based on the strength of the City's consolidated cash flows and balance sheet. It is also known that such an assessment analysis was done independent of this analysis and established the City's credit worthiness for accessing the required $1.7 million to undertake the project. In this regard, the financial analysis was conducted as a necessary building block to the economic and distributive analysis of the two alternative technologies. This however, does not take anything away from the tool's ability to assess financial viability and the ability to service debt as it basically comes to the same conclusion that in its own right the project is not financially viable from investors and lenders points of view. Investment decision will therefore be guided by net economic and social benefits to be realized by the project, cost effectiveness of technology to be adopted and the ability of the City to service debt from its consolidated cash flows. This thesis focuses on creating a basis for deciding whether or not to undertake the project on the basis of the economic and social benefits to be delivered and determining most cost effective technology to adopt.

The second building block of an Integrated Investment Appraisal, Economic Analysis, aims to optimize the use of the country's scarce resources. It provides a methodological framework for estimating the true economic cost and benefits of the project. The economic resource flow statement is derived from the financial cash flows of the project and the net resource flows are discounted at the Economic Opportunity Cost of Capital (EOCK) to establish project's economic feasibility. The necessary adjustments are made to the financial values in order to arrive at the economic shadow values for the costs and benefits of the project.

The third building block is the Distributive Analysis which considers how externalities are shared among the different stakeholders affected by the project. The economic externalities are computed as the difference between financial and economic values. The net present value of externalities are subsequently computed and allocated amongst project stakeholders to determine who gains or losses from the implementation of the traffic lights project.

In the real world, the actual outcome of the financial, economic, and distributive analysis vary from projected outcomes due to uncertainty involved in the projection of future values of project parameters. This uncertainty creates risks, which may affect the choice of technology and the allocation of externalities to various stakeholders differently. Sensitivity analysis is the first step in risk analysis used to identify critical risk variables whose likely variation impacts on project outcomes. The Integrated Investment Appraisal analytical tool allows for risk analysis to be conducted on identified risk variables to determine the degree of riskiness of the identified variables to the project outcomes. Various computer based software, such as Crystal Ball's Monte Carlo Risk Simulation, can be used in this regard and guide the crafting of risk mitigation measures to reduce and/or eliminate the risks created. In this study however, risks analysis ends with the sensitivity analysis as not much benefit can be derived from full risk analysis given that project outcomes are not highly sensitive to variations in the risk variables. Effective decisions can therefore be made on the basis of the financial, economic, distributive and risk (sensitivity analysis only) analysis of the project.

3.2 Objectives of Financial Analysis

The financial analysis of a project determines whether the project is financially sustainable. It is a cornerstone of any capital investment project (Glenn P Jenkins et al (March 2005), Integrated Investment Appraisal-Concepts and Practices). Glenn P Jenkins et al advanced persuasive arguments for conducting financial analysis on public sector projects such as this one. For instance, he argues that it is important to realize that for certain projects it is essential to estimate their financial profitability. However, to ensure that the project is financially sustainable, it is necessary to analyze the year-by-year cash flows. He further states that conducting a financial appraisal of public-sector projects is directly related to understanding of the distributional impacts of the project. In this regard a financial analysis is a necessary pre-requisite to economic, distributive and risk analysis of a project. Another important consideration is to ensure the availability of funds to finance the project through its investment and operational phases.

The financial analysis of Colourful City traffic lights is mainly used as a building block to the integrated investment appraisal of the project given that the City's (sponsor/investor) investment decision will be based on economic and social benefits of project and the cost effectiveness of technology to be used. In addition to the economic and stakeholder viability, Zamzam Infrastructure Bank's lending decision will also be based on the City's overall financial position and ability to service debt as opposed to project cash flows.

Chapter 4 is devoted to the financial analysis of the proposed traffic lights project.

3.3 Objectives of An Economic Analysis

The main objective of an economic evaluation of the project is to estimate the real economic value of the project's net benefits to the society as a whole, and to assess whether the resources employed in the traffic lights project are used efficiently. The net present value of the net economic benefits will indicate whether the net economic benefits of the project, measured in terms of the base year, are greater than zero, that is, whether the project is a net contribution to Zamzam's welfare.

The central tool in an economic analysis is the project's statement of economic costs and benefits. This statement is generated by converting the financial values of the project's financial cash flow into the economic values by using the commodity specific conversion factors (CSCF). The financial value of any good or service used or produced by the project is multiplied by the corresponding CSCF to obtain its economic value. Commodity Specific Conversion Factors (CSCF) indicate the premium that must be added or the discount that must be subtracted to reflect differences between financial and economic values. These differences arise from market distortions such as subsidies, foreign exchange premium and impact of taxes.

In addition to determining whether the project is worth undertaking from an economic point of view, the analysis also assists in selecting the technology which yields greater economic benefits for the traffic lights project.

Chapter 5 attempts to deal with the various aspects of the economic analysis.

3.4 Objectives of Distributive Analysis

It is important for the sustainability of the project over time to identify the winners and losers and how much they would gain and lose as a result of the project implementation. The purpose of distributive analysis is to see if the groups who were targeted to receive benefits as a result of the project will actually receive them as well as to ensure that no specific group is subjected to an undue burden as a result of a project. The magnitude of any burden can be measured by the NPV of the incremental net cash flows that are expected to be realized by that group. Among the main stakeholders affected by a public project are generally the project's suppliers, consumers, project competitors, labor, and the government. The impact on government is mainly externalities generated through taxes and subsidies.

In the case of the traffic lights project, a distributive analysis is undertaken for the two technology options. The main objective being to identify the externalities created by the project and evaluate the impact of these externalities on the key stake holder's of the project. Chapter 6 discusses the modeling of the externalities flows and the computation of their net present value as well as the reconciliation between the financial and economic analysis.

3.5 Objectives of Sensitivity Analysis

The sensitivity tests are performed on the financial, economic and distributive results in order to asses the degree of vulnerability of the project to various exogenous variables. The tests are used to detect the crucial project's variables, that the project owners or the government may redesign, if needed, in order to improve the performance of the project. The main objective of the sensitivity analysis is to identify the critical project variables and to evaluate the uncertainties associated with these variables. It also helps to understand the sources of the risks created by these uncertainties that affect the financial and economic outcome of the project.

3.6 Objectives of Risk Analysis

After identifying these critical variables, a risk analysis is then carried out. Its main objective is to assess the degree of risk ness of these variables to the project's outcomes and also help in finding the appropriate mitigation measures to reduce the risk exposure.

3.7 Model Overview

The cost benefit analysis model of Colourful City Traffic Lights project was developed using mathematical and logical formulas to manipulate given and estimated technical, financial and economic parameters in order to predict project outcomes. In this regard, Microsoft Excel spreadsheet processor was used and project outcomes in critical decision areas such as economic and stakeholder viability as well as risk predicted. All assumptions on the project are provided in the table of parameters. Subsequent tables in the model contain formulas that refer to assumptions in the table of parameters.

In addition, all the relationships among the tables presented in the model are a set of links expressed in formulas constructed in such a way that any change in the basic parameters is automatically reflected in all consequent formulas and the project's outcomes. Figure 1 provides an overview of the steps taken in the integrated investment appraisal of the traffic lights project, and show the tables used in the model.

Table 1: Project Parameters

Tables I - X

TABLE 2 INFLATION AND PRICE INDICES	TABLE 3 TRAFFIC AND TIME DELAY
TABLE 4 CASH FLOW STATEMENT:	TABLE 5 INVESTMENT COSTS-W/PRJT A
TABLE 6 LOAN SCHEDULE	TABLE 7: C/FLOW STATEMENT: COUNCIL'S
TABLE 8 INVESTMENT COSTS-W/PRJT B	TABLE 9 LOAN SCHEDULE

TABLE 10

CASH FLOW STATEMENT-COUNCIL'S

FINANCIAL ANALYSIS

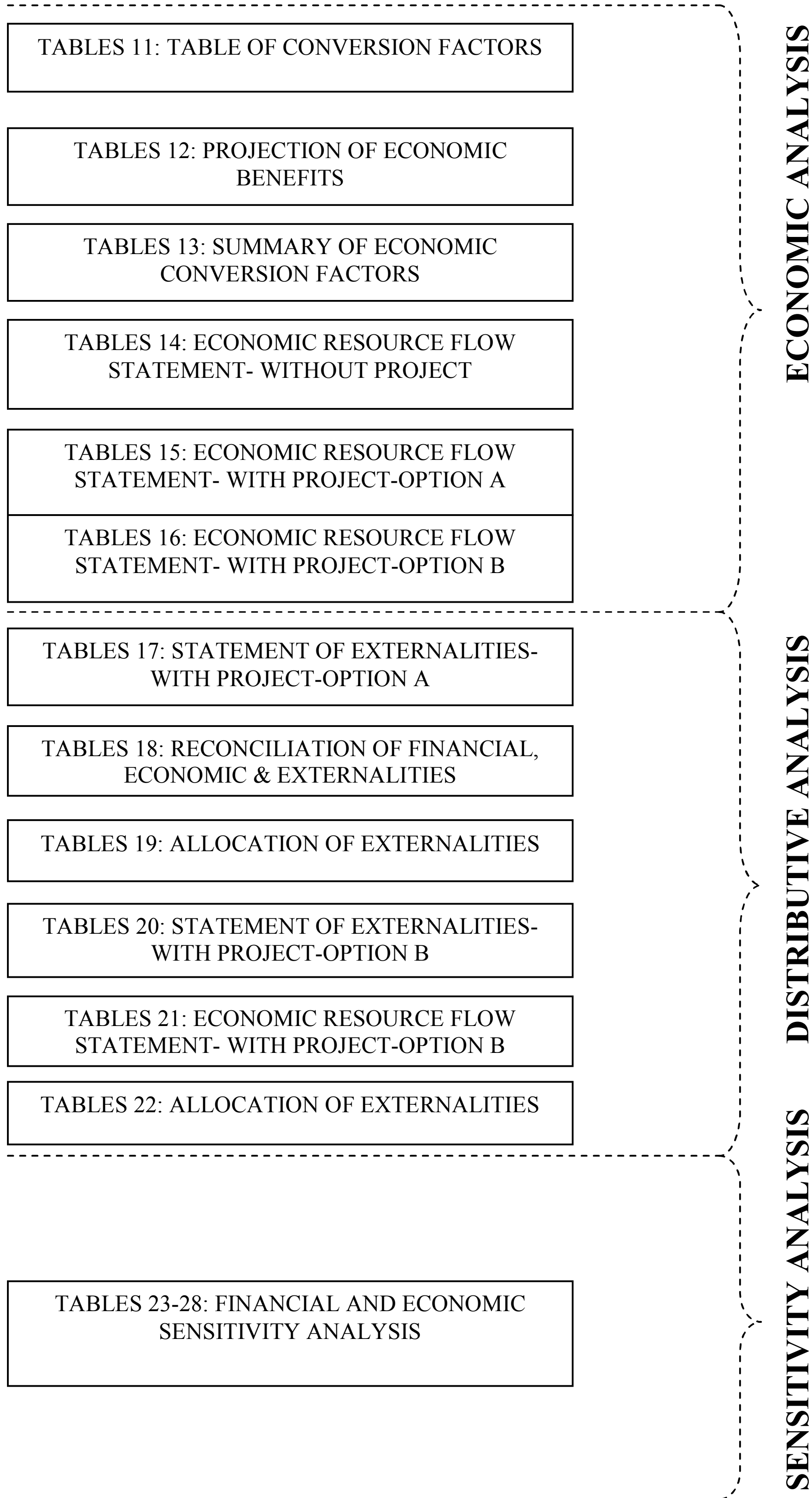

Figure 1: Overview of the Integrated Appraisal Approach.

Chapter 4

FINANCIAL ANALYSIS

4.1 Scope of Financial Analysis

The Integrated Investment Appraisal methodology allows for an interrogation of the project from two alternative viewpoints, that is, total investment or banker's point of view and equity (owner's) point of view.

The total investment perspective excludes any external sources of finance into the cash flows of the project and assesses ability of financial receipts generated from operations to sufficiently cover investments and operations expenditures of the project as well as provide sufficient return. It is also known as the banker's point of view as it enables bankers to ascertain if net cash flows are sufficient to cover the project's interest and loan obligations. However, in this case loan cash flows are excluded from the model as debt service will not be based on the performance of the project, but on strength of Colourful City's balance sheet and consolidated revenues. It is given that Colourful City passed this debt service ability test.

The cash flow statement prepared from the equity or owner's point of view is developed in a similar fashion to the cash flow statement from the total investment point of view. However, they include receipts of the loan as an inflow and all subsequent repayments of the loan and interest as expenditures. This aspect is a distinguishing factor between the cash flow statement from the equity point of view and total investment point of view.

The evaluation criteria for assessing the project's net worth to the owners is the Net Present Value (NPV) and Internal Rate of Return (IRR).The computation of NPV and IRR are based on the annual net cash flows after financing from the real cash flow statement from equity point of view. The relevant discount rate is required rate of return on equity, in real terms. In this analysis, it was considered more convenient to present the cash flows from the City Council's (owner) point of view. However, since debt cash flows are not a factor in this project, there is practically no difference between the cash flows prepared from both total (banker's) investment and equity holder's (owner's) points of view.

The financial analysis considered three scenario viz. "Without Project" scenario, "With Project- Option A" (Solar Powered traffic lights with battery backup) scenario and "With Project-Option B" (AC Powered traffic lights with Uninterrupted Power Supply (UPS) battery backup) scenario". An important element in the investment appraisal is to examine the incremental impact of the project; that is, the net financial receipts or net financial cash flows (or net economic benefits) with the project in excess of the net financial receipts or net financial cash flows (or net economic benefits) without the project (Glenn P Jenkins et al (March 2005), Integrated Investment Appraisal-Concepts and Practices). Glenn P Jenkins et al argue that it should be noted that the "without project" situation does not mean that nothing is done to the current situation if the project is not undertaken. It simply implies that the situation goes on as usual into the future, but no major capital expenditures are made in the activity. In this context, one should conceptualize two states of nature: one with the project and the other without the project. The former identifies the revenues and expenditures associated with the case in which the project is undertaken, while the latter refers to the on-going revenues and expenditures that would prevail even if the project was not undertaken. In comparison, a project usually involves incremental net expenditures in the construction phase followed by incremental net receipts in the operating phase. An incremental net cash flow (or net economic resource flow) refers to the net cash flow (or net economic benefits) that occur with a project less the net cash flow (or net economic benefits) that would have occurred in the absence of the project. Setting the problem up in this way, we can identify the additional net cash flow that is expected to arise as a result of a project and the corresponding change in economic well-being that is attributed to it.

The equity holder's point of view evaluates the project as it is perceived by Colourful City, the project owners, and helps to determine whether the net cash flows of the project make them better or worse off. Consequently, the City benefits from the residual or net cash flows after paying off all other parties. It is important to note that it is known from the onset that cash flow outcomes will be negative because of the absence of direct cash inflows associated with the project. This analysis was therefore done for the purposes of facilitating economic and distributive analysis to follow in chapters 5 and 6 which will form the basis of deciding whether or not to proceed with the project.

The following sections provide a detailed explanations of the model assumptions and parameters under which the base case financial model for the proposed traffic lights project was developed. It should be noted that all prices factored in the model are in real prices. This is mainly because the impact of inflation on loan interest and principal payments, tax depreciation, accounts receivables and payables and working capital is considered immaterial for this analysis. This is because debt is excluded from cash flows, the City is exempt from corporate tax and accounts receivable and payable as well as working capital are tied to City's consolidated cash flows.

4.2 Model Assumptions and Parameters

4.2.1 Project Timing

The traffic lights project has a life span of 10 years. The project commences in 2010, is launched and starts operations in 2011 and winds up in year 2021. It is expected that after year 2021 the system will be replaced by better technology available at that time. The physical construction of the project will be phased over 3 years with 10 intersections being completed in years 2011 and 2012 and remaining 3 intersections being done in 2013. After year 2021, the project's assets are assumed to be liquidated.

4.2.2 Investment Costs

Two possible total investment outlays are considered for alternative technologies proposed for the project and are both given in real terms (2010 prices). The outlays comprise 5 categories to be expended in US dollars, the default currency for Zamzam. The investment outlays and categories for "With Project" scenarios are shown in table 2 below.

1.3.1 Dismantling Old Structures

The city plans to replace malfunctioning traffic lights on 7 existing traffic lights controlled intersections with new ones. An estimated $50 000 is required to dismantle existing old structures in 2011 for both technology options.

4.2.2.2 Civil Works

The total cost of all civil works, irrespective of the technology used, is $44 800 incurred over the three year construction period. Of this amount, $8 400 will be used in 2011 and $28 000 and $8 400 in years 2012 and 2013 respectively.

4.2.2.3 Cabling & Fitting Accessories

Cabling and fitting of accessories will cost an estimated $410 000 for both options broken down as $10 000 in 2011 and $200 000 each in years 2012 and 2013.

4.2.2.4 New Traffic Heads

The total capital cost for traffic heads inclusive of backup batteries is $1 035 000 and $ 262 844 for Solar powered and AC powered traffic lights procurement options respectively. The investment cost will be spread over the three years as follows: 43% each in years 2011 and 2012 and the remaining 14% in 2013. This distribution reflects the installation of new traffic lights at 10 intersections each in years 2011 and 2012 and the balance of 3 in 2013.

4.2.2.5 Transport and Installation

Transport and installation costs of $75 000 will be evenly spread at $25 000 a year over the three years of investment for both options.

Table 2: Investment Costs (USD, Year 2010 Prices)
OPTION A: SOLAR POWERED WITH 12 HOUR BATTERY BACK UP
INVESTMENT COSTS (USD , Real 2010 Prices)

Year	2011	2012	2013	Total
Dismantling old structures	50,000			**50,000**
Civil Works	8,400	28,000	8,400	**44,800**
Cabling & fitting accessories	10,000	200,000	200,000	**410,000**
New Traffic Heads	450,000	450,000	135,000	**1,035,000**
Transport & Installation	25,000	25,000	25,000	**75,000**
Cost overrun factor	-			
Intersections fully developed	10	10	3	

OPTION B: AC POWERED WITH 12 HOUR UPS BACK UP
INVESTMENT COSTS (USD, Real Prices)

Year	2011	2012	2013	Total
Dismantling old structures	50,000			**50,000**
Civil Works	8,400	28,000	8,400	**44,800**
Cabling & fitting accessories	10,000	200,000	200,000	**410,000**
NewTraffic Heads	114,280	114,280	34,284	**262,844**
Transport & Installation	25,000	25,000	25,000	**75,000**
Cost overrun factor	-			

4.2.3 Operating Costs

Operational costs for the project are given in real terms for the “Without Project” and “With Project” scenarios and summarised in tables 3 and 4 below. The table of parameters outlines fixed and variable costs assumptions for the project.

4.2.3.1 Without Project

With respect to fixed operating costs, annual labour costs are estimated at $52 860 while operations and maintenance costs (O&M) average $2 484 per annum. Annual general and administration costs are given as 5% of labour and operations and maintenance costs. No long term service agreements and other obligations are envisaged. Annual variable costs comprise fuel costs ($1 080) and electricity consumed by each traffic light controlled intersection ($768 per year). These operational costs were based on historic records of the City. According to the City's records, motor vehicle fuel costs for trucks used to transport technicians to traffic light controlled intersections for repair & maintenance work and electricity consumed by each traffic light make up annual variable costs. It is important to point out that whilst the annual operations and maintenance costs and fuel costs appear too low for this type of project, they reflect neglect and the general shortage of spare parts characteristic of the years of economic hardships.

Table 3: Operating Costs (USD, Year 2010 Prices)

OPERATING COSTS
Without Project
Fixed Costs

Labor		52,860	US$/Year	
General & Admin (excluding VAT)		5%	of Labour + O&M Costs	
O&M		2,484	US$/Year	
Long Term Service Agreement & Others		-	US$/Year	
Variable Costs				
Fuel Requirement Cost		1,080	US$/Year	
Electricity consumed per intersection		768	US$/Year	
LTSA and Other Variable Costs		-		

4.2.3.2 With Project

Two options are presented for the “With Project” scenario, namely, Solar powered and AC powered options. The solar power option defaults to stored battery power in the event of prolonged cloud cover and other obstacles and to AC power where battery power is completely lost. The AC power option on the other hand defaults to Uninterrupted Power Supply battery backup in the event of power loss. Fixed costs for the “With Project” scenarios are similar to the “Without Project” scenario serve for operations and maintenance costs which are estimated at 5% of investment costs. In addition, the solar powered option carries a unique assumption that annual operations and maintenance costs reduce annually by 1% from year 2014. This is as a result of reduced costs of spare parts and components due to massive research currently being invested in this technology option. Variable costs are the same at $1 200 per year for fuel and $154 in electricity consumed per year per intersection for both “With Project” options. The 80% reduction in electricity consumption per year per intersection when compared to “Without Project” scenario is due to the replacement of incandescent lights with power saving Light Emitting Diode (LED) lighting system.

It should be noted that whilst the “With Project” scenarios cover 23 intersections against the current 7 intersections for the “Without Project” scenario annual fuel requirement marginally go up from $1 080 (without project) to $1 200. This represents fuel consumed by vehicles used by technicians for routine and adhoc maintenance work at traffic controlled intersections. With the without project scenario each traffic controlled intersection has to be reprogrammed after every power outage. Fuel is consumed in visiting each site. With the project, savings will be realised in this regard. This is explained by the fact that the new technologies and new equipment will result in less maintenance induced fuel requirement for the "With Project" scenarios. Although electricity consumed per intersection assumption of $154 per year applies to both options of "With Project" scenario, this cost will only be partially incurred for the solar power option in rare occasions where solar power is out due to prolonged cloud cover of more than 12 hours and no AC power back up is available due to power outages. There is electricity cost savings associated with the solar option. The savings arise when solar power is used instead of electrical power. In the rare event that solar power is off due to prolonged cloud cover, electrical power back up is used. In this event, the project will consume electricity at the same rate of $154 per annum. No long term service and other obligations are expected for the "With Project" scenarios.

Table 4: Operating Costs (Usd, Year 2010 Prices)

With Project-OPTION A

Fixed Costs

Labor			
General & Admin (excluding VAT)		52,860	US$/Year
O&M		5%	of Labour + O&M Costs
Annual reduction in O&M costs(from year 3)		5%	of Investment Costs
Long Term Service Agreement & Others		1%	of O&M costs
Variable Costs		-	US$/Year
Fuel Requirement Cost			
Electricity consumed per intersection		1,200	US$/Year
LTSA and Other Variable Costs		154	US$/Year
		-	

With Project-OPTION B

Fixed Costs

Labor			
General & Admin (excluding VAT)		52,860	US$/Year
O&M		5%	of Labour + O&M Costs
Long Term Service Agreement & Others		5%	of investment costs
Variable Costs		-	US$/Year
Fuel Requirement Cost			
Electricity consumed per intersection		1,200	US$/Year
LTSA and Other Variable Costs		154	US$/Year
		-	

4.2.4 Tax and Economic Depreciation, Inflation and Discount Rates

4.2.4.1 Tax and Economic Depreciation

The useful economic life for cables and fittings and traffic heads is estimated at 25 years for both “With Project” options.

4.2.4.2 Inflation and Discount Rates

Annual inflation rate is estimated at 4.5% whilst the required rate of return on equity is given as 15%. It is important however to note that the model was constructed using real figures. The inflation rate was therefore used to determine investment costs in nominal terms and subsequently the loan requirement and resultant loan schedule in nominal terms for illustration purposes only. The loan schedule was therefore not wired in the model.

4.2.5 Project Financing, Residual Values and Conversion

4.2.5.1 Project Financing

Although project financing and the analysis thereof was dealt with separately from this economic cost benefit analysis, the high level financing arrangement is given for information purposes. The main objective of the information is to complete the picture and put the model in context.

A composite loan facility will be established with Zamzam Infrastructure Bank under both "With Project" scenarios for drawdown through annual sub loan facilities over implementation period of three years. The sub loans will have tenures of 2 years with 1 year grace period on capital only and attract interest of 18% per annum. The composite loan facility will be $1 680 337 and $883 805 for solar and AC power options respectively. The sub loan facilities will be 43% of composite loan in years 2011 and 2012 and 14% of composite loan for 2013 for both scenarios.

4.2.5.2 Residual Values

Residual values for solar power option are computed as $270 000 and $649 800 for cables and fittings and traffic heads respectively. Cables and fittings and traffic head residual values of $270 000 and $165 020 respectively apply to AC power option.

4.2.5.3 Conversion

The conversion assumption is used to convert figures and values into thousands or millions as applicable.

4.2.6 Technical Data and Parameters

4.2.6.1 Power Cuts for 2010

Zamzam's power utility company provided electricity outage (power cuts) statistics for the year 2010 for Colourful City (See table 5 below). These indicate that power was out for 118 of the 365 days of the year. Of the 118 days, 47 experienced power outages of more than the backup battery life of 12 hours. On days experiencing power outages of more than 12 hours, the average duration of the power outage was 15.4 hours. This therefore means that, in the event of continuous cloud cover causing default to backup batteries, on average 3.4 hours would elapse after batteries have run out and awaiting recharging by AC power. These historic statistics were used as assumptions to predict future outages and their impact on both the "With" and "Without" project scenarios in the model. Other power outage statistics given for information purposes but not used in the model are minimum and maximum daily outages of 0.1 hours and 18.7 hours respectively. The likelihood or probably of power outage in general and one which lasts for more than 12 hours is calculated as 32% and 13% respectively.

Table 5: Power Cuts For 2010: (Source: Power Utility)

DAYS IN YEAR						**TTL IN YR**
				AV	**AV.12 Hrs +**	
Total	**Powercut**	**6-12h +**	**12 hours +**	**Hours**	**Hours**	**Hours**
365	118		47	9.2	15.4	1140.6
Backup Battery Life	12	hrs				
Average down time > 12 hours	3.4	hrs				
Probability Powercut	32%					
Probability Powercut > 12 hours	13%					

4.2.6.2 Cloud Cover for Colourful City

The meteorology department provided cloud cover statistics for Colourful City for the years 2009 and 2010 (table 6). Taking averages for the two years the annual average distribution of bright sunshine, partly cloudy and cloudy days were estimated at 42%, 28% and 31% respectively. The cloud cover statistic of 31% was used as an assumption to predict future occurrences of cloud cover and their impact on solar power option n the model. It is assumed that 60% of cloudy days experience continuous cloud cover of more than 12 hours. Based on the above, the probability of continuous cloud cover of more than 12 hours is 19% (60% x 31%). Multiplying probability of cloud cover of more than 12 hours and probability of power outage of more than 12 hours gives probability of experiencing the two outcomes at the same time. This is estimated at 2%.

Table 6: Cloud Cover (% Days In Year-Source: Met Dept)

YEAR	2009	2010	AVERAGE
Bright Sunshine	43%	40%	42%
Partly Cloudy	27%	28%	28%
Cloudy	30%	32%	31%
Continuous cloud cover > 12 hours % of cloudy days			60%
Probability continuous cloud cover > 12 hours			19%
Probability continuous cloud cover > 12 hours + Probability Powercut > 12 hours			2%

4.2.7 Inflation and Price Index

The inflation rate is assumed to be constant at 4.5% per annum giving rise to price index which grows annually from 1 in 2011 to peak at 1.55 in 2021.

4.3 Results of Financial Analysis

4.3.1 Without Project Scenario

4.3.1.1 Equity Holder's (Owner's) Point of View

The without project scenario assumes that no investment is made in new technology and that the current outdated and malfunctioning system remains in place. Table 7 presents a real cash flow statement from council or owner's point of view.

The project does not generate cash inflows throughout the life of the project. Cash outflows comprise investment and operating costs. Since there is no investment in new technology, no investment costs arise. Fixed operating costs remain constant at a total of $58 111 per annum throughout the life of the project. With respect to variable operating costs, fuel costs and electricity consumed remain constant at $1 080 and $5 376 per annum respectively. Each time there is power outage, the City incurs additional maintenance costs due to the need to physically visit each of the traffic lights controlled intersection to reprogramme control panels when electricity is restored. The additional maintenance costs arising from the outages, such as fuel & transport costs and overtime wages, are computed as proportion of average days in year when outages are experienced (118) to total days in year (365) multiplied by normal operations and maintenance costs for that year. These are however relatively small and average $803 per annum for the life of the project.

Due to the absence of cash inflows, net cash flows for the project are negative and average $65 370 annually. Consequently, the project has a negative Net Present Value (NPV) of $393 448 using discount rate of 15%.

Table 7. Cash flow Statement: Council's Perspective, ($ Thousand Real)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
CASH INFLOWS											
Direct Inflows	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CASH OUTFLOWS											
Investment Costs											
Dismantling old structures	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cabling & fitting accessories	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New Traffic Heads	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport & Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Investment Costs	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Operating Costs											
Fixed Operating Costs											
Labor	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9
General & Admin (excluding VAT)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
O&M	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Long Term Service Agreement & Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Fixed Operating Costs	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**	**58.1**
Variable Costs											
Fuel Requirement Cost	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

Electricity Consumed	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Additional O&M costs Due To Power cuts	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
LTSA and Other Variable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Variable Costs	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**	**7.3**
Total Outflow	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**	**65.4**
NET CASHFLOW	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**	**-65.4**

FNPV @	**15%**	**-393.4**	**US$**	**FIRR**	**#NUM!**

4.3.2 With Project Scenario

4.3.2.1 Option A- Solar Powered with 12 hour Backup Battery

4.3.2.1.1 Investment Costs and Loan Schedule

The investment costs and loan schedules in tables 8 and 9 below are given in nominal terms and basically serve to illustrate the project's loan obligation and how it is structured. The tables are however not wired in the cost benefit analysis model. The project requires a total of $1 680 337 in nominal investment costs to be financed through a composite loan facility of the same amount from Zamzam Infrastructure Bank. The facility will be disbursed through sub loans of $722 545, $722 545 and $235 247 in the first three years. Each sub loan will be payable over 2 years with 1 year grace period on principle only and at an interest rate of 18% per annum. Total interest of $303 889 will be charged to the project over a period of three years.

Table 8: Investment Costs (Thousand, Nominal)

Year	**2011**	**2012**	**2013**	**Total**
Dismantling old structures	50	-	-	**50**
Civil Works	8	29	9	**47**
Cabling & fitting accessories	10	209	218	**437**
NewTraffic Heads	450	470	147	**1,068**
Transport & Installation	25	26	27	**78**

Table 9: Loan Schedule

Year	**2011**	**2012**	**2013**	**2014**
Nominal Interest Rate	18%	18%	18%	18%
Outstanding at the Beginning	-	723	723	235
Loan Disbursement (Nominal)	723	723	235	-
Interest Accrued	-	131	131	43
Repayment	-	853	853	278
Interest	-	131	131	43
Principal	-	723	723	235
Outstanding at the End (Nominal)	723	723	235	-
Loan Disbursement (Nominal)	723	723	235	-
Annual Loan Repayment (Nominal)	-	853	853	278
Annual Interest Payment (Nominal)	-	131	131	43
Annual Interest Payment (Real)	**-**	**125**	**120**	**37**

4.3.2.1.2 Equity Holder's (Owner's) Point of View

Table 10 presents a real cash flow statement from council or owner's point of view. As is with the "Without Project" scenario, there are no direct cash inflows associated with the project. However, due to the investment in cables and fittings as well as traffic lights, residual values of $270 000 and $650 000 are registered as inflows for the two respectively in year 2021. This is because although cables and fittings and traffic heads have economic lives of 25 years, the project has 10 year duration. Total inflows of $920 000 associated with residual values are therefore only realised in year 2021.

With regards to cash outflows, total investment cost outlays of $543 000, $703 000, $368 000 are made in years 2011, 2012 and 2013 respectively. Fixed operating costs are on average 50% higher than the "Without Project" scenario mainly as a result of higher operations and maintenance costs tied to new investment cost. The fixed operation costs grow from $92 363 in 2011 to peak at $140 280 in 2013 before declining steady thereafter to reach $133 731 in 2021. The annual decline in fixed operating cost from year 2013 is associated with decreases in operation and maintenance costs due to technological improvements. Variable operating costs on the other hand are significantly lower than the "Without Project" scenario due to very low electricity consumption levels and the absence of additional operation and maintenance costs associated with power cuts. These reduce from an annual average of $7 259 for the "Without Project" scenario to about $1 282 for the "With Project"-Solar powered option. It is important to note that electricity is only used in the event that the solar back up batteries are completely flat and not charging due to continuous cloud cover of more than 12 hours. The probability of this happening in any given year is calculated as 19% in the table of parameters. Negative net cash flows for the solar powered option are on average more than ten times those of the without project scenario in the first three years due to new investment in traffic lights system. Negative net cash flows average $660 000 in the first three years and $138 000 thereafter to year 2020 and close in year 2021 with positive net cash flow of $785 000 from residual values. The project realises negative financial net present value of $1 990 000 using discount rate of 15%. This is considerably lower than the "Without Project" scenario because of the impact of investment outlays.

Table 10. Cash flow statement: council's perspective, ($thousand, real)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CASH INFLOWS											
Direct Inflows	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Residual Values											
Cables and Fittings											270.0
Traffic Heads											649.8
Total Inflows	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**919.8**
CASH OUTFLOWS											
Investment Costs											
Dismantling old structures	50.0	0.0	0.0								
Civil Works	8.4	28.0	8.4								
Cabling & fitting accessories	10.0	200.0	200.0								
NewTraffic Heads	450.0	450.0	135.0								
Transport & Installation	25.0	25.0	25.0								
Total Investment Costs	**543.4**	**703.0**	**368.4**								
Operating Costs											
Fixed Operating Costs											
Labor	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9
General & Admin (excluding	4.4	6.2	6.7	6.6	6.6	6.6	6.5	6.5	6.4	6.4	6.4

VAT)											
O&M	35.1	70.2	80.7	79.9	79.1	78.3	77.6	76.8	76.0	75.3	74.5
Long Term Service Agreement & Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Fixed Operating Costs	**92.4**	**129.2**	**140.3**	**139.4**	**138.6**	**137.8**	**136.9**	**136.1**	**135.3**	**134.5**	**133.7**
Variable Costs											
Fuel Requirement Cost	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Electricity Consumed	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Additional O&M costs Due To Power cuts	-	-	-	-	-	-	-	-	-	-	-
LTSA and Other Variable Costs	-	-	-	-	-	-	-	-	-	-	-
Total Variable Costs	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**
Total Outflow	**637.0**	**833.5**	**510.0**	**140.7**	**139.9**	**139.0**	**138.2**	**137.4**	**136.6**	**135.8**	**135.0**
NET CASHFLOW	**(637.0)**	**(833.5)**	**(510.0)**	**(140.7)**	**(139.9)**	**(139.0)**	**(138.2)**	**(137.4)**	**(136.6)**	**(135.8)**	**784.8**

FNPV @	**15%**	**-1,990**	**US$**	**FIRR**	**#NUM!**

4.3.2.2 Option B- AC Powered with 12 hour Backup Battery

4.3.2.2.1 Investment Costs and Loan Schedule

Tables 11 and 12 show investment costs and loan schedule of project in nominal terms. They indicate a lower financing requirement of $883 805 to be structured in the same manner and on the same terms as the solar power option outlined above. The facility will be disbursed through sub loans of $380 086, $380 036 and $123 733 in the first three years respectively and attract interest charges of $159 836 over a period of three years.

Table 11: Investment Costs (Usd , Real 2011 Prices)

Year	**2011**	**2012**	**2013**	**Total**
Dismantling old structures	50	-	-	**50**
Civil Works	8	29	9	**47**
Cabling & fitting accessories	10	209	218	**437**
New Traffic Heads	114	119	37	**271**
Transport & Installation	25	26	27	**78**

Table 12: Loan Schedule

Year	2011	2012	2013	2014
Nominal Interest Rate	18%	18%	18%	18%
Outstanding at the Beginning	-	380	380	124
Loan Disbursement (Nominal)	380	380	124	-
Interest Accrued	-	69	69	22
Repayment	-	449	449	146
Interest	-	69	69	22
Principal	-	380	380	124
Outstanding at the End (Nominal)	380	380	124	-
Loan Disbursement (Nominal)	380	380	124	-
Annual Loan Repayment (Nominal)	-	449	449	146
Annual Interest Payment (Nominal)	-	69	69	22
Annual Interest Payment (Real)	**-**	**66**	**63**	**20**

4.3.2.2.2 Equity Holder's (Owner's) Point of View

Table 13 presents a real cash flow statement from council or owner's point of view. Total cash inflows of $435 020 arising from residual values of investment assets are recorded in year 2021.

Cash outflows comprise investment and operating costs. At less than half of those of solar power option, total investment cost outlays are considerably lower. These add up to $843 000 and are spread over the first three years. Fixed operating costs are correspondingly lower due to savings in investment costs associated with this option.

The fixed operating costs average $97 000 annually as compared to $132 208 for the solar option. Variable costs on the other hand are higher for the AC powered option and average $4 000 as compared to $1 277 for the solar powered alternative. The higher variable costs are mainly driven by electricity consumed by the AC powered traffic lights. It is important to note that these variable costs are reduced by the impact of load shedding and other power cuts. Negative net cash flows for AC powered option are lower than those of solar option and average $138 000 annually. This option has a higher net present value of -$1 216 000 (discounted at 15%) as compared to the solar option

Table 13. Cash Flow Statement: Council's Perspective, ($ Thousand, Real)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CASH INFLOWS											
Direct Inflows	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Residual Values											
Cables and Fittings	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	270
Traffic Heads	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	165
Total Inflows	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**435**
CASH OUTFLOWS											
Investment Costs											
Dismantling old structures	50	-	-								
Civil Works	8	28	8								
Cabling & fitting accessories	10	200	200								
New Traffic Heads	114	114	34								
Transport & Installation	25	25	25								
Total Investment Costs	**208**	**367**	**268**								

Operating Costs											
Fixed Operating Costs											
Labor	53	53	53	53	53	53	53	53	53	53	53
General & Admin (excluding VAT)	4	4	5	5	5	5	5	5	5	5	5
O&M	18	37	42	42	42	42	42	42	42	42	42
Long Term Service Agreement & Others	-	-	-	-	-	-	-	-	-	-	-
Total Fixed Operating Costs	**75**	**94**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Variable Costs											
Fuel Requirement Cost	1	1	1	1	1	1	1	1	1	1	1
Electricity Consumed	1	3	3	3	3	3	3	3	3	3	3
Additional O&M costs Due To Power cuts	-	-	-	-	-	-	-	-	-	-	-
LTSA and Other Variable Costs	-	-	-	-	-	-	-	-	-	-	-
Total Variable Costs	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**

Total Outflow	**285**	**465**	**372**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
NET CASHFLOW	**(285)**	**(465)**	**(372)**	**(104)**	**(104)**	**(104)**	**(104)**	**(104)**	**(104)**	**(104)**	**331**

FNPV @ 15% -1,216	**US$**	**FIRR #REF!**

4.3.3 Conclusion

Purely from a financial point of view, it would not make sense for the City to embark on the traffic lights project. This is because the City's financial wealth is only eroded by $393 000 if the project is not undertaken as compared to an erosion of $1 990 000 and $1 216 000 for the Solar Power and AC power "With Project" options respectively. It is also clear that if the project is pursued, the AC power option is preferred as it has a higher albeit negative NPV than the solar option.

Colourful City has a statutory mandate to provide efficient transport infrastructure to all roads users accessing the City. In this regard, the City places more emphasis on the economic and social impacts of the project rather than its financial viability. Decision on whether or not to embark on the project will therefore be based these socio-economic impacts of the project. This financial analysis is therefore done more as a building block to the economic and distributive analysis of the project rather than it being an end in its own right.

Chapter 5

ECONOMIC ANALYSIS

5.1 Scope of Economic Analysis

The financial analysis of a project measures the benefits and costs through the actual cash transactions of the project while the economic analysis measures the benefits and costs by the value of the economic benefits arising from the outputs produced by the project and the economic costs of the inputs used by the project. The economic evaluation of the proposed traffic lights project involves the estimation of economic value of the project's net economic benefits to the society and the economy of Zamzam.

The central tool of economic analysis is the project's statement of economic costs and benefits called the real economic resource flow statement. This statement is generated from the financial values of the project's real financial cash flow statement from the total investment point of view using the economic conversion factors. The financial revenues or inflows become economic benefits while financial expenditures or outflows become economic costs after adjustment for various externalities. The difference between the economic benefits and costs is the project's net economic benefits. The stream of these net economic benefits is then discounted by the economic opportunity costs of capital (EOCK) to estimate the net present value of the project to the country's economy as a whole. The economic IRR is also calculated from the project's net economic benefits. The economic NPV and IRR serve as an indicator of economic feasibility of the project. The difference between the financial and economic NPV presents the project's externalities that measure the economic impact created by the project.

The following section provide assumptions driving the economic and distributive analysis of the project and the steps involved in the estimation of the economic conversion factors used in generating a real economic resource flow. The assumptions cover taxes and import duty, national parameter, economic data and parameters and estimation of economic conversion factors.

5.2 Taxes and Import Duty, National Parameters and Economic Data and Parameters

5.2.1 Taxes and Import Duty

Local authorities, defined to include City and Town Councils as well as Rural District Councils, are exempt from income tax and import duty on capital and other goods. In this regard Colourful City enjoys 0% corporate income tax and 0% import duty on capital goods. The City is however liable to pay import duty on fuel at the rate of 20% and Value Added Tax (VAT) of 15%. The effective tax rate is estimated at 8%.

5.2.2 National Parameters

5.2.2.1 Economic Opportunity Cost of Capital (EOCK)

EOCK is the minimum economic rate of return that Colourful City traffic lights project must earn if it is to contribute to the growth of the economy of Zamzam. It is estimated as 15% real for the purpose of this analysis.

5.2.2.2 Foreign Exchange Premium (FEP)

The foreign exchange premium (FEP) is assumed to be 0%. Zamzam is currently using the United States dollar as its default currency hence the estimation of FEP at 0%.

5.2.2.3 Shadow Price for Non-Tradable Outlays (SPNTO)

The shadow price of non tradable outlays is estimated at 1%.

5.2.3 Economic Data and Parameters

5.2.3.1 Economic Opportunity Cost of Labour

The table 14 below summarises details of skilled and unskilled labour's social security, tax and income tax forgone elsewhere in the economy because a share of labour (Hd) will be sourced from alternative jobs where taxes where being paid on wages .

Table 14: Economic Opportunity Cost of Labour

Economic Opportunity Cost of Labor			
	Social Security	Personal tax	(Hd)
Skilled	18%	35%	90%
Unskilled	10%	25%	50%

5.2.3.2 Non Tradable Data

Demand and supply elasticity data on non-tradable infrastructure and civil works, cement and other non-metalic products, business and other services and other non-traded items are estimated in table 15 below. The demand and supply elasticity data from BLEG electricity supply generation project were used as proxies for this data.

Table 15: Non Tradable Data

NON-TRADABLE DATA		Demand Elasticity (η)		Supply Elasticity (ε)
Non-tradable infrastructure and civil works		-0.5		2.5
Cement and other-non-metallic products		-1.5		3
Business and other services		-1		2
Other non-traded items		-1		2.5

5.2.3.3 Transport and Handling Assumptions

Transport and handling fees are estimated at 2% of cost insurance freight plus import duty. Conversion factors were derived from the BLEG case and shown in table 16 below.

Table 16: Transport and Handling Assumptions

Transport and Handling Assumptions	% of CIF+ID	CF
Cost of transport, port-project	2%	0.935
Port handling	2%	0.924

5.2.3.4 Motor Vehicle Fuel and Maintenance Cost Data

Expert opinion obtained from the Automobile Association of Zamzam (Table 17) indicates that a vehicle constantly exposed to stop to idling speed conditions in heavy traffic or due to malfunctioning traffic lights consumes 100 millilitres of fuel per minute. This translates to 1.7 millilitres per second. Average diesel and petrol fuel costs of $1.4 per litre were used to estimate average fuel costs of $0.001 per millilitre. The two assumptions, that is, fuel consumption at traffic controlled intersection of 1.7 millilitres per second and fuel costs per second are used in this chapter to estimate additional fuel costs incurred due to delays at traffic controlled intersections.

Expert opinion also advised that vehicle maintenance costs increase by 20% when a vehicle is constantly exposed to slow to idling speed conditions due to heavy traffic and/or malfunctioning traffic lights. Using vehicle service statistics from Amalgamated Motor Corporation, average annual service costs of $0.0000412 per second were estimated. The annual service cost assumption as well as the additional maintenance cost factors are used to estimate additional vehicle maintenance costs imposed by malfunctioning traffic lights in this chapter, economic analysis, of this study.

Table 17: Motor Vehicle Fuel & Maintenance Cost Data (Source: Aaz)		
Stop-Idling Speed Fuel Consumption	100	ML/ Minute
Stop-Idling Speed Fuel Consumption	1.7	ML/ Second
Petrol Price	1.4	US$/litre
Diesel Price	1.3	US$/litre
Average Fuel Cost	1.4	US$/litre
Average Fuel Cost	0.001	US$/ML
Stop-Idling Speed Maintenance Cost Factor	20%	
SOURCE: AMALGAMATED MOTOR CORPORATION (AMC)		
Av. Annual Minor Service Costs (A Service)	500	USD/ vhcle
Av. Annual Intermediate Service Costs (B Service)	350	USD/ vhcle
Av. Annual Major Service Costs (C Service)	450	USD/ vehicle
Av. Annual Service Costs	1,300	USD/ vehicle
Av. Service Costs per second	0.0000412	$/ second

5.2.3.5 Motor Vehicle Type and Passenger Data

Light and heavy vehicles are expected to pass through traffic light controlled intersections in Colourful city. Of the light vehicles, 70% are estimated to be private vehicles with an average occupancy of 4 passengers whilst 30% are assumed to be commuter taxis with an average of 15 occupants (See Table 18 below). Heavy vehicles were assessed to comprise of 70% buses carrying an average of 50 passengers whilst heavy trucks make up the remaining 30% and carry an average of 2 people.

Table 18: Motor Vehicle Type And Passenger Data

Light Vehicles	Proportion	Av. Occupancy
Private vehicles	70%	4
Commuter taxis	30%	15
Heavy Vehicles		
Buses	70%	50
Heavy Trucks	30%	2

5.2.3.6 Motor Vehicle Repair Costs

All motor vehicle repair costs assumed are associated with traffic accidents at traffic lights controlled intersections (See Table 19 below). These were based on professional estimates from motor vehicle repair garages servicing mostly motor vehicle insurance companies' business. Low, medium and high impact accident repair costs were assumed at \$120, \$500 and \$100 per vehicle. It is also assumed that 70% of the accidents involve another vehicle in which case additional repair costs would be incurred. Low impact accidents were defined as those where no injuries or deaths are experienced whist medium impact and high impact accidents involve injuries and deaths respectively.

Table 19: Motor Vehicle Repair Costs

Low Impact Accident	120	US$/vehicle
Medium Impact	500	US$/vehicle
High Impact	1,000	US$/vehicle
% Impact with another vehicle	70%	

5.2.3.7 Medical Costs

Medical costs associated with accidents at traffic controlled intersections and where injuries and/or deaths are experienced are estimated at $45 in outpatients consultation and medical expenses; $25 in ambulance costs and $210 in mortuary and related costs. Medical costs are shown in table 20 below.

Table 20: Medical Costs

Outpatients consultation & med.	45	US$/per person
Ambulance Costs	25	US$/vehicle
Mortuary & related costs	210	US$/corpse

5.2.3.8 Statistical Value of Life

When conducting a cost benefit analysis of new public policy, estimates of how much people are willing to pay for small reductions in their risks of dying from adverse health conditions that may be caused by risks the policy seeks to mitigate are determined. These estimates of willingness to pay for small reductions in mortality risks are often referred to as the "value of a statistical life." This is because these values are typically reported in units that match the aggregate dollar amount that a large group of people would be willing to pay for a reduction in their individual risks of dying in a year, such that one fewer death is expected among the group during that year on average. This is best explained by way of an example. Suppose each person in a sample of 100,000 people were asked how much he or she would be willing to pay for a reduction in their individual risk of dying of 1 in 100,000, or 0.001%, over the next year. Since this reduction in risk would mean that we would expect one fewer death among the sample of 100,000 people over the next year on average, this is sometimes described as "one statistical life saved.” Now suppose that the average response to this hypothetical question was $100. Then the total dollar amount that the group would be willing to pay to save one statistical life in a year would be $100 per person × 100,000 people, or $10 million. This is what is meant by the "value of a statistical life.” The statistical value of life is a mathematical concept which does not place a dollar value on individual lives.

Cost benefit analysis compares the willingness to pay for the health risk reduction from new policy to additional costs that people will bear if the policies are adopted. The cost benefit analysis helps policy makers decide on whether or not proposed policy should be adopted. With respect to the traffic lights project, policy of introducing new technology to, amongst other benefits, reduce risk of loss of life due to accidents caused by malfunctioning traffic lights is tested using the statistical value of life concept.

A study conducted in Bangkok, Thailand in 2005 measuring individuals’ willingness to pay (WTP) to reduce mortality risk arising from air pollution traffic accidents estimated the average statistical value of life at $1 175 000. Using the Gross

Domestic Product (GDP) per capita comparatives for Thailand ($9 200) and Zamzam ($400) for the year 2010, the estimated statistical value of life for Zamzam derived from that of Thailand is $51 087 (see Table 21 below). The risk of loss of life due to air pollution traffic accidents is considered a close proxy to that of risk of loss of life as a result of accidents caused by malfunctioning traffic lights.

Table 21: Statistical Value Of Life (Svl)-Traffic Accidents

	$	**Year**
SVL Thailand	1,175,000	2,005
GDP Per Capita Thailand	9,200	2,010
GDP Per Capita Zamzam	400	2,010
SVL Zamzam	51,087	

5.2.3.9 Intersections/ Junctions

A study conducted by ABC Engineering Consultants indicates that traffic lights at 7 existing traffic controlled intersections require replacement whilst an addition 16 intersections require new traffic lights to be installed. The 7 existing traffic controlled intersections are four way whilst 5 are four way and 11 three way for the 16 intersections to be fitted with new traffic lights. The full list of intersections is given in table 22 below.

Table 22: Intersections/Junctions

INTERSECTION	CODE	TYPE	COMMENT
White/Black	A	4-way	Replacement
Green/Blue	B	4-way	Replacement
White/Orange	C	4-way	Replacement
White/Blue	D	4-way	Replacement
Red/ Blue	E	4-way	Replacement
Red/White	F	4-way	Replacement
Brown/Yellow	G	4-way	Replacement
Brown/Pink	H	3-way	New
Brown/Marron	I	3-way	New
Pink/Purple	J	3-way	New
Pink/Marron	K	3-way	New
Purple / Cream	L	3-way	New
Violet/ Scarlet	M	3-way	New
Mauve/ Brown	N	3-way	New
Grey/Brown	O	4-way	New
Orange/ Crimson	P	4-way	New
Red/Velvet	Q	3-way	New
Red/ Silver	R	3-way	New
Red/Amber	S	3-way	New
Orange/ Gold	T	3-way	New
Red/ Violet	U	4-way	New
Red/Black	V	4-way	New
Red/Lilac	W	4-way	New

INTERSECTIONS/JUNCTIONS

Existing	7
New	16
Total	**23**

5.2.3.9.1 Coping Cost of Time Delays at Traffic Intersections

The coping cost of time delays (Table 23) at traffic intersections were estimated using the minimum wage rate of $150 per month for all commuters and $215 per month for bus and truck driver. These coping costs/ wage rates translate to $0.000058 per second and $0.000083 per second for commuter and bus and truck driver wages rates respectively.

Table 23: Coping Cost Of Time Delays At Traffic Intersections

Days in year	365	
Average days in month	30	
Hours in day	24	
Minutes in hour	60	
Seconds in minute	60	
Minimum wage rate	150	p/mnth
Minimum wage rate	0.000058	p/second
Buses and Truck Drivers wage rate	215	p/mnth
Buses and Truck Drivers wage rate	0.000083	p/second

5.2.3.9.2 Traffic Data Per Intersection

Traffic data per intersection (table 24) show average daily traffic compiled by ABC Engineering Consultants, average time delays statistics compiled by Colourful City, accident statistics received from the Republic police and proportion of light to heavy vehicles estimated by ABC Engineers. The table also shows normal time delays of 30 seconds expected on fully functioning traffic lights. This “normal” time delay, reflecting traffic light sequence red (stop) –amber (caution)-green (go), is therefore not considered a delay for the purposes of this analysis. Annual growth in traffic is estimated at 6% per annum whilst reduction in accidents due to project is assumed to be 80%.

Table 24: Traffic Data Per Intersection (Sources: Abc Engineering Report (Traffic Counts) ; City (Time Delays) ; Republic Police(Accident Rate))

INTERSECTION	**TRAFFIC COUNT (Av. Daily)**		**TIME DELAY (seconds)**		**ACCIDENT RATE (AV. ANNUAL)**			**VEHICLE TYPE (%)**	
	A1, B1..W1	**A2, B2..W2**	**A1, B1..W1**	**A2, B2..W2**	**Total**	**Injured**	**Deaths**	**LIGHT**	**HEAVY**
Normal Delay (With Project)			***30***	***30***					
A	1921	2729	17	10	7	1	-	96%	4%
B	1429	2181	13.2	9	0.4	0	0	94%	6%
C	4,885	827	31	16	2	1	0.1	93%	7%
D	1,645	4,207	21	12	1	-	-	97%	3%
E	2,609	2,471	21	12	6	1	-	95%	5%
F	4,046	5,276	21	12	9	4	0.2	96%	4%
G	5581	2769	21	12	5.7	3.8	0.4	92%	8%
H	367	3,127	60	27	*3.7*	*2*	*0.2*	95%	5%
I	1,001	1,839	60	27	*3.7*	*2*	*0.2*	92%	8%
J	737	35	60	27	*3.7*	*2*	*0.2*	84%	16%
K	598	152	60	27	*3.7*	*2*	*0.2*	86%	14%
L	66	30	60	27	*3.7*	*2*	*0.2*	83%	17%
M							*0.2*	90%	10%

	203	1,131	60	27	*3.7*	*2*			
N	2,709	239	60	27	8	2	0.2	90%	10%
O	3,918	822	60	27	17	12	2	93%	7%
P	1,292	1,904	60	27	3	4	-	93%	7%
Q	294	2,156	60	27	1	-	-	94%	6%
R	62	1,052	60	27	*3.7*	*2*	*0.2*	90%	10%
S	381	2,039	60	27	*3.7*	*2*	*0.2*	91%	9%
T	666	2,206	60	27	-	-	-	94%	6%
U	1,514	1,060	60	27	3	1	-	94%	6%
V	2,174	2,760	60	27	*3.7*	*2*	*0.2*	95%	5%
W	220	2,300	60	27	*3.7*	*2*	*0.2*	90%	10%
Annual growth In traffic	6%				100	45	5	WA	6%
Power Factor (n) in 2011	1	(1+r)^n							
Reduction in accidents due to project	80%								

5.2.3.9.3 Value of Time Parameters-Heavy Trucks

The value of time parameters for heavy vehicles shown in table 25 below consider the opportunity costs of the driver(s) time, load value carried and value of the truck. The average number of occupants is estimated to be 2 attracting an average wage rate of $0.000083 per second. The average value of load carried is $36 571. The average value of the truck is estimated at $64 000 whilst its operating life is given at 4000 hours. Real interest rate real is estimated at 10%. The assumptions above were used to estimate the opportunity costs of drivers' time as well as that of load value carried and the value of the truck. The opportunity costs add up to $0.00473 per second in time value associated with heavy trucks.

Table 25: Value Of Time Parameters-Heavy Trucks

Average wage rate	0.000083	US$/second
Average number of occupants	2.0	drivers
Load value carried	36,571	US$/truck
Interest rate, real	10%	per year
Average value of truck	64,000	US$
Operating life in a year	4,000	hours

Value Of Time-Heavy Trucks

Wage paid to truck drivers/second		0.000165895
Opportunity cost of load/second		0.000115967
Opportunity cost of value of truck/second		0.00444444
Time value of time		0.004726307

5.3 Traffic and Time Delay Projection

Traffic and time delay projections are estimated on the basis of data in table 25 above.

5.3.1 Projection of Annual Traffic per Intersection

Table 26 shows projection of annual traffic per intersection. Traffic at each intersection is accounted for by way of two counts derived from each of the intersecting roads. The two counts are added by to give total traffic at each intersection. The traffic is then estimated to grow annually at the rate of 6% per annum for the life of the project. Adding up traffic at each of the intersections gives total for all intersections. Traffic for all intersections is projected to grow from 31.6 million in 2011 to 56.6 million in final year 2021.

Table 26: Projection Of Annual Traffic Per Intersection (# Thousand)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Power Factor	1	2	3	4	5	6	7	8	9	10	11
ANNUAL GROWTH IN TRAFFIC	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**
INTERSECTION											
A1	743	788	835	885	938	995	1,054	1,118	1,185	1,256	1,331
A2	1,056	1,119	1,186	1,258	1,333	1,413	1,498	1,588	1,683	1,784	1,891
Total A	**1,799**	**1,907**	**2,021**	**2,143**	**2,271**	**2,408**	**2,552**	**2,705**	**2,867**	**3,040**	**3,222**
B1	553	586	621	658	698	740	784	831	881	934	990
B2	844	894	948	1,005	1,065	1,129	1,197	1,269	1,345	1,426	1,511
Total B	**1,397**	**1,481**	**1,569**	**1,664**	**1,763**	**1,869**	**1,981**	**2,100**	**2,226**	**2,360**	**2,501**
C1	1,890	2,003	2,124	2,251	2,386	2,529	2,681	2,842	3,012	3,193	3,385
C2	320	339	360	381	404	428	454	481	510	541	573
Total C	**2,210**	**2,343**	**2,483**	**2,632**	**2,790**	**2,957**	**3,135**	**3,323**	**3,522**	**3,734**	**3,958**

D1	636	675	715	758	804	852	903	957	1,014	1,075	1,140
D2	1,628	1,725	1,829	1,939	2,055	2,178	2,309	2,447	2,594	2,750	2,915
Total D	**2,264**	**2,400**	**2,544**	**2,697**	**2,858**	**3,030**	**3,212**	**3,404**	**3,609**	**3,825**	**4,055**
E1	1,009	1,070	1,134	1,202	1,274	1,351	1,432	1,518	1,609	1,705	1,808
E2	956	1,013	1,074	1,139	1,207	1,279	1,356	1,438	1,524	1,615	1,712
Total E	**1,965**	**2,083**	**2,208**	**2,341**	**2,481**	**2,630**	**2,788**	**2,955**	**3,133**	**3,321**	**3,520**
F1	1,565	1,659	1,759	1,864	1,976	2,095	2,221	2,354	2,495	2,645	2,803
F2	2,041	2,164	2,294	2,431	2,577	2,732	2,896	3,069	3,253	3,449	3,656
Total F	**3,607**	**3,823**	**4,052**	**4,296**	**4,553**	**4,827**	**5,116**	**5,423**	**5,749**	**6,093**	**6,459**
G1	2,159	2,289	2,426	2,572	2,726	2,890	3,063	3,247	3,442	3,648	3,867
G2	1,071	1,136	1,204	1,276	1,353	1,434	1,520	1,611	1,708	1,810	1,919
Total G	**3,231**	**3,424**	**3,630**	**3,848**	**4,079**	**4,323**	**4,583**	**4,858**	**5,149**	**5,458**	**5,786**
H1	142	151	160	169	179	190	201	214	226	240	254
H2											

	1,210	1,282	1,359	1,441	1,527	1,619	1,716	1,819	1,928	2,044	2,167
Total H	**1,352**	**1,433**	**1,519**	**1,610**	**1,707**	**1,809**	**1,918**	**2,033**	**2,155**	**2,284**	**2,421**
I1	387	411	435	461	489	518	549	582	617	654	694
I2	712	754	799	847	898	952	1,009	1,070	1,134	1,202	1,274
Total I	**1,099**	**1,165**	**1,235**	**1,309**	**1,387**	**1,470**	**1,559**	**1,652**	**1,751**	**1,856**	**1,968**
J1	285	302	320	340	360	382	404	429	454	482	511
J2	14	14	15	16	17	18	19	20	22	23	24
Total J	**299**	**317**	**336**	**356**	**377**	**400**	**424**	**449**	**476**	**505**	**535**
K1	231	245	260	276	292	310	328	348	369	391	414
K2	59	62	66	70	74	79	83	88	94	99	105
Total K	**290**	**308**	**326**	**346**	**366**	**388**	**412**	**436**	**462**	**490**	**520**
L1	26	27	29	30	32	34	36	38	41	43	46
L2	12	12	13	14	15	16	16	17	18	20	21
Total L	**37**	**39**	**42**	**44**	**47**	**50**	**53**	**56**	**59**	**63**	**67**

M1	79	83	88	94	99	105	111	118	125	133	141
M2	438	464	492	521	552	586	621	658	697	739	784
Total M	**516**	**547**	**580**	**615**	**652**	**691**	**732**	**776**	**823**	**872**	**924**
N1	1,048	1,111	1,178	1,248	1,323	1,403	1,487	1,576	1,671	1,771	1,877
N2	92	98	104	110	117	124	131	139	147	156	166
Total N	**1,141**	**1,209**	**1,282**	**1,358**	**1,440**	**1,526**	**1,618**	**1,715**	**1,818**	**1,927**	**2,043**
O1	1,516	1,607	1,703	1,805	1,914	2,029	2,150	2,279	2,416	2,561	2,715
O2	318	337	357	379	402	426	451	478	507	537	570
Total O	**1,834**	**1,944**	**2,061**	**2,184**	**2,315**	**2,454**	**2,601**	**2,758**	**2,923**	**3,098**	**3,284**
P1	500	530	562	595	631	669	709	752	797	845	895
P2	737	781	828	877	930	986	1,045	1,108	1,174	1,245	1,319
Total P	**1,237**	**1,311**	**1,389**	**1,473**	**1,561**	**1,655**	**1,754**	**1,859**	**1,971**	**2,089**	**2,214**
Q1	114	121	128	135	144	152	161	171	181	192	204
Q2											

	834	884	937	993	1,053	1,116	1,183	1,254	1,330	1,409	1,494
Total Q	**948**	**1,005**	**1,065**	**1,129**	**1,197**	**1,269**	**1,345**	**1,425**	**1,511**	**1,601**	**1,698**
R1	24	25	27	29	30	32	34	36	38	41	43
R2	407	431	457	485	514	545	577	612	649	688	729
Total R	**431**	**457**	**484**	**513**	**544**	**577**	**611**	**648**	**687**	**728**	**772**
S1	147	156	166	176	186	197	209	222	235	249	264
S2	789	836	886	940	996	1,056	1,119	1,186	1,257	1,333	1,413
Total S	**936**	**992**	**1,052**	**1,115**	**1,182**	**1,253**	**1,328**	**1,408**	**1,492**	**1,582**	**1,677**
T1	258	273	290	307	325	345	366	387	411	435	461
T2	854	905	959	1,017	1,078	1,142	1,211	1,283	1,360	1,442	1,528
Total T	**1,111**	**1,178**	**1,249**	**1,323**	**1,403**	**1,487**	**1,576**	**1,671**	**1,771**	**1,877**	**1,990**
U1	586	621	658	698	740	784	831	881	934	990	1,049
U2	410	435	461	488	518	549	582	617	654	693	734
Total U	**996**	**1,056**	**1,119**	**1,186**	**1,257**	**1,333**	**1,413**	**1,497**	**1,587**	**1,683**	**1,783**

V1	841	892	945	1,002	1,062	1,126	1,193	1,265	1,341	1,421	1,506
V2	1,068	1,132	1,200	1,272	1,348	1,429	1,515	1,606	1,702	1,804	1,912
Total V	**1,909**	**2,024**	**2,145**	**2,274**	**2,410**	**2,555**	**2,708**	**2,870**	**3,043**	**3,225**	**3,419**
W1	85	90	96	101	107	114	121	128	136	144	152
W2	890	943	1,000	1,060	1,123	1,191	1,262	1,338	1,418	1,503	1,594
Total W	**975**	**1,033**	**1,095**	**1,161**	**1,231**	**1,305**	**1,383**	**1,466**	**1,554**	**1,647**	**1,746**
All Intersections (A1, B1….)	14,825	15,715	16,658	17,657	18,717	19,840	21,030	22,292	23,629	25,047	26,550
All Intersections (A2, B2….)	16,757	17,763	18,829	19,958	21,156	22,425	23,771	25,197	26,709	28,311	30,010
Total All Intersections	**31,583**	**33,478**	**35,486**	**37,615**	**39,872**	**42,265**	**44,801**	**47,489**	**50,338**	**53,358**	**56,560**

5.3.2 Projection of Annual Time Delays Per Intersection

Projections of annual time delays per intersection are shown in table 27 below. Time delay per intersection is given as the difference between observed delays at each intersection and the 30 second normal delay time on functional traffic lights. This delay multiplied by total traffic at the intersection gives total delay time for that particular intersection. In the event that the delay is less than the 30 second normal delay, it is not considered a time saving for the purposes of this analysis. This is mainly because the “saving’ comes at a higher risk of traffic accidents and loss of life. Annual time delays for each intersection are added up to give total time delays for all intersections. Total time delays for all intersections grow annually from 202.8 million seconds in 2011 to peak at 438.5 million seconds in 2021.

Table 27: Projection Of Annual Time Delays Per Intersection (Thousand Seconds)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Without Project											
INTERSECTION											
A1	-	-	-	-	-	-	-	-	-	-	-
A2	-	-	-	-	-	-	-	-	-	-	-
Total A	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
B1	-	-	-	-	-	-	-	-	-	-	-
B2	-	-	-	-	-	-	-	-	-	-	-
Total B	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
C1	2,457	2,604	2,761	2,926	3,102	3,288	3,485	3,694	3,916	4,151	4,400
C2	-	-	-	-	-	-	-	-	-	-	-
Total C	**2,457**	**2,604**	**2,761**	**2,926**	**3,102**	**3,288**	**3,485**	**3,694**	**3,916**	**4,151**	**4,400**
D1	-	-	-	-	-	-	-	-	-	-	-
D2	-	-	-	-	-	-	-	-	-	-	-
Total D	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
E1	-	-	-	-	-	-	-	-	-	-	-
E2	-	-	-	-	-	-	-	-	-	-	-
Total E	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
F1	-	-	-	-	-	-	-	-	-	-	-
F2	-	-	-	-	-	-	-	-	-	-	-
Total F	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
G1	-	-	-	-	-	-	-	-	-	-	-
G2	-	-	-	-	-	-	-	-	-	-	-

Total G	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
H1	4,260	4,515	4,786	5,073	5,378	5,701	6,043	6,405	6,789	7,197	7,629
H2	-	-	-	-	-	-	-	-	-	-	-
Total H	**4,260**	**4,515**	**4,786**	**5,073**	**5,378**	**5,701**	**6,043**	**6,405**	**6,789**	**7,197**	**7,629**
I1	11,619	12,316	13,055	13,838	14,668	15,548	16,481	17,470	18,518	19,629	20,807
I2	-	-	-	-	-	-	-	-	-	-	-
Total I	**11,619**	**12,316**	**13,055**	**13,838**	**14,668**	**15,548**	**16,481**	**17,470**	**18,518**	**19,629**	**20,807**
J1	8,554	9,068	9,612	10,188	10,800	11,448	12,135	12,863	13,634	14,452	15,320
J2	-	-	-	-	-	-	-	-	-	-	-
Total J	**8,554**	**9,068**	**9,612**	**10,188**	**10,800**	**11,448**	**12,135**	**12,863**	**13,634**	**14,452**	**15,320**
K1	6,941	7,357	7,799	8,267	8,763	9,289	9,846	10,437	11,063	11,727	12,430
K2	-	-	-	-	-	-	-	-	-	-	-
Total K	**6,941**	**7,357**	**7,799**	**8,267**	**8,763**	**9,289**	**9,846**	**10,437**	**11,063**	**11,727**	**12,430**
L1	766	812	861	912	967	1,025	1,087	1,152	1,221	1,294	1,372
L2	-	-	-	-	-	-	-	-	-	-	-
Total L	**766**	**812**	**861**	**912**	**967**	**1,025**	**1,087**	**1,152**	**1,221**	**1,294**	**1,372**
M1	2,356	2,498	2,647	2,806	2,975	3,153	3,342	3,543	3,755	3,981	4,220

M2	-	-	-	-	-	-	-	-	-	-	-
Total M	**2,356**	**2,498**	**2,647**	**2,806**	**2,975**	**3,153**	**3,342**	**3,543**	**3,755**	**3,981**	**4,220**
N1	31,443	33,330	35,330	37,450	39,697	42,078	44,603	47,279	50,116	53,123	56,310
N2	-	-	-	-	-	-	-	-	-	-	-
Total N	**31,443**	**33,330**	**35,330**	**37,450**	**39,697**	**42,078**	**44,603**	**47,279**	**50,116**	**53,123**	**56,310**
O1	45,476	48,205	51,097	54,163	57,413	60,857	64,509	68,379	72,482	76,831	81,441
O2	-	-	-	-	-	-	-	-	-	-	-
Total O	**45,476**	**48,205**	**51,097**	**54,163**	**57,413**	**60,857**	**64,509**	**68,379**	**72,482**	**76,831**	**81,441**
P1	14,996	15,896	16,850	17,861	18,932	20,068	21,272	22,549	23,902	25,336	26,856
P2	-	-	-	-	-	-	-	-	-	-	-
Total P	**14,996**	**15,896**	**16,850**	**17,861**	**18,932**	**20,068**	**21,272**	**22,549**	**23,902**	**25,336**	**26,856**
Q1	3,412	48,205	51,097	54,163	57,413	60,857	64,509	68,379	72,482	76,831	81,441
Q2	-	-	-	-	-	-	-	-	-	-	-
Total Q	**3,412**	**48,205**	**51,097**	**54,163**	**57,413**	**60,857**	**64,509**	**68,379**	**72,482**	**76,831**	**81,441**
R1	720	763	809	857	909	963	1,021	1,082	1,147	1,216	1,289
R2	-	-	-	-	-	-	-	-	-	-	-
Total R	**720**	**763**	**809**	**857**	**909**	**963**	**1,021**	**1,082**	**1,147**	**1,216**	**1,289**

S1	4,422	4,688	4,969	5,267	5,583	5,918	6,273	6,649	7,048	7,471	7,920
S2	-	-	-	-	-	-	-	-	-	-	-
Total S	**4,422**	**4,688**	**4,969**	**5,267**	**5,583**	**5,918**	**6,273**	**6,649**	**7,048**	**7,471**	**7,920**
T1	7,730	8,194	8,686	9,207	9,759	10,345	10,966	11,623	12,321	13,060	13,844
T2	-	-	-	-	-	-	-	-	-	-	-
Total T	**7,730**	**8,194**	**8,686**	**9,207**	**9,759**	**10,345**	**10,966**	**11,623**	**12,321**	**13,060**	**13,844**
U1	17,573	18,627	19,745	20,930	22,186	23,517	24,928	26,423	28,009	29,689	31,471
U2	12,303	13,042	13,824	14,654	15,533	16,465	17,453	18,500	19,610	20,786	22,034
Total U	**29,876**	**31,669**	**33,569**	**35,583**	**37,718**	**39,981**	**42,380**	**44,923**	**47,618**	**50,476**	**53,504**
V1	25,234	26,748	28,352	30,054	31,857	33,768	35,794	37,942	40,219	42,632	45,190
V2	-	-	-	-	-	-	-	-	-	-	-
Total V	**25,234**	**26,748**	**28,352**	**30,054**	**31,857**	**33,768**	**35,794**	**37,942**	**40,219**	**42,632**	**45,190**
W1	2,554	2,707	2,869	3,041	3,224	3,417	3,622	3,840	4,070	4,314	4,573
W2	-	-	-	-	-	-	-	-	-	-	-
Total W	**2,554**	**2,707**	**2,869**	**3,041**	**3,224**	**3,417**	**3,622**	**3,840**	**4,070**	**4,314**	**4,573**
All Intersections (A1, B1….)	190,514	246,532	261,324	277,003	293,624	311,241	329,915	349,710	370,693	392,935	416,511
All Intersections (A2, B2….)											

	12,303	13,042	13,824	14,654	15,533	16,465	17,453	18,500	19,610	20,786	22,034
Total All Intersections	**202,817**	**259,574**	**275,148**	**291,657**	**309,156**	**327,706**	**347,368**	**368,210**	**390,303**	**413,721**	**438,544**

5.4 Estimation of Economic Conversion Factors

5.4.1 Conversion Factor for Fuel

Council pays 20% import duty on fuel and value added tax on the Cost Insurance Freight (CIF) price plus import duty of the commodity. The resultant conversion factor for fuel, as provided in table 28 below, is 0.725.

Table 28: Economic Value and Conversion Factor for Fuel

		Financial value	**CF for NT Services**	**Value of FEP**	**Economic Value**
CIF		1000		0	1000
(+) Import Duty	20%	200			0
(+) VAT (% of CIF + ID)	15%	180			0
Project-site Price		**1380**			**1000**
				CF	**0.725**

5.4.2 Conversion Factor for Imported Capital Items

Council does not pay import duty on capital items. It is however liable to pay value added tax and transport and handling charges for the items. The conversion factor for imported capital items is 0.872 as shown in table 29 below.

Table 29: Economic Value & Conversion Factor for Imported Capital Items

		Financial value	CF for NT Services	Value of FEP	Economic Value
CIF		1,000		-	1000
(+) Import Duty	0%	0			0
(+) VAT (% of CIF + ID)	15%	150			0
(+) Handling (% of CIF + ID)	2%	20	0.92		18
(+) Transport, port to project (% of CIF +ID)	2%	20	0.94		19
Project-site Price		**1,190.00**			**1,037**
				CF	**0.872**

5.4.3 Conversion Factor for Major Maintenance Materials

Council is liable to pay handling and transport costs on major imported materials resulting in a conversion factor of 0.997 as indicated in table 30 below.

Table 30: Economic Value & Conversion Factor For Major Maintenance Materials

		Financial value	CF for NT Services	Value of FEP	Economic Value
CIF		1000		0	1000
(+) Import Duty	0%	0			0
(+) Handling (% of CIF + ID)	2%	20	0.92		18
(+) Transport, port to project (% of CIF + ID)	2%	20	0.94		19
Project-site Price		1040			1037
				CF	**0.997**

5.4.4 Conversion Factor for O&M Materials

Operations and maintenance materials attract handing and transport costs and have a conversion factor of 0.997 and are shown in table 31 below.

Table 31: Economic Value And Conversion Factor On O&M Materials

		Financial value	CF for NT Services	Value of FEP	Economic Value
CIF		1000		0	1000
(+) Import Duty	0%	0			0
(+) Handling (% of CIF + ID)	2%	20	0.92		18
(+) Transport, port to project (% of CIF +ID)	2%	20	0.94		19
Project-site Price		1040			1037
				CF	**0.997**

5.4.5 Conversion Factor for Tradable Services

The conversion factor for tradable services, in table 32 below, is 0.870.

Table 32 Economic Value & Conversion Factor On Tradable Services (Advisory &Consulting Fees)

		Financial value	CF for NT Services	Value of FEP	Economic Value
CIF		1000		0	1000
(+) VAT	15%	150			0
Financial value		1150			1000
				CF	**0.870**

5.4.6 Conversion Factor for Labour

The conversion factors for skilled and unskilled labour shown in the table 33 below are 0.815 and 0.825 respectively.

Table 33: Conversion Factor for Labour

Local labor	**Wp**	**Wa**	**Ws**	**T**	**Hd**	**Ws(1-T)**	**HdWaT**	**EOCL**	**CF**
						(a)	**(b)**	**=(a) + (b)**	
Skilled	250	215	215	53 %	90 %	102	102	204	0.815
Unskilled	150	150	150	35 %	50 %	98	26	124	0.825

Labor benefits (Wp*(1-T) - Ws*(1-T))	**Govt. benefits (Wp*T - HdWaT)**	**Total benefits**	**Ext.% to labor**	**Ext.% to Gvt.**
16.625	**29.6625**	**46.288**	**35.9%**	**64.1%**
22.5	**26.25**	**48.75**	**46.2%**	**53.8%**

5.4.7 Conversion Factor for Non Tradable Infrastructure and Civil Works

The conversion factors non tradable infrastructure and Civil Works is 0.676(table 34).

Table 34: Conversion Factor And Economic Value Of Non-Tradable Infrastructure And Civil Works

INPUTS		**Ax**	**Unit Cost P_i (distorted)**	**Unit Cost P_i^m (undistorted)**	**Elasticity of Demand**	**Elasticity of Supply**	**Ws**	**Wd**	**Import duty**	**Indirect tax**	**Effective Distortion Rate d_i**	**Tradable Distortions**	**Non-tradable Distortions**
Tradable items													
100mm PVC Conduit Pipe		14.1	13.0	11.3					0%	15.0%	15.0%	23.909	
Bolts & Nuts		1.0	30.0	26.1					0%	15.0%	15.0%	3.913	
Non-tradable items													
PC 15 Cement		15.0	13.0	11.3	-1.5	3.0	0.667	0.333		15.0%	15.0%		16.957
19mm Stone		1.0	62.0	53.9	-1.0	2.5	0.714	0.286		15.0%	15.0%		5.776
Riversand		4.0	16.0	13.9	-1.0	2.5	0.714	0.286		15.0%	15.0%		5.963
Return to capital		1.0	63.0										

Labor		8.0	150.0										198.156
Other non-tradeable		1.0	519.0										
											Total	**27.822**	**226.852**
P^d = FV =	1000						W^sP^s+W^dP^d=	891.30	(a)				
P^s =P^m=	870						W^dP^md*=	11.59	(b)				
%T=	2%						Ws(T Distortions + NT Distortions)=	6212.239	(c)				
%NT=	98%						Value of FEP =	0.00	(d)				
Supply Elasticity (ε) =	2.5	W^s =	**ε / (ε-η) =**	83%			Value of NTP =	8.53	(e)				
Demand Elasticity (η) =	-0.5	W^d =	**-η / (ε-η) =**	17%			**EV =**	**352.15**	= (a) - (b) - (c) + (d) + (e)				
d*=	8%						**CF =**	**0.352**					

5.4.7 Summary of Conversion Factors

Table 35 below summarizes conversion factors for the project.

Table 35: Summary Of Conversion Factors

Investment Costs	**CF**	
Dismantling old structures	0.8	average skilled and unskilled labour
Civil Works	0.7	Non tradeable infras. and civil works
Cabling & fitting accessories	1.0	same as O&M materials
NewTraffic Heads	0.9	imported capital items
Transport & Installation	0.7	Same as non tradable infrast. and civils
Fixed Operating Costs		
Labor	0.8	average skilled and unskilled labour
General & Admin (excluding VAT)	0.8	CF skilled labour
O&M	1.0	average maintenance materials + O&M
Long Term Service Agreement	0.9	tradeable services
Variable Costs		
Fuel Requirement Cost	0.7	factor for fuel
Electricity Consumed	1.0	same as tradeable services
Additional O&M costs Due To PC	0.8	average labour + fuel requirement
LTSA and Other Variable Costs	0.9	same as tradeable services

5.5 Projection of Economic Benefits

5.5.1 Value of Time Savings

The value of time savings are summarised in table 36 below.

5.5.1.1 Without Project

The value of time savings is computed for light and heavy vehicles at each intersection for both the "With" and "Without" Project scenarios. In this regard time delays are noted as negative time savings and the value of negative time savings represent the opportunity cost of time spent by road users in traffic due to malfunctioning traffic lights. Any reduction in these delays translates to time savings which yield positive value of time savings. It is assumed that the value of a commuter's opportunity cost of idle time spent in traffic (due to delays associated with malfunctioning traffic lights) can be estimated using the minimum wage rate. The minimum wage rate is translated to dollars per second (C260 table of parameters) and multiplied to the product of total time delays in seconds and number of commuters for each intersection to give the total value of opportunity cost of time to commuters for that particular intersection. Any reduction in that opportunity cost of time is accounted for as a time saving. Since these commuters travel in light and heavy vehicles with different carrying capacities (D199 to D203 table of parameters) and with different proportionate representation at each intersection (J268 and K268 to J290 and K290 table of parameters), opportunity costs or value of time delays have to be computed for each intersection and added up to give total time delays for the project. Arithmetically, the value of time delays or negative time savings, in seconds, for light vehicles for each intersection are computed as the total time delay for the intersection multiplied by minimum wage rate per second adjusted for proportion of light to total vehicles for intersection and weighted averages of proportion of private and commuter vehicles applied to their corresponding average vehicle occupancy levels. For example, time savings for light vehicles passing through intersection H in year 2011 are computed as total time delays for intersection of 4.26 million seconds (or -4.26 million seconds in time savings) multiplied by minimum wage rate per second of $0.000058 per second multiplied by proportion of light to total vehicles using intersection, that is, 95% multiplied by weighted average of proportion of private vehicles to total light vehicles of 70% applied to average occupancy of private vehicles of 4 people and proportion of commuter taxis to total light vehicles of 30% applied to average occupancy of commuter taxis of 15 people [-4.26m seconds x $0.000058 x 95% x {(70% x 4 occupants) + (30% x 15 occupants)}] to give value of time savings of -$1 710 per year. The same formula is used to calculate the value of time savings for heavy vehicles for each intersection. The only difference being that adjustments are made for proportion of heavy vehicles to total vehicles passing through intersection and weighted averages of proportion of buses and heavy trucks to total heavy vehicles applied to their corresponding average occupants of 50 and 2 people respectively. In the case of intersection H, the value of time savings is calculated as -$1 220 for year 2011.

Adding up total value of time savings for all 23 intersections gives value of -$172 000 for year 2011 which grows annually commensurate with projected traffic growth to -$363 000 in year 2021.

5.5.1.2 With Project Option A (Solar Power)

For “With Project” scenarios, it is assumed that when traffic lights are fully functional no time delays beyond the programmed normal 30 seconds are envisaged. Should these arise, they would be for other reasons not linked to malfunctioning traffic lights system. However in the event of traffic lights down time, the "Without Project" time delays would apply. In this case, the combined effect of prolonged cloud cover beyond battery life of 12 hours and power outages of more than 12 hours on systems down time is used to estimate value of time savings under this scenario. At -$97 000, the value of time savings is lowest in year 2011. This is because only 10 of the 23 intersections would experience "With Project" conditions. In this regard the remaining 13 intersections experience "Without Project" value of time savings whilst further negative value of time savings would be realised on down time associated with 10 new traffic lights.

Mathematically, the value of time savings for this "With Project' option is computed as number of outstanding traffic light installation as a proportion of total planned installations times total "Without Project" time delays (or negative time savings) for that year plus percentage annual down time of total new installations (2%) times total "Without Project" time delays for the same year times proportion of hours in day downtime is experienced. For example, time savings for light vehicles passing through in year 2011 are computed as number of outstanding traffic light installation as a proportion of total planned installations (13/23) times total "Without Project" time delays (or negative time savings) for that year (-$79 000) plus, in brackets, percentage annual down time of total new installations (2%) times total "Without Project" time delays for the same year (-$79 000) times proportion of day when downtime is experienced (3.4/24 hours) to give value of time savings of -$45 000 [13/23 x -$79 000 +(2% x -$79 000 x 3.4/24 hours)].

The value of time savings increases to -$29 000 in year 2012 as an additional 10 intersections are installed and further increases to -$1 000 in year 2013 as the installation programme is completed. The value of time savings remains constant at -$1 000 for the remaining life of the project.

5.5.1.3 With Project Option B (AC Power)

In this case, traffic lights system downtime will be experienced in the event of power outages of more than 12 hours. The probability of power outages of more than 12 hours and therefore experiencing downtime is 13%. This is considerably higher than the 2% for the solar power option. For that reason and using the same arithmetic logic as the solar power option, the value of time savings associated with this option is considerably lower. The value of time savings is lowest in 2011 at -$107 000, increases to -$52 000 in 2012 and averages -$37 000 for the remaining life of the project.

Table 36:Value Of Time Savings ($ Thousands)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Without Project											
Intersection A											
Time Savings-light vehicles	-	-	-	-	-	-	-	-	-	-	-
Time Savings-heavy vehicles	-	-	-	-	-	-	-	-	-	-	-
Intersection B											
Time Savings-light vehicles	-	-	-	-	-	-	-	-	-	-	-
Time Savings-heavy vehicles	-	-	-	-	-	-	-	-	-	-	-
Intersection C											
Time Savings-light vehicles	(0.97)	(1.02)	(1.08)	(1.15)	(1.22)	(1.29)	(1.37)	(1.45)	(1.54)	(1.63)	(1.73)
Time Savings-heavy vehicles	(0.99)	(1.05)	(1.11)	(1.18)	(1.25)	(1.32)	(1.40)	(1.48)	(1.57)	(1.67)	(1.77)
Intersection D											
Time Savings-light vehicles	-	-	-	-	-	-	-	-	-	-	-
Time Savings-heavy vehicles	-	-	-	-	-	-	-	-	-	-	-
Intersection E											
Time Savings-light	-	-	-	-	-	-	-	-	-	-	-

vehicles											
Time Savings-heavy vehicles	-	-	-	-	-	-	-	-	-	-	-
Intersection F											
Time Savings-light vehicles	-	-	-	-	-	-	-	-	-	-	-
Time Savings-heavy vehicles	-	-	-	-	-	-	-	-	-	-	-
Intersection G											
Time Savings-light vehicles	-	-	-	-	-	-	-	-	-	-	-
Time Savings-heavy vehicles	-	-	-	-	-	-	-	-	-	-	-
Intersection H											
Time Savings-light vehicles	(1.71)	(1.81)	(1.92)	(2.04)	(2.16)	(2.29)	(2.43)	(2.57)	(2.72)	(2.89)	(3.06)
Time Savings-heavy vehicles	(1.22)	(1.30)	(1.37)	(1.46)	(1.54)	(1.64)	(1.73)	(1.84)	(1.95)	(2.07)	(2.19)
Intersection I											
Time Savings-light vehicles	(4.52)	(4.79)	(5.07)	(5.38)	(5.70)	(6.04)	(6.41)	(6.79)	(7.20)	(7.63)	(8.09)
Time Savings-heavy vehicles	(5.33)	(5.65)	(5.99)	(6.35)	(6.73)	(7.14)	(7.57)	(8.02)	(8.50)	(9.01)	(9.55)
Intersection J											
Time Savings-light vehicles	(3.04)	(3.22)	(3.41)	(3.62)	(3.83)	(4.06)	(4.31)	(4.56)	(4.84)	(5.13)	(5.44)
Time Savings-heavy											

vehicles	(7.85)	(8.33)	(8.83)	(9.36)	(9.92)	(10.51)	(11.14)	(11.81)	(12.52)	(13.27)	(14.07)
Intersection K											
Time Savings-light vehicles	(2.52)	(2.67)	(2.83)	(3.00)	(3.18)	(3.37)	(3.58)	(3.79)	(4.02)	(4.26)	(4.52)
Time Savings-heavy vehicles	(5.58)	(5.91)	(6.27)	(6.64)	(7.04)	(7.46)	(7.91)	(8.39)	(8.89)	(9.42)	(9.99)
Intersection L											
Time Savings-light vehicles	(0.27)	(0.28)	(0.30)	(0.32)	(0.34)	(0.36)	(0.38)	(0.40)	(0.43)	(0.45)	(0.48)
Time Savings-heavy vehicles	(0.75)	(0.79)	(0.84)	(0.89)	(0.94)	(1.00)	(1.06)	(1.12)	(1.19)	(1.26)	(1.34)
Intersection M											
Time Savings-light vehicles	(0.90)	(0.95)	(1.01)	(1.07)	(1.13)	(1.20)	(1.27)	(1.35)	(1.43)	(1.51)	(1.60)
Time Savings-heavy vehicles	(1.35)	(1.43)	(1.52)	(1.61)	(1.71)	(1.81)	(1.92)	(2.03)	(2.16)	(2.28)	(2.42)
Intersection N											
Time Savings-light vehicles	(11.96)	(12.67)	(13.43)	(14.24)	(15.09)	(16.00)	(16.96)	(17.98)	(19.05)	(20.20)	(21.41)
Time Savings-heavy vehicles	(18.05)	(19.13)	(20.28)	(21.49)	(22.78)	(24.15)	(25.60)	(27.13)	(28.76)	(30.49)	(32.32)
Intersection O											
Time Savings-light vehicles	(17.87)	(18.94)	(20.08)	(21.28)	(22.56)	(23.91)	(25.34)	(26.87)	(28.48)	(30.19)	(32.00)
Time Savings-heavy vehicles	(18.27)	(19.37)	(20.53)	(21.76)	(23.06)	(24.45)	(25.91)	(27.47)	(29.12)	(30.87)	(32.72)
Intersection P											

Time Savings-light vehicles	(5.89)	(6.25)	(6.62)	(7.02)	(7.44)	(7.88)	(8.36)	(8.86)	(9.39)	(9.95)	(10.55)
Time Savings-heavy vehicles	(6.02)	(6.39)	(6.77)	(7.18)	(7.61)	(8.06)	(8.55)	(9.06)	(9.60)	(10.18)	(10.79)
Intersection Q											
Time Savings-light vehicles	(1.36)	(19.14)	(20.29)	(21.51)	(22.80)	(24.17)	(25.62)	(27.15)	(28.78)	(30.51)	(32.34)
Time Savings-heavy vehicles	(1.18)	(16.60)	(17.59)	(18.65)	(19.77)	(20.96)	(22.21)	(23.55)	(24.96)	(26.46)	(28.04)
Intersection R											
Time Savings-light vehicles	(0.27)	(0.29)	(0.31)	(0.33)	(0.35)	(0.37)	(0.39)	(0.41)	(0.44)	(0.46)	(0.49)
Time Savings-heavy vehicles	(0.41)	(0.44)	(0.46)	(0.49)	(0.52)	(0.55)	(0.59)	(0.62)	(0.66)	(0.70)	(0.74)
Intersection S											
Time Savings-light vehicles	(1.70)	(1.80)	(1.91)	(2.02)	(2.15)	(2.28)	(2.41)	(2.56)	(2.71)	(2.87)	(3.04)
Time Savings-heavy vehicles	(2.28)	(2.42)	(2.57)	(2.72)	(2.88)	(3.06)	(3.24)	(3.43)	(3.64)	(3.86)	(4.09)
Intersection T											
Time Savings-light vehicles	(3.07)	(3.25)	(3.45)	(3.66)	(3.88)	(4.11)	(4.35)	(4.62)	(4.89)	(5.19)	(5.50)
Time Savings-heavy vehicles	(2.66)	(2.82)	(2.99)	(3.17)	(3.36)	(3.56)	(3.78)	(4.00)	(4.24)	(4.50)	(4.77)
Intersection U											
Time Savings-light vehicles	(11.86)	(12.58)	(13.33)	(14.13)	(14.98)	(15.88)	(16.83)	(17.84)	(18.91)	(20.04)	(21.25)

Time Savings-heavy vehicles	(10.29)	(10.90)	(11.56)	(12.25)	(12.99)	(13.77)	(14.59)	(15.47)	(16.40)	(17.38)	(18.42)
Intersection V											
Time Savings-light vehicles	(10.13)	(10.73)	(11.38)	(12.06)	(12.79)	(13.55)	(14.37)	(15.23)	(16.14)	(17.11)	(18.14)
Time Savings-heavy vehicles	(7.24)	(7.68)	(8.14)	(8.62)	(9.14)	(9.69)	(10.27)	(10.89)	(11.54)	(12.23)	(12.97)
Intersection W											
Time Savings-light vehicles	(0.97)	(1.03)	(1.09)	(1.16)	(1.23)	(1.30)	(1.38)	(1.46)	(1.55)	(1.64)	(1.74)
Time Savings-heavy vehicles	(1.47)	(1.55)	(1.65)	(1.75)	(1.85)	(1.96)	(2.08)	(2.20)	(2.34)	(2.48)	(2.62)
All Intersections											
Time Savings-light vehicles	(79)	(101)	(108)	(114)	(121)	(128)	(136)	(144)	(153)	(162)	(171)
Time Savings-heavy vehicles	(93)	(113)	(120)	(127)	(135)	(143)	(152)	(161)	(171)	(181)	(192)
Total	**(172)**	**(215)**	**(228)**	**(241)**	**(256)**	**(271)**	**(288)**	**(305)**	**(323)**	**(342)**	**(363)**
With Project A											
Time Savings-light vehicles	(45)	(14)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Time Savings-heavy vehicles	(52)	(15)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Total	**(97)**	**(29)**		**(1)**		**(1)**	**(1)**	**(1)**		**(1)**	

			(1)		**(1)**				**(1)**		**(1)**
With Project B											
Time Savings-light vehicles	(49)	(25)	(14)	(15)	(16)	(16)	(17)	(19)	(20)	(21)	(22)
Time Savings-heavy vehicles	(57)	(27)	(15)	(16)	(17)	(18)	(20)	(21)	(22)	(23)	(25)
Total	**(107)**	**(52)**	**(29)**	**(31)**	**(33)**	**(35)**	**(37)**	**(39)**	**(42)**	**(44)**	**(47)**

5.5.2 Value of Fuel Cost Savings

The value of fuel cost savings are summarised in table 37 below.

5.5.2.1 Without Project

The value of additional fuel costs incurred (or negative fuel cost saving) per intersection due to time delays caused by malfunctioning traffic lights is calculated as average fuel cost of 0.001 United States Dollar per millilitre multiplied by stop-start idling speed fuel consumption of 1.7 millilitres per second times annual time delays in seconds for that intersection. In the case of intersection C, for instance, the value of additional fuel consumed of -$6 000 per year are computed as average fuel costs (0.001 US$/ml) times stop-start idling speed fuel consumption (1.7 ml/s) times annual time delays at intersection (2.457 million seconds).

For all intersections, additional fuel cost savings are -$456 000 in 2011, drop to -$584 000 in 2012 and average -$790 000 for the remaining years.

5.5.2.2 With Project Option A (Solar Power)

Using the same reasoning and arithmetic logic as in value of time savings in 5.1 above, additional fuel savings realised as a result of delays in traffic due to malfunctioning traffic lights are -$259 000 in 2011, increase to -$78 000 in 2012 and averages -$3 000 for the remaining life of the project.

5.5.2.3 With Project Option B (AC Power)

Additional fuel savings realised are -$262 000 in 2011, increase to -$86 000 in 2012 and averages -$15 000 for the remaining life of the project.

Table 37: Value Of Fuel Cost Savings ($ Thousands)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Without Project											
Intersection A											
Additional Fuel Savings	-	-	-	-	-	-	-	-	-	-	-
Intersection B											
Additional Fuel Savings	-	-	-	-	-	-	-	-	-	-	-
Intersection C											
Additional Fuel Savings	(6)	(6)	(6)	(7)	(7)	(7)	(8)	(8)	(9)	(9)	(10)
Intersection D											
Additional Fuel Savings	-	-	-	-	-	-	-	-	-	-	-
Intersection E											
Additional Fuel Savings	-	-	-	-	-	-	-	-	-	-	-
Intersection F											
Additional Fuel Savings	-	-	-	-	-	-	-	-	-	-	-
Intersection G											
Additional Fuel Savings	-	-	-	-	-	-	-	-	-	-	-
Intersection H											
Additional Fuel Savings	(10)	(10)	(11)	(11)	(12)	(13)	(14)	(14)	(15)	(16)	(17)
Intersection I											
Additional Fuel Savings	(26)	(28)	(29)	(31)	(33)	(35)	(37)	(39)	(42)	(44)	(47)

Intersection J											
Additional Fuel Savings	(19)	(20)	(22)	(23)	(24)	(26)	(27)	(29)	(31)	(33)	(34)
Intersection K											
Additional Fuel Savings	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(25)	(26)	(28)
Intersection L											
Additional Fuel Savings	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(3)
Intersection M											
Additional Fuel Savings	(5)	(6)	(6)	(6)	(7)	(7)	(8)	(8)	(8)	(9)	(9)
Intersection N											
Additional Fuel Savings	(71)	(75)	(79)	(84)	(89)	(95)	(100)	(106)	(113)	(120)	(127)
Intersection O											
Additional Fuel Savings	(102)	(108)	(115)	(122)	(129)	(137)	(145)	(154)	(163)	(173)	(183)
Intersection P											
Additional Fuel Savings	(34)	(36)	(38)	(40)	(43)	(45)	(48)	(51)	(54)	(57)	(60)
Intersection Q											
Additional Fuel Savings	(8)	(108)	(115)	(122)	(129)	(137)	(145)	(154)	(163)	(173)	(183)
Intersection R											
Additional Fuel Savings											

	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(3)	(3)	(3)
Intersection S											
Additional Fuel Savings	(10)	(11)	(11)	(12)	(13)	(13)	(14)	(15)	(16)	(17)	(18)
Intersection T											
Additional Fuel Savings	(17)	(18)	(20)	(21)	(22)	(23)	(25)	(26)	(28)	(29)	(31)
Intersection U											
Additional Fuel Savings	(67)	(71)	(76)	(80)	(85)	(90)	(95)	(101)	(107)	(114)	(120)
Intersection V											
Additional Fuel Savings	(57)	(60)	(64)	(68)	(72)	(76)	(81)	(85)	(90)	(96)	(102)
Intersection W											
Additional Fuel Savings	(6)	(6)	(6)	(7)	(7)	(8)	(8)	(9)	(9)	(10)	(10)
All Intersections											
Additional Fuel Savings	**(456)**	**(584)**	**(619)**	**(656)**	**(696)**	**(737)**	**(782)**	**(828)**	**(878)**	**(931)**	**(987)**
With Project A											
Additional Fuel Savings	**(259)**	**(78)**	**(2)**	**(2)**	**(2)**	**(3)**	**(3)**	**(3)**	**(3)**	**(3)**	**(3)**

With Project B											
Additional Fuel Savings	**(262)**	**(86)**	**(11)**	**(12)**	**(13)**	**(14)**	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**

5.5.3 Value of Vehicle Maintenance Cost Savings

The value of vehicle maintenance cost savings are shown in table 38 below.

5.5.3.1 Without Project

The value of additional vehicle maintenance costs incurred (or negative vehicle maintenance cost saving) per intersection due to time delays caused by malfunctioning traffic lights is calculated as average service costs per second of 0.0000412 United States Dollar per millilitre multiplied by stop-Idling speed maintenance cost factor (increase) of 20% times annual time delays for that intersection for given time period. The costs are added up for all intersections to give total picture for the respective years.

The additional vehicle maintenance cost savings are -$1 672 in 2011, -$2 140 in 2012 and average 2 896 for the remaining years.

5.5.3.2 With Project Option A (Solar Power)

Additional vehicle maintenance cost savings realised as a result of delays in traffic due to malfunctioning traffic lights are -$948 in 2011, increase to -$285 in 2012 and averages -$10 for the remaining life of the project.

5.5.3.3 With Project Option B (AC Power)

Additional vehicle maintenance cost savings realised as a result of delays in traffic due to malfunctioning traffic lights are -$958 in 2011, increase to -$313 in 2012 and averages -$53 for the remaining life of the project.

Table 38: Value Of Vehicle Maintenance Cost Savings ($ Thousand)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Without Project											
Intersection A											
Add. Maintenance Costs Saving	-	-	-	-	-	-	-	-	-	-	-
Intersection B											
Add. Maintenance Costs Saving	-	-	-	-	-	-	-	-	-	-	-
Intersection C											
Add. Maintenance Costs Saving	(0.020)	(0.021)	(0.023)	(0.024)	(0.026)	(0.027)	(0.029)	(0.030)	(0.032)	(0.034)	(0.036)
Intersection D											
Add. Maintenance Costs Saving	-	-	-	-	-	-	-	-	-	-	-
Intersection E											
Add. Maintenance Costs Saving	-	-	-	-	-	-	-	-	-	-	-
Intersection F											
Add. Maintenance Costs Saving	-	-	-	-	-	-	-	-	-	-	-
Intersection G											
Add. Maintenance Costs Saving	-	-	-	-	-	-	-	-	-	-	-
Intersection H											

Add. Maintenance Costs Saving	(0.035)	(0.037)	(0.039)	(0.042)	(0.044)	(0.047)	(0.050)	(0.053)	(0.056)	(0.059)	(0.063)
Intersection I											
Add. Maintenance Costs Saving	(0.096)	(0.102)	(0.108)	(0.114)	(0.121)	(0.128)	(0.136)	(0.144)	(0.153)	(0.162)	(0.172)
Intersection J											
Add. Maintenance Costs Saving	(0.071)	(0.075)	(0.079)	(0.084)	(0.089)	(0.094)	(0.100)	(0.106)	(0.112)	(0.119)	(0.126)
Intersection K											
Add. Maintenance Costs Saving	(0.057)	(0.061)	(0.064)	(0.068)	(0.072)	(0.077)	(0.081)	(0.086)	(0.091)	(0.097)	(0.102)
Intersection L											
Add. Maintenance Costs Saving	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.010)	(0.011)	(0.011)
Intersection M											
Add. Maintenance Costs Saving	(0.019)	(0.021)	(0.022)	(0.023)	(0.025)	(0.026)	(0.028)	(0.029)	(0.031)	(0.033)	(0.035)
Intersection N											
Add. Maintenance Costs Saving	(0.259)	(0.275)	(0.291)	(0.309)	(0.327)	(0.347)	(0.368)	(0.390)	(0.413)	(0.438)	(0.464)
Intersection O											
Add. Maintenance Costs Saving	(0.375)	(0.397)	(0.421)	(0.447)	(0.473)	(0.502)	(0.532)	(0.564)	(0.598)	(0.633)	(0.671)
Intersection P											
Add. Maintenance Costs Saving	(0.124)	(0.131)	(0.139)	(0.147)	(0.156)	(0.165)	(0.175)	(0.186)	(0.197)	(0.209)	(0.221)

Intersection Q											
Add. Maintenance Costs Saving	(0.028)	(0.397)	(0.421)	(0.447)	(0.473)	(0.502)	(0.532)	(0.564)	(0.598)	(0.633)	(0.671)
Intersection R											
Add. Maintenance Costs Saving	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)	(0.009)	(0.010)	(0.011)
Intersection S											
Add. Maintenance Costs Saving	(0.036)	(0.039)	(0.041)	(0.043)	(0.046)	(0.049)	(0.052)	(0.055)	(0.058)	(0.062)	(0.065)
Intersection T											
Add. Maintenance Costs Saving	(0.064)	(0.068)	(0.072)	(0.076)	(0.080)	(0.085)	(0.090)	(0.096)	(0.102)	(0.108)	(0.114)
Intersection U											
Add. Maintenance Costs Saving	(0.246)	(0.261)	(0.277)	(0.293)	(0.311)	(0.330)	(0.349)	(0.370)	(0.393)	(0.416)	(0.441)
Intersection V											
Add. Maintenance Costs Saving	(0.208)	(0.221)	(0.234)	(0.248)	(0.263)	(0.278)	(0.295)	(0.313)	(0.332)	(0.351)	(0.373)
Intersection W											
Add. Maintenance Costs Saving	(0.021)	(0.022)	(0.024)	(0.025)	(0.027)	(0.028)	(0.030)	(0.032)	(0.034)	(0.036)	(0.038)
All Intersections											
Add. Maintenance Costs Saving	**(1.672)**	**(2.140)**	**(2.268)**	**(2.405)**	**(2.549)**	**(2.702)**	**(2.864)**	**(3.036)**	**(3.218)**	**(3.411)**	**(3.616)**

With Project A											
Add. Maintenance Costs Saving	**(0.948)**	**(0.285)**	**(0.008)**	**(0.008)**	**(0.009)**	**(0.009)**	**(0.010)**	**(0.010)**	**(0.011)**	**(0.012)**	**(0.012)**
With Project B											
Add. Maintenance Costs Saving	**(0.958)**	**(0.313)**	**(0.042)**	**(0.044)**	**(0.047)**	**(0.050)**	**(0.053)**	**(0.056)**	**(0.059)**	**(0.063)**	**(0.066)**

5.5.4 Value of Reduction in Accident Costs

The value of reduction in accident costs is shown in table 39 below.

5.5.4.1 Without Project

Repair costs for accident damaged vehicles due to malfunctioning traffic lights are added by for low, medium and high impact accidents to give total costs for the respective years. These are estimated at an average of $56 550 per year (or repair cost savings of -$56 550 per annum). Medical costs associated with injuries and deaths are also added up to give an average yearly cost of $4 280. The estimated statistical value of life for Zamzam of $51 087 is multiplied to average number of annual deaths due to malfunctioning traffic lights to arrive at average annual statistical value of life of $245 220 per annum. These costs are added up to give total value of reduction in accidents of -$306 040 per annum.

5.5.4.2 With Project Option A (Solar Power)

Value of reduction in accident costs caused by malfunctioning traffic lights are estimated at -$200 050 in 2011, reduce to -$94 050 in 2012 and averages -$62 for the remaining life of the project.

5.5.4.3 With Project Option B (AC Power)

Value of reduction in accident costs caused by malfunctioning traffic lights are estimated at -$202 040 in 2011, reduce to -$98 030 in 2012 and averages -$67 for the remaining life of the project.

Table 39: Value Of Reduction In Accident Costs ($Thousand)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Accident Costs											
Motor Vehicle Repairs Costs	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**	**(56.55)**
Low Impact Accident	(10.14)	(10.139)	(10.139)	(10.139)	(10.139)	(10.139)	(10.139)	(10.139)	(10.139)	(10.139)	(10.139)
Medium Impact	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)	(38.25)
High Impact	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)	(8.16)
Medical & Related Costs	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**	**(4.28)**
Injuries	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)	(3.15)
Death	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)	(1.13)
Statistical Value of Life	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**	**(245.22)**
Statistical Value of Life-Zam Zam	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)	(245.22)

Total Accident Costs	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**	**(306.04)**
With Project A											
Accident Costs	**(200.05)**	**(94.05)**	**(62)**	**(62)**	**(62)**	**(62)**	**(62)**	**(62)**	**(62)**	**(62)**	**(62)**
With Project B											
Accident Costs	**(202.04)**	**(98.03)**	**(67)**	**(67)**	**(67)**	**(67)**	**(67)**	**(67)**	**(67)**	**(67)**	**(67)**

5.6 Economic Resource Flow Statement

5.6.1.1 Without Project

The economic resource flow statement is presented in Table 40. This statement is generated based on the real financial cash flow statement from equity holders/total investment point of view in Table 7. The various distortions are adjusted in the real financial cash flow statement from total investment point of view to arrive at the economic resource flow statement. These distortions are adjusted by the use of the commodity specific conversion factors depicted in Table 35 for each project item.

The economic benefits of the proposed project comprises value of time savings, value of fuel cost savings, value of vehicle maintenance cost savings and value of reduction in accidents. Table 40 clearly shows that total economic benefits are negative because of the impact of time delays at intersections on the value of time, fuel and vehicle maintenance costs savings as well as impact of malfunctioning traffic lights induced accidents on value of reduction in accident costs. The economic benefits are -$936 000 in year 2011 and reduce to -$1 659 000 by year 2021.

On the cost side, all the adjusted values of investment costs and operating costs represent the real economic costs or resources that have been used by the project. The economic costs however remain constant at -$56 000 annually for the life of the project.

The difference between these economic benefits and costs presents the project's annual net economic benefits. These are -$991 000 in year 2011 and reduce annually thereafter to close at -$1 715 000 in year 2021. The stream of these net economic benefits is then discounted by the economic opportunity costs of capital (EOCK) of 15% to estimate the net present value of the project to economy of Zamzam. The results of the economic analysis show a negative economic NPV of $7.8 million. This clearly demonstrates the "Without Project" scenario is untenable from both financial and economic points of view.

Table 40: Without Project Scenario
Table 40: Economic Resource Flow Statement ($ Thousands)
Economic Benefits

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
VALUE OF TIME SAVINGS											
Light vehicles	(79)	(101)	(108)	(114)	(121)	(128)	(136)	(144)	(153)	(162)	(171)
Heavy vehicles	(93)	(113)	(120)	(127)	(135)	(143)	(152)	(161)	(171)	(181)	(192)
Total Value of Time Savings	**(172)**	**(215)**	**(228)**	**(241)**	**(256)**	**(271)**	**(288)**	**(305)**	**(323)**	**(342)**	**(363)**
VALUE OF FUEL COST SAVINGS	**(456)**	**(584)**	**(619)**	**(656)**	**(696)**	**(737)**	**(782)**	**(828)**	**(878)**	**(931)**	**(987)**
VALUE OF VEHICLE MAINTENANCE COST SAVINGS	**(2)**	**(2)**	**(2)**	**(2)**	**(3)**	**(3)**	**(3)**	**(3)**	**(3)**	**(3)**	**(4)**
VALUE OF REDUCTION IN ACCIDENT COSTS	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**	**(306)**
TOTAL BENEFITS	**(936)**	**(1,107)**	**(1,155)**	**(1,206)**	**(1,260)**	**(1,317)**	**(1,378)**	**(1,442)**	**(1,511)**	**(1,583)**	**(1,659)**
ECONOMIC COSTS											
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Investment Costs											

Dismantling old structures	-	-	-	-	-	-	-	-	-	-	-
Civil Works	-	-	-	-	-	-	-	-	-	-	-
Cabling & fitting accessories	-	-	-	-	-	-	-	-	-	-	-
NewTraffic Heads	-	-	-	-	-	-	-	-	-	-	-
Transport & Installation	-	-	-	-	-	-	-	-	-	-	-
Total Investment Costs	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Operating Costs											
Fixed Operating Costs											
Labor	44	44	44	44	44	44	44	44	44	44	44
General & Admin (excluding VAT)	2	2	2	2	2	2	2	2	2	2	2
O&M	2	2	2	2	2	2	2	2	2	2	2
Long Term Service Agreement & Others	-	-	-	-	-	-	-	-	-	-	-
Total Fixed Operating Costs	**49**	**49**	**49**	**49**	**49**	**49**	**49**	**49**	**49**	**49**	**49**

Variable Costs											
Fuel Requirement Cost	1	1	1	1	1	1	1	1	1	1	1
Electricity Consumed	5	5	5	5	5	5	5	5	5	5	5
Additional O&M costs Due To Powercuts	1	1	1	1	1	1	1	1	1	1	1
LTSA and Other Variable Costs	-	-	-	-	-	-	-	-	-	-	-
Total Variable Costs	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**
Total Economic Costs	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**
NET BENEFITS	**(991)**	**(1,163)**	**(1,211)**	**(1,262)**	**(1,316)**	**(1,373)**	**(1,434)**	**(1,498)**	**(1,566)**	**(1,638)**	**(1,715)**

ENPV @ 15% -7,767	**US$**	**FIRR #DIV/0!**

5.6.1.2 With Project Option A (Solar Power)

The economic resource flow statement is presented in Table 41 is prepared in a similar manner to the "Without Project" Scenario.

In this case, the economic benefits of the project are calculated as the difference between the "With" and " Without" project scenarios on benefit line items value of time savings, value of fuel cost savings, value of vehicle maintenance cost savings and value of reduction in accidents. The total economic benefits are clearly positive and induced by the impact of reduced time delays at intersections. Unlike with the "Without Project" scenario, residual values of cables and fittings as well as traffic heads come in as benefits in year 2021. The total economic benefits are $379 000 in year 2011 and increase annually to peak at $2 514 000 in year 2021.

The total economic costs commence at $550 000 in year 2011 and average $22 000 annually for the remaining years. Net benefits average $1 037 000 for the life of the project resulting in Economic Net Present Value of $4.7 million discounted at EOCK of 15%. The economy of Zamzam is therefore better off to the tune of $4.7 million through the implementation of the project.

TABLE 41: WITH PROJECT-OPTION A (SOLAR POWERED WITH 12 HOUR BATTERY BACK UP) SCENARIO

Table 41: Economic Resource Flow Statement ($ Thousand)

ECONOMIC BENEFITS	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Year											
TIME SAVINGS	34	115	108	114	121	128	136	144	153	162	172
Light vehicles	40	129	121	128	135	144	152	161	171	181	192
Heavy vehicles	**74**	**244**	**229**	**242**	**257**	**272**	**288**	**306**	**324**	**343**	**364**
Total Time Savings											
	198	**506**	**617**	**654**	**693**	**735**	**779**	**826**	**875**	**928**	**983**
FUEL COST SAVINGS											
	1	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**4**
VEHICLE MAINTENANCE COST SAVINGS											
	106	**212**	**244**	**244**	**244**	**244**	**244**	**244**	**244**	**244**	**244**
REDUCTION IN ACCIDENT COSTS											
RESIDUAL VALUES	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	270
Cables and Fittings	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	650
Traffic Heads											

	379	**963**	**1,092**	**1,142**	**1,196**	**1,253**	**1,314**	**1,378**	**1,446**	**1,518**	**2,514**
TOTAL BENEFITS											
ECONOMIC COSTS											
Investment Costs	42	-	-	-	-	-	-	-	-	-	-
Dismantling old structures	6	19	6	-	-	-	-	-	-	-	-
Civil Works	10	199	199	-	-	-	-	-	-	-	-
Cabling & fitting accessories	392	392	118	-	-	-	-	-	-	-	-
NewTraffic Heads	17	17	17	-	-	-	-	-	-	-	-
Transport & Installation	**467**	**627**	**340**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Investment Costs											
Operating Costs											
Fixed Operating Costs	44	44	44	44	44	44	44	44	44	44	44
Labor	4	5	6	5	5	5	5	5	5	5	5
General & Admin (excluding VAT)	35	70	81	80	79	78	77	77	76	75	74
O&M	-	-	-	-	-	-	-	-	-	-	-

Long Term Service Agreement & Others	**83**	**119**	**130**	**129**	**128**	**128**	**127**	**126**	**125**	**124**	**124**
Total Fixed Operating Costs											
Variable Costs	1	1	1	1	1	1	1	1	1	1	1
Fuel Requirement Cost	0	0	0	0	0	0	0	0	0	0	0
Electricity Consumed	-	-	-	-	-	-	-	-	-	-	-
Additional O&M costs Due To Powercuts	-	-	-	-	-	-	-	-	-	-	-
LTSA and Other Variable Costs	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Total Variable Costs											
	550	**748**	**471**	**130**	**129**	**129**	**128**	**127**	**126**	**125**	**125**
Total Economic Costs											
NET BENEFITS	**(171)**	**216**	**621**	**1,012**	**1,067**	**1,125**	**1,186**	**1,251**	**1,320**	**1,393**	**2,390**
		ENPV @	**15%**	**4,721**	**US$**	**EIRR**	**222.51%**				

5.6.1.3 With Project Option B (AC Power)

The economic resource flow statement is presented in Table 42 is prepared in a similar manner to the "Solar Power" Scenario.

The economic benefits and costs are also computed in similar fashion. The total economic benefits are \$364 000 in year 2011 and increase annually to peak at \$1 963 000 in year 2021. The total benefits average \$1.2 million annually for the life of the project.

The total economic costs commence at \$241 000 in year 2011 and average \$152 000 annually for the remaining years. Net benefits average \$1 032 000 for the life of the project resulting in Economic Net Present Value of \$5.1 million discounted at EOCK of 15%. The economy of Zamzam is therefore better off to the tune of \$5.1 million through the implementation of the project. The AC Power project option therefore performs better than solar option mainly due to lower investment costs.

WITH PROJECT-OPTION B (AC POWERED WITH 12 HOUR UPS BACK UP) SCENARIO

Table 42: Economic Resource Flow Statement ($ Thousand)

ECONOMIC BENEFITS											
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
TIME SAVINGS											
Light vehicles	30	77	94	99	105	112	118	125	133	141	149
Heavy vehicles	35	86	105	111	118	125	132	140	149	157	167
Total Time Savings	**65**	**163**	**198**	**210**	**223**	**236**	**250**	**266**	**281**	**298**	**316**
FUEL COST SAVINGS	**195**	**499**	**608**	**644**	**683**	**724**	**767**	**813**	**862**	**914**	**969**
VEHICLE MAINTENANCE COST SAVINGS	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**4**
REDUCTION IN ACCIDENT COSTS	**104**	**208**	**239**	**239**	**239**	**239**	**239**	**239**	**239**	**239**	**239**
RESIDUAL VALUES											
Cables and Fittings	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	270
Traffic Heads	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	165

TOTAL BENEFITS	364	871	1,048	1,096	1,147	1,202	1,260	1,321	1,386	1,455	1,963
ECONOMIC COSTS											
Investment Costs											
Dismantling old structures	42	-	-	-	-	-	-	-	-	-	-
Civil Works	6	19	6	-	-	-	-	-	-	-	-
Cabling & fitting accessories	10	199	199	-	-	-	-	-	-	-	-
NewTraffic Heads	100	100	30	-	-	-	-	-	-	-	-
Transport & Installation	17	17	17	-	-	-	-	-	-	-	-
Total Investment Costs	**174**	**335**	**252**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Operating Costs											
Fixed Operating Costs											
Labor	44	44	44	44	44	44	44	44	44	44	44
General & Admin (excluding VAT)	3	4	4	4	4	4	4	4	4	4	4
O&M	18	37	42	42	42	42	42	42	42	42	42

Long Term Service Agreement & Others	-	-	-	-	-	-	-	-	-	-	-
Total Fixed Operating Costs	**65**	**84**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**
-											
Variable Costs											
Fuel Requirement Cost	1	1	1	1	1	1	1	1	1	1	1
Electricity Consumed	1	3	3	3	3	3	3	3	3	3	3
Additional O&M costs Due To Powercuts	-	-	-	-	-	-	-	-	-	-	-
LTSA and Other Variable Costs	-	-	-	-	-	-	-	-	-	-	-
Total Variable Costs	**2**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
Total Economic Costs	**241**	**423**	**346**	**94**	**94**	**94**	**94**	**94**	**94**	**94**	**94**
NET BENEFITS	**123**	**448**	**702**	**1,002**	**1,053**	**1,108**	**1,166**	**1,227**	**1,292**	**1,361**	**1,869**
		ENPV @	**15%**	**5,092**	**US$**	**FIRR**	**#REF!**				

Chapter 6

STAKEHOLDER IMPACT ASSESSMENT

6.1 Scope of Stakeholder Impact Assessment

The stakeholder impact assessment or distributive analysis identifies the externalities created by the project and evaluates the impact of these externalities on its key stake holders. These externalities are created when there is a difference between the financial and the economic cashflows. The identified externalities, either negative or positive are then distributed among various stakeholders of the project. The distributive analysis typically identifies the winners and losers of the project and quantifies the gains or losses that accrue to them due to the implementation of the project. After the externalities are distributed, reconciliation between financial and economic resource flow statements with the distributive impacts is done. This reconciliation helps to ensure that the project appraisal analysis has been carried out in a consistent manner.

6.2 Identification of Project Externalities

The Colourful City traffic lights project has externalities as verified by the conversion factors of not equal to one for almost all of the project items shown in Table 35. This clearly demonstrates the difference between the financial and economic cashflows of the project. The real cash flow statement from total investment point of view, and real economic resources flow statement presented in Tables 7, 10 and 13 for financial analysis and tables 40, 41 and 42 for economic analysis respectively, serve as a basis for the calculation of the externalities created from the proposed project. The difference between these two statements (economic and financial) presents the externalities of the proposed project. The identified externalities are then discounted by the economic opportunity cost of capital of 15% to arrive at their present values. The present value of the externalities is estimated for both the Solar Power and AC Power project procurement options. These are $6 711 000 and $6 308 000 for the Solar Power and AC Power options respectively. These externalities can be computed as follows:

$$NPV_{EXT} = NPV_{ECON} - NPV_{FIN}$$

This translates to

= 4.721 – (-1.99) = $ 6.711 million for Solar Power option and,

= 5.092 – (-1.216) = $ 6.308 million for Solar Power option and,

Where: NPV_{EXT} = NPV of externalities

NPV_{ECON} = NPV of real economic cash flows

NPV_{FIN} = NPV of real financial cash flows, using economic discount rate

The project externalities are distributed among three stakeholders; road users, labor and Government. Tables 43 and 44 present the distribution of the externalities among the project stakeholders and also provides reconciliation between economic and financial with the distributive impacts using a common economic discount rate of 15%.

6.2.1.1 With Project Option A (Solar Power)

Table 43 shows that from the total externalities for solar power option of $6.711 million, 96% will be allocated to road users, 3% to government and 1% will be allocated to labour. Of the 96% share of road users, 78% accrues to all road users, 12% to heavy vehicle users and the remaining 10% to light vehicle users. Benefits to road users mostly comprise value of time savings, value of fuel cost savings, value of vehicle maintenance cost savings and value of reduction in accidents. Labour benefits from wage rates priced above their economic value whilst government benefits from taxes and duties. It is however important to note that although the 1% labour externality applies to workforce working on the project, road users' share of externalities of 96% largely comprises labour externalities accruing to workforce employed elsewhere.

Table 43: Allocation Of Externalities, 2011 (Us$ Thousand)

	EXTERNALITIES		**ROAD USERS**					**LABOUR**	**GOVERNMENT**	
			LIGHT VEHICLES		**HEAVY VEHICLES**		**ALL USERS**			
TIME SAVINGS										
Light vehicles	676		676						0.00	
Heavy vehicles	757				757				0.00	
Total Time Savings	**1,433**		**676**		**757**		**0**		0.00	
FUEL COST SAVINGS	**3,736**						**3,736**			
VEHICLE MAINTENANCE COST SAVINGS	**14**						**14**		**0.00**	
REDUCTION IN ACCIDENT COSTS	**1,302**						**1,302**		0	
Residual Values										
Cables and Fittings	**-**									
Traffic Heads	**-**									

TOTAL BENEFITS	**6,485**		**676**		**757**		**5,052**		**0**	
ECONOMIC COSTS										
Investment Costs										
Dismantling old structures	-8							-8		
Civil Works	-13								-13	
Cabling & fitting accessories	-1								-1	
NewTraffic Heads	-121								-121	
Transport & Installation	-21								-21	
Total Investment Costs	**-164**		**0**		**0**		**0**	**-8**	**-156**	
Operating Costs										
Fixed Operating Costs										
Labor	-53							-53		
General & Admin (excluding VAT)	-6							-6		
O&M	-1								-1.14	
Long Term Service Agreement & Others	0								0.00	
Total Fixed Operating	**-60**		**0**		**0**		**0**	**-59**	**-1**	

Costs										
Variable Costs										
Fuel Requirement Cost	-2								-1.99	
Electricity Consumed	0									
Additional O&M costs Due To Powercuts	0								0.00	
LTSA and Other Variable Costs	0								0.00	
Total Variable Costs	**-2**								**-1.99**	
Outflow before financing	**-226**		**0**		**0**		**0**	**-67**	**-159**	
Total Outflow	-226									
NET BENEFITS	**6,711**	**0**	**676**	**0**	**757**	**0**	**5,052**	**67**	**159**	

6.2.1.2 With Project Option B (AC Power)

Table 44 shows that from the total externalities AC solar power option of $6.308 million, 97% will be allocated to road users, 2% to government and 1% will be allocated to labour. Of the 97% share of road users, 81% accrues to all road users, 10% to heavy vehicle users and the remaining 9% to light vehicle users. Benefits to road users mostly comprise value of time savings, value of fuel cost savings, value of vehicle maintenance cost savings and value of reduction in accidents. Labour benefits from wage rates priced above their economic value whilst government benefits from taxes and duties.

Table 44: Allocation Of Externalities, 2011 (Us$ Thousand)

	EXTERNALITIES		ROAD USERS					LABOUR	GOVERNMENT
			LIGHT VEHICLES		HEAVY VEHICLES		ALL USERS		
TIME SAVINGS									
Light vehicles	567		567						0.00
Heavy vehicles	636				636				0.00
Total Time Savings	**1,203**		**567**		**636**		**0**		0.00
FUEL COST SAVINGS	**3,680**						**3,680**		
VEHICLE MAINTENANCE COST SAVINGS	**13**						**13**		**0.00**
REDUCTION IN ACCIDENT COSTS	**1,277**						**1,277**		
Residual Values									
Cables and Fittings	-								-
Traffic Heads	-								-
TOTAL BENEFITS	**6,174**		**567**		**636**		**4,971**	**0**	**0**
ECONOMIC COSTS									

Investment Costs								
Dismantling old structures	-8						-8	
Civil Works	-25							-25.33
Cabling & fitting accessories	-1							-0.91
NewTraffic Heads	-31							-30.77
Transport & Installation	-43							-42.53
Total Investment Costs	-108						-8	-100
Operating Costs								
Fixed Operating Costs								
Labor	-53						-53	
General & Admin (excluding VAT)	-5						-5	
O&M	-1							-0.61
Long Term Service Agreement & Others	0							0.00
Total Fixed Operating Costs	-58						-57	-1
Variable Costs								
Fuel Requirement Cost	-2							-1.99
Electricity Consumed	0							
Additional O&M costs Due To Powercuts	0							0.00
LTSA and Other Variable Costs	0							0.00

Total Variable Costs	-2								-1.99
Total Outflow	**-168**		**0**		**0**		**0**	**-66**	**-102**
NET BENEFITS	**6,342**	**0**	**567**		**636**	**0**	**4,971**	**66**	**102**

6.2.1.3 Conclusion

The solar power option yields higher value of externalities of $6.711 million as compared to $6.308 million. Stakeholders therefore benefit more from the implementation of the solar power option than AC power option.

It is however interesting to note from economic analysis in chapter 5 that the AC option has a higher economic NPV of $5.092 million as compared to $4.721 million for solar option and therefore preferred. Although the distributive analysis seems to indicate the opposite, the AC power option remains the preferred option. The apparent “contradiction” can be explained by the fact that the net increase in benefits to stakeholders between Solar and AC option is more than offset by incremental financial benefit arising from lower investment and operating costs associated with the AC power option. The difference between present value of externalities for Solar and AC power is $403 000 in favour of solar. This is more than offset by financial savings of $774 000 (difference between financial NPVs of solar and AC power option) arising from using the AC Power option. The net difference in savings of $371 000($774 000- $403 000) is equivalent to the difference in economic NPVs of the two options in favour of AC Power option. Since financial benefits associated with AC power option accrue to Council and council is “owned” by rate payers and Government, it can be reasonably argued that the financial benefit accrues to all project stakeholders. In this regard the distributive analysis would also confirm the superiority of the AC Power option to the solar option.

Chapter 7

RISK ANALYSIS

Results of the economic and distributive analysis of the project indicate that the AC powered traffic lights procurement option is preferred as it has higher net benefits to the economy and project stakeholders. With respect to this project, financial analysis was conducted only as a building block to the economic and distributive analysis. There is therefore no merit in conducting risk analysis on the financial analysis part of the model. Although risk analysis is conducted on both project procurement options, distributive analysis was conducted on the preferred AC Power option only.

7.1 The Risk Analysis Process

7.1.1 Identification of Risk Variables

The first step of risk analysis involves identification of the risk variables, which should be both uncertain and very sensitive to the outcomes of the proposed project. Sensitivity analysis is carried out to determine risky variables of parameters.

7.1.2 Probability Distributions of Selected Variables

Once the most risky variables have been identified, the reliable set of their historical data is obtained in order to project their future movements. The second stage particularly involves the selection of the appropriate probability distributions and the likely range of values for each of the selected risk variables, based on their historical observations. After risk assumptions have been made and modeled, the next step is to model the outcomes of the project. A Monte Carlo simulation generates a probability distribution of the outcomes of the project based on the underlying uncertainty surrounding each of the key risk variables identified. These expected outcomes are known as risk forecasts. In the case of the traffic lights project , the risk forecasts of may include financial NPV from owner's point of view, economic NPV, PV of road users, government and labour externalities.

7.1.3 Interpretation of Risk Results

The results of the risk analysis are presented by the forecast charts for each of the risk forecasts and the overlay chart for financial and economic NPVs. These are in turn interpreted and observations and conclusions made.

7.2 Sensitivity Analysis

The first step of risk analysis involves identification of the risk variables using sensitivity analysis. Sensitivity analysis was conducted on annual growth in traffic, minimum wage rate, cloud cover, power cuts-days in year, power cuts of more than 12 hours (12HR+) and battery life.

7.2.1 Annual Growth in Traffic

Table 45 shows that as the traffic growth rate increases, project economic and distributive benefits for both Solar and AC power options increase. The opposite is true. Externalities to road users increase or decrease in similar fashion and those to Government remain constant at $159 000. Government externalities remain constant because taxes are applied to investment costs which are not affected by annual growth in traffic. Using excel goal seek function reveals that annual growth in traffic has to drop to at least -200% for negative economic NPVs to be realised for both project outcomes. As the percentage suggests, this is highly unlikely.

Table 45: Sensitivity test: annual growth in traffic

					AC POWERED			
	ENPV	**ENPV**	**PV EXT**	**PV EXT**	**LV USERS**	**HV USERS**	**ALL USERS**	**GVT**
	SOLAR $	**AC POWER $**	**SOLAR $**	**AC POWER $**	**$**	**$**	**$**	**$**
	4,721	**5,092**	**6,711**	**6,308**	**676**	**757**	**5,052**	**159**
10.00%	5,957	6,267	7,946	7,483	834	934	5,952	159
8.00%	5,303	5,645	7,293	6,861	750	841	5,475	159
6.00%	4,721	5,092	6,711	6,308	676	757	5,052	159
4.00%	4,203	4,599	6,193	5,815	609	683	4,674	159
2.00%	3,742	4,161	5,732	5,377	550	617	4,339	159

7.2.2 Minimum Wage Rate

Table 46 shows that as minimum wage rate increases, project economic and distributive benefits for both Solar and AC power options increase. The opposite is true. Externalities to light and heavy vehicle users increase or decrease in similar fashion and those to all road users remain constant at $5.052 million. This is because benefits to all road users, which include value of fuel cost savings, value of vehicle maintenance cost savings and value of reduction in accidents, are not dependant on minimum wage rate. Using excel goal seek function reveals that minimum wage rate has to drop to at least $5 per month for negative economic NPVs to be realised for both project outcomes. This is also highly unlikely.

Table 46: Sensitivity Test: Minimum Wage Rate

					AC POWERED			
	ENPV	ENPV	PV EXT	PV EXT	LV USERS	HV USERS	ALL USERS	GVT
	SOLAR $	AC POWER $	SOLAR $	AC POWER $	$	$	$	$
	4,721	**5,092**	**6,711**	**6,308**	**676**	**757**	**5,052**	**159**
350	5,849	6,057	7,839	7,273	1,576	870	5,052	184
250	5,308	5,597	7,298	6,813	1,126	814	5,052	177
150	4,721	5,092	6,711	6,308	676	757	5,052	159
100	4,368	4,779	6,358	5,995	450	729	5,052	137
75	4,141	4,573	6,131	5,789	338	715	5,052	115
50	3,815	4,267	5,805	5,482	225	701	5,052	71

7.2.3 Cloud Cover

Table 47 shows economic and distributive benefits of AC power project option are insensitive to changes in cloud cover whilst the Solar power option is marginally sensitive. Even 100% cloud cover does not have a material impact on project outcomes. Externalities to all stakeholders, except Government, increase or decrease with reductions or increases in cloud cover. Externalities to Government remain constant at $159 000.

Table 47: Sensitivity Test: Cloud Cover

					AC POWERED			
	ENPV	**ENPV**	**PV EXT**	**PV EXT**	**LV USERS**	**HV USERS**	**ALL USERS**	**GVT**
	SOLAR $	**AC POWER $**	**SOLAR $**	**AC POWER $**	**$**	**$**	**$**	**$**
	4,721	**5,092**	**6,711**	**6,308**	**676**	**757**	**5,052**	**159**
50%	4,712	5,092	6,702	6,308	677	758	5,040	159
40%	4,717	5,092	6,707	6,308	676	758	5,046	159
31%	4,721	5,092	6,711	6,308	676	757	5,052	159
20%	4,727	5,092	6,716	6,308	675	757	5,058	159
10%	4,732	5,092	6,721	6,308	675	756	5,064	159
5%	4,734	5,092	6,723	6,308	674	756	5,067	159

7.2.4 Power Cuts Days in Year

Table 48 shows economic and distributive benefits of solar power project option are insensitive to increases in power cuts whilst AC power option is marginally sensitive. The sensitivity analysis indicates however that this does not change the attractiveness of the AC Power option over the Solar Power option. Changes power cut days in year have no bearing on the quantum and share of externalities to and by project stakeholders.

Table 48: Sensitivity Test: Powercuts-Days In Year

					AC POWERED			
	ENPV	ENPV	PV EXT	PV EXT	LV USERS	HV USERS	ALL USERS	GVT
	SOLAR $	AC POWER $	SOLAR $	AC POWER $	$	$	$	$
	4,721	**5,092**	**6,711**	**6,308**	**676**	**757**	**5,052**	**159**
200	4,721	5,093	6,711	6,308	676	757	5,052	159
150	4,721	5,092	6,711	6,308	676	757	5,052	159
118	4,721	5,092	6,711	6,308	676	757	5,052	159
75	4,721	5,091	6,711	6,308	676	757	5,052	159
50	4,721	5,090	6,711	6,308	676	757	5,052	159
25	4,721	5,090	6,711	6,308	676	757	5,052	159

7.2.5 Power Cuts of More than 12 Hours

Table 49 shows that project outcomes on both Solar and AC power project options respond to power cuts of more than 12 hours. Reduced incidences of power cuts of more than 12 hours cause Economic NPVs and PV of Externalities for both Solar and AC power options to increase. The opposite is true. Light and heavy vehicle users however lose their share of externalities to all road users as incidences reduce and verse versa. Externalities to government remain constant at $159 000.

Table 49: Sensitivity test: power cuts 12hr+ (days in year)

					AC POWERED			
	ENPV	**ENPV**	**PV EXT**	**PV EXT**	**LV USERS**	**HV USERS**	**ALL USERS**	**GVT**
	SOLAR $	**AC POWER $**	**SOLAR $**	**AC POWER $**	**$**	**$**	**$**	**$**
	4,721	**5,092**	**6,711**	**6,308**	**676**	**757**	**5,052**	**159**
80	4,711	4,897	6,701	6,113	677	759	5,039	159
60	4,717	5,015	6,707	6,231	676	758	5,047	159
47	4,721	5,092	6,711	6,308	676	757	5,052	159
30	4,727	5,192	6,716	6,408	675	757	5,058	159
20	4,730	5,251	6,720	6,467	675	756	5,062	159
10	4,733	5,310	6,723	6,526	674	756	5,066	159

7.2.6 Battery Life

Table 50 shows that project outcomes on both Solar and AC power project options improve when battery life is extended. The reverse is true. The outcomes remain positive even when battery life drops to 0. All road users lose their share of externalities to light and heavy vehicle users as battery life reduces and verse versa.

Table 50: Sensitivity Test: Battery Life (Hrs)

					AC POWERED			
	ENPV	**ENPV**	**PV EXT**	**PV EXT**	**LV USERS**	**HV USERS**	**ALL USERS**	**GVT**
	SOLAR $	**AC POWER $**	**SOLAR $**	**AC POWER $**	**$**	**$**	**$**	**$**
	4,721	**5,092**	**6,711**	**6,308**	**676**	**757**	**5,052**	**159**
36	4,737	5,191	6,726	6,407	674	755	5,070	159
24	4,737	5,191	6,726	6,407	674	755	5,070	159
12	4,721	5,092	6,711	6,308	676	757	5,052	159
6	4,694	4,918	6,685	6,134	679	761	5,019	159
2	4,676	4,802	6,667	6,018	681	763	4,998	159
1	4,672	4,773	6,663	5,989	681	763	4,992	159

7.3 Interpretation of Results of Risk Analysis(Sensitivity Analysis)

The sensitivity analysis conducted above clearly show that all risk variables identified do not cause material changes in the economic and distributive outcomes of the project. There is therefore no merit in conducting full risk analysis using Monte Carlo simulation. The sensitivity analysis can be used to make critical decisions on the project.

7.3.1 Optimising Project Performance

The sensitivity analysis indicates that project performance can be optimising by increasing battery life to beyond 15.4 hours. Reducing incidences and duration of power cuts would also boost the performance of the project. Council can impact directly on battery life through its tender specifications. Council can also lobby the power utility to reduce power cuts on electricity feeders to the traffic lights system. The economic and distributive analysis exposed the fact that the AC Power option's superiority over the solar power option is tied to the lower investment costs associated with the former. It is also clear that should the investment costs for Solar option go down to the extent of increasing financial NPV by more than $371 000, the Solar option would became preferable. Investment cost of solar option would therefore be critical selection criteria for solar solutions in the tendering process.

Chapter 8

CONCLUSION

The evaluation of the proposed traffic lights project has been based on the integrative investment appraisal methodology, developed by Jenkins and Harberger (Jenkins & Harberger, 2002). This integrated project appraisal technique involves the evaluation of the financial, economic, stakeholder, sensitivity and risk analysis in order to assess the feasibility and long term sustainability of the project.

The objective of the project is to reduce economic and social costs associated with malfunctioning and inadequate traffic lights by rehabilitating and installing new traffic lights in and around Colourful City's central business district (CBD). The economic analysis showed that both project procurement alternatives achieve this and that the AC powered option is more cost effective as it has a higher Economic Net Present Value of $5.1 million when compared to $4.7 million for solar power option. All road users, heavy vehicles users, light vehicles users and Government benefit from project in that ranking order. Risk analysis shows that project is not sensitive to power cuts, cloud cover and battery life. Although sensitive to annual growth in traffic and minimum wage rate, the risk parameters do not pose a significant threat to the economic viability of the project.

Zamzam Development Bank is justified in financing the project has it delivers demonstrable positive economic and social impacts. The appraisal also shows that the Bank and Council can rely on the model to adjudicate tenders for the traffic lights system. The analysis indicates that the Request for Proposal should include clear specifications on battery life, electricity consumption per intersection and investment cost breakdown amongst other criteria

REFERENCES

Cambridge Resources International (2004). *Integrated Investment Appraisal: Concept and Practice*, Prepared for Department of Finance and Economic Development Limpopo Provincial Government, Republic of South Africa.

Cambridge Resources International (2005). *An Operational Manual For An Integrated Appraisal of Investments in Roads, Schools and Hospitals* Prepared for Department of Finance and Economic Development Limpopo Provincial Government, Republic of South Africa.

Harberger A.C., (1967). "Cost-Benefit Analysis of Transport Projects", paper prepared for a conference on "Engineering The Economic Opportunity Cost of Capital for South Africa", *South African Journal of Economics*.

Glenn P Jenkins and Chun-Yan Kuo (2006), *Evaluation of the Benefits of Transnational Transportation Projects*, Journal of Applied Economics Vol IX, No 1 (May 2006), 1-17.

Frequently Asked Questions on Mortality Risk Evaluation , National Center for Environmental Economics, United States Environmental Protection Agency. http://yosemite.epa.gov/ee/epa/eed.nsf/pages/MortalityRiskValuation.htm

Statistical Value of Life, Contingent Valuations Done in Bangkok http://www.springerlink.com/content/m4514276t3161116/

Economy of Thailand, http://en.wikipedia.org/wiki/Economy_of_Thailand,
http://www.indexmundi.com/thailand/gdp_per_capita_(ppp).html