An Investment Appraisal of Cogeneration of Electricity Using Bagasse

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ABSTRACT

The bagasse cogeneration project that has not been largely exploited till now provides one of the best examples of renewable cogeneration. Cogeneration from sugarcane explains the use of fibrous sugarcane waste bagasse to generate heat and electricity at high efficiency in sugar factory. The cogeneration of bagasse has numerous advantages; amongst many others are social, economic and environmental advantages. Sustainable development, variety of supply and security also apply across these categories.

This thesis is an integrated investment appraisal of the use of bagasse to generate electricity both for consumption by a sugar refinery as well as to sell to the electricity grid of Nicaragua. From this analysis it appears to be potentially very attractive investment both financially as well as economically.

Keywords: Bagasse, cogeneration, sugarcane, economic growth

ÖZ

Şeker kamışı atıklarından üretilen kojenerasyon henüz keşfedilmeyen yenilenebilir tabanlı kojenerasyonun en iyi örneklerinden biridir. Şeker kamışından kojenerasyon şeker fabrikasında yüksek verimlilikte ısı ve elektrik üretimi için lifli şeker kamışı atığı kullanımını açıklar. Şeker kamışı atığının kojenerasyon için yakıt olarak kullanımının çevresel, sosyal ve ekonomik yönden birçok avantajı vardır. Diğer avantajları artan güvenlik ve arzın çeşitliliği veya sürdürülebilir kalkınma hedefleri bu kategoriler arasında sıralanabilir.

Bu tez elektrik üretiminde şeker kamışı atığı kullanımının hem şeker rafinerisi tarafından tüketilen hem de Nikaragua elektrik şebekesine satmak için üretilen elektriğin bütünleşmiş yatırım değerlendirmesidir. Analizler sonucunda bu yatırım hem finansal hem de ekonomik açıdan cazip bir yatırım olarak değerlendirilmiştir.

Anahtar Kelimeler: Şeker Kamışı atığı, kojenarasyon, şeker kamışı, ekonomik büyüme

To my late dad

MR. BENNETT OWOLABI

My Mum

GRACE OWOLABI

And to my Sister

BOSEDE OWOLABI

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Firstly, I would like to thank God for seeing me through this stage of my life. Secondly, I would like to show my appreciation to Prof. Dr. Glenn P. Jenkins for his continuous support and guidance in the preparation of this study. Without his invaluable supervision, all my efforts could have been short-sighted.

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LIST OF SYMBOLS OR LIST OF ABBREVIATIONS

NPV……………………………Net Present Value

EOCK…………………………Economic Opportunity Cost of Capital

FEP……………………………Foreign Exchange Premium

LLCR…………………………Loan Life Coverage Ratio

ADSCR………………………Average Debt Service Coverage Ratio

INE……………………………National Energy Regulatory Agency

ENEL…………………………Empresa Nicaraguense de Electricidad

PPA……………………………Power Purchase Agreement

FAO……………………………Food and Agricultural Organization

OECD…………………………Organization for Economic Co-operation Development

T&D……………………………Transmission and Distribution

IPP……………………………..Independent Power Producer

CNE…………………………… Comisión Nacional de Enegía

MT……………………………… Metric Ton

Chapter 1

INTRODUCTION

1.1 Background

In the past, burning of bagasse (a leftover of the process of producing sugar out of sugarcane) was seen as a method of getting rid of a residue[1]. In recent years, bagasse has become to be seen more and more as a useful by product to generate heat and power. Historically, the sugarcane industry has been using bagasse for generation of heat and power to fulfill its own energy demand. In Nicaragua, there is a potential for the sugar factories to extend their power production and sell power to the national grids, both during and after the sugarcane crushing season. A potential off-season fuel is chipwood from dedicated energy plantations. In addition to the environmental advantages, this use of idle capacity is likely to generate significant socio-economic benefits as well. The objective of this thesis is to analyze the existing expansion plans of the Agroinsa sugar factory which is also known as Victoria de Julio sugar factory power plant in the capital of Nicaragua, Managua.

1.2 Agroinsa (Victoria de Julio) Sugar Factory Power Plant

The Victoria de Julio sugar factory is the second largest sugar factory in Nicaragua, which started its operation in 1985. This sugar factory is typical in Central America. The

[1] Richard van den Broek and Ad van Wijk (2010). Heat and Power From Eucalyptus and Bagasse in Nicaragua: Part A: Description of Existing Initiatives

concept of electricity cogeneration was already integrated in the original design of the plant as described in the figure below. The plant was designed to have 36MW of total installed electricity generation capacity for a crushing rate of 7000 tons/day. At this moment 12MW is already installed[2]. Although the other two 12MW turbines, on which the power sales are mainly based, have been available at the sugar factory for more than 8 years, they were never installed.

The main reason was that due to an economic meltdown in Nicaragua. As a consequence the factory turbine was never been used to its full capacity and there was no demand for extra power capacity in the country. Recently, with the privatization of the sugar factory and the opening of the electrical market for private investors, the original plans were revived again. The expansion that is needed mainly consists of the installation of the 12MW turbines and upgrading of the existing boiler system. One 12MW low pressure condensing turbine will be placed in series with the existing three 4MW turbines and will generate power outside the harvesting season. The other 12MW turbine is a high pressure extraction condensing turbine which can be used for power generation the whole year, but could also back up the three 4 MW turbines as supply source of steam to the sugar factory. Because of the relatively low steam temperature, the net electrical efficiency will remain limited to about 20%.

[2] Rogerio Carneiro de Miranda and Richard van den Broek, (2007). Power Generation from Fuelwood by the Nicaraguan Sugar mills.

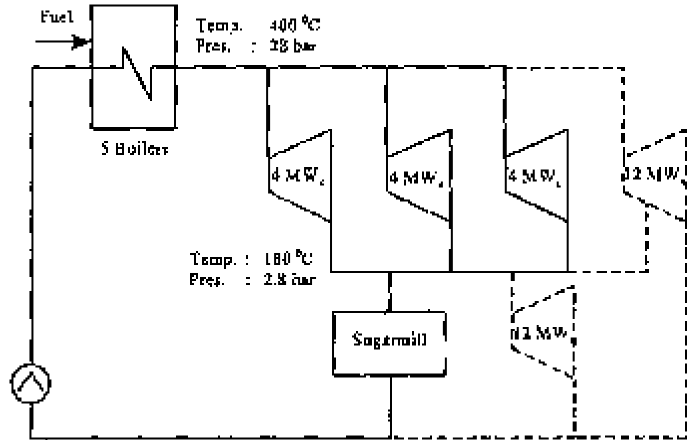


Figure 1: Victoria de Julio sugar factory[3]

A unique concept of the company's sugarcane plantations is that they are all irrigated by circular pivot systems with 500m radius each. An excellent system has been created, consisting of the more than 180 circles with roads running in between them. The sugar factory is located in the middle. The eucalyptus plantations which provide the chipwood make use of the soil in between the circular sugarcane plantations. This means that about 20 hectares can be used in each square (of 1 by 1 km) containing a circular pivot irrigation system.

1.3 Methodology and Approach

In this research, a model will be developed to evaluate the project's variability through the discounting of expenditures and receipts from different points of view. This model determines whether the project creates a positive return throughout its lifetime with respect to the required rate of return. In addition, it examines the economic feasibility of the project to see how a positive or negative the performance affects the economy as a whole. The model then recognizes the externalities of project that accrue to others than

[3] Scheme of the Victoria de Julio sugar factory dotted lines indicate the extensions

the owners of project. The model continues with further analysis on stakeholders of the project. The purpose of this analysis is to measure the benefits and loses to the domestic and foreign investors and to determine what will be left for the host country due to the performance of the project. This extra study is the main part of this thesis, which demonstrates the economic net present value of project adjusted for foreign financing. The final product of analysis demonstrates the project's developmental impacts on the country.

The model should determine:

- The economic net resource flow of project discounted by economic opportunity cost of capital (EOCK)
- The amount of foreign financing adjusted for foreign exchange premium (FEP)
- The economic resource flows adjusted for foreign financing.

1.4 Result of Analysis

This study shows that the bagasse cogeneration project has a profitable and high rate of return for investors. In addition, the project is strong enough to cover its debts, which form a significant proportion of its capital. The economic analysis reveals that the bagasse cogeneration project boosts the economic performance of Nicaragua. In addition, the distributive analysis identifies that the labors (skilled and unskilled) benefit from implementation of project due to improvement of their skills, knowledge and earnings. In this study, it is demonstrated that resources is been transferred from foreign investors to the economy.

1.5 Structure of the Thesis

This first chapter introduces the main idea of the thesis and aspects that would be discussed more as we go on. The second chapter is an overview and mainly discusses the benefits and advantages of using bagasse as a fuel. The third chapter discusses the methodology used in this thesis. The fourth chapter outlines the project description and scope of the project. The fifth chapter explains the financial and economic analysis. The sixth chapter shows the sensitivity analysis and risk analysis results for the bagasse cogeneration project. Lastly, the seventh chapter gives the conclusion.

Chapter 2

BAGASSE OVERVIEW

2.1 What is Bagasse?

Bagasse is a sugarcane fiber waste after the extraction of sugar juice from sugarcane[4]. The word bagasse, from the French bagage via the Spanish bagazo, originally meant "rubbish," "refuse," or "trash." Applied first to the remains from the pressing of olives, palm nuts, and grapes, the word was subsequently used to mean residues from other processed plant materials such as sisal, sugarcane, and sugar beets. In modern use, the word is limited to the end product of the sugarcane factory. Bagasse may be used as fuel in the sugarcane refinery or as a source of cellulose for manufacturing animal feeds. Paper is produced from bagasse in several South American countries and in all sugar producing countries that are deficient in forest resources. Bagasse is the most important ingredient in the making of pressed building board, acoustical tile, and other construction materials. The figure below shows what bagasse look like.

Figure 2: Bagasse

[4] http://www.britannica.com/EBchecked/topic/48728/bagasse

2.2 Combined Heat and Power

The cogeneration of electricity using the waste of sugarcane is one of the best renewable examples that are yet to be developed to a large extent. In sugar factories, cogeneration of electricity is at high efficiency using bagasse. The cogeneration of bagasse has numerous advantages; amongst many others are social, economic and environmental advantages. Sustainable development, variety of supply and security also apply across these categories.

2.3 Sugar Industry

The problem that the sugar industries worldwide usually face is extreme instability of sugar prices. There is a tough competition between countries that are able to produce sugar cheaply and the ones that cannot produce cheap sugar. A sugar factory consumes more electricity. From the past history of sugar factories, they heat bagasse and other fuels to produce their own electricity so as to meet the factory's need. The electricity generated by the sugar factories has never been a sold to the third party because there have been no incentive and encouragement to efficiently produce electricity. It is a different case now because there is tax involved for electricity supplied to the grid by the IPP. The zeal to generate electricity has been pushed aside because there is no much need for it. Now with introduction of taxes in Nicaragua's IPP, there has been motivation for countries producing sugar to learn how it is been done around the world. The full advantage of cogeneration of bagasse has not been adequately realized not until recently that most South American countries found new interest in this project.

2.4 Sugar Making and Production

In the tropical and subtropical regions, sugarcane grows with presence of adequate water either by irrigation or good rainfall distribution. Harvesting of sugarcane happens every third to fourth quarter of the year, depending on crop variety. The table below shows the comparison between countries that produce sugarcane.

Table 1: Sugar Producers

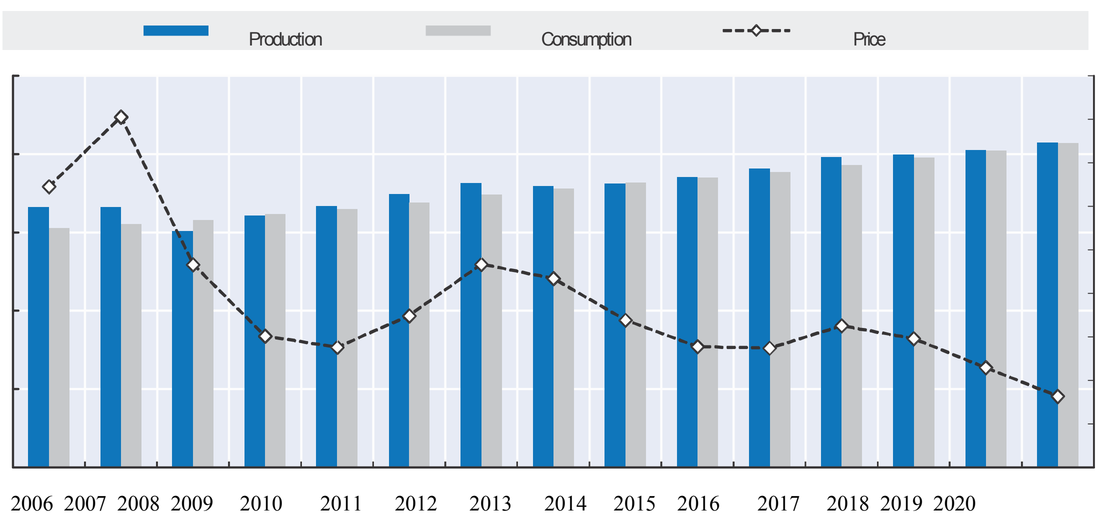
	Area Harvested (Ha)	Production ranking	Yield (tonnes/ha)	Production (tonnes)
Australia	423,000	8	85.13	36,012,000
Brazil	5,303,560	1	73.83	386,232,000
China	1,328,000	3	70.71	93,900,000
Colombia	435,000	7	84.14	36,600,000
Cuba	1,041,200	9	33.33	34,700,000
India	4,300,000	2	67.44	290,000,000
Mexico	639,061	6	70.61	45,126,500
Pakistan	1,086,000	5	47.93	52,055,800
Philippines	385,000	11	67.1	25,835,000
Thailand	970,000	4	76.36	74,071,952
USA	403,390	10	77.29	31,178,130
Other	4,091,132			244,581,738
TOTAL	20,405,343			1,350,293,120
Average			68.53	

Source: FAO[5]

[5] FAO

2.5 Sugar Prices

There has been instability in the price of sugar for decades due to the imbalances of supply and demand. Prices have been relatively low overall this past 40 years because world supply has been more than demand. In the early eighties when the prices of sugar went higher from a long term average price, there was a short price abnormal growth. The growth is then followed by a lengthy period of low prices, which normally goes below the production cost. The table below highlights the trend in consumption, prices and production.



Source: OECD and FAO Secretaries[6]

Figure 3: Production, consumption and prices

The instability of sugar prices is expected to come to its barest minimum due to the invention of alternative artificial sweeteners. Developing countries may have reduce unevenness in the sugar prices around the world because they are more interested in lowering the price so it can be affordable by the people.

[6] OECD and FAO

2.6 Production Process of Sugar

The sugar production process from sugarcane is shown in figure below. The process is very energy intensive. It requires the inputs of both heat and power at many stages. This is why it is called the application of cogeneration.

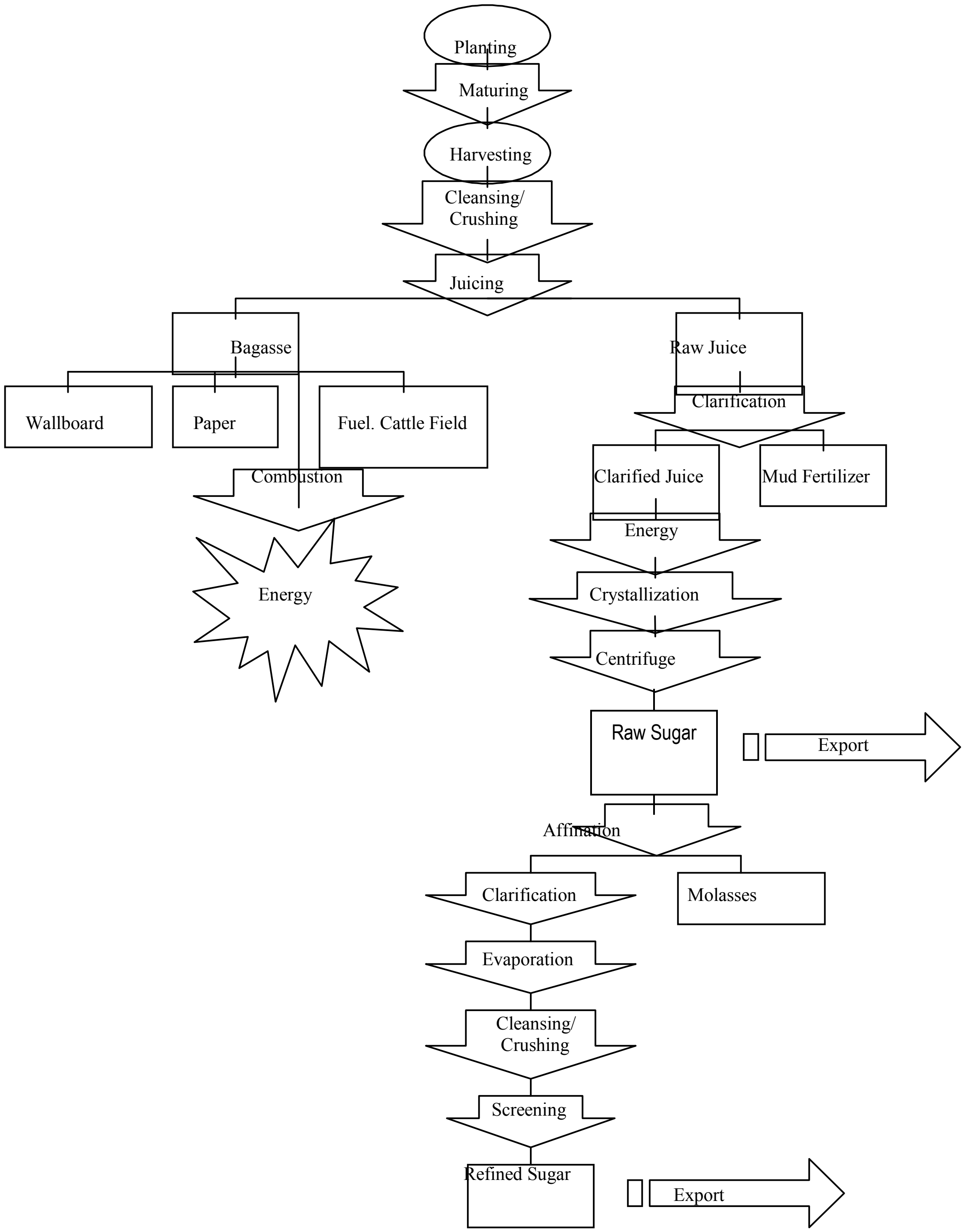


Figure 4: Sugarcane Processing Flow Chart

2.7 Benefits of Bagasse Cogeneration

Bagasse cogeneration has numerous advantages over traditional electricity generation. All parties will benefit according to the financial point of view of the sugar industry. The social benefits which is mainly the reduction of the emission of carbon dioxide, the efficiency in distribution and also the low cost makes the cogeneration of bagasse more attractive. All these benefits and more are classified into economic benefits, social benefits and environmental benefits.

2.7.1 The Economic Benefits

2.7.1.1 Effective Transmission and Distribution

Transmission and distribution losses are reduced in bagasse cogeneration because electricity is been supplied near the generation point and this also make less wires to be used. A huge loss mostly happens in big countries, where the average of sixteen to twenty percent generated electricity is lost nationally due to the fact that there is long distance between generation point and the consumers. The benefits of bagasse cogeneration are massive for the consumers that will not have to pay for losses in transmission and distribution process. The use of latest technology in the sugar refineries will contribute much benefit to the cogeneration process and it will also enhance the long term growth of the refineries in countries that produces sugar. The more the needs of the sugar refinery is been met due to the increase in the energy needed and also actualizing the exportation to utilities could make the sugar refineries strong and withstand the test of times.

2.7.1.2 Costs

Bagasse cogeneration project has a lower capital costs compared to all other renewable forms of power generation. It is same result of low costs like the biomass gas projects. The total cost of generation despite being higher than biomass gas projects are on equal base with biomass power and are lower than wind. Due to the tested, trusted and well established technologies used, bagasse cogeneration project has short development periods.

2.7.2 The Social Benefits

2.7.2.1 Constant Electricity

Sugar factories are always located near the sugarcane plantations. In the case of Nicaragua, Agroinsa is situated in the rural area near the sugarcane plantations which is more beneficial to local populations. Electricity supplies will get there first. Also, the boards of electricity will be able to distribute to those users in the rural areas better because it will be easier to network the links between the rural and the urban areas.

2.7.2.2 The Employment Opportunities

Energy plantations create new employment opportunities for the real people. This would create a formal and assured market benefiting potentially large numbers of people thereby increasing the income for farmers. Bagasse cogeneration will also allow operational personnel to develop skills to use local equipment and technologies, improving the local socio economy.

2.7.3 The Environmental Benefits

2.7.3.1 Low Carbon Emission

The energy function of a sugar industry can lead to less CO^2 emissions. This is true when the cogeneration of bagasse replaces carbon intensive fossil fuel generation. For instance, in Nicaragua, bagasse could displace coal, which amongst other problems has very high levels of ash.

2.7.3.2 Combustion

Burning of bagasse will produce CO^2. The same thing also happens when you compost a bagasse. Sugar refineries also add more benefits like social and financial to their revenues because they are a potential important contributor to the international carbon credit markets in the future.

Chapter 3

METHODOLOGY

3.1 Introduction

For governments to achieve the appropriate level of development and improvement, the effective use of public funds is a strategic and important instrument. Given the scarcity of economic resources, projects should be fitted within the overall development policies hence there should be the identification of good projects to meet the needs of society. After this identification, projects should be precisely defined.

A project can be defined as the smallest separable unit. It can be found and planned independently. A project is different from a program. Programs may include inter related projects with different characteristics, through which they are distinguished from each other. Projects are often smaller than programs, yet analyst can treat the program as a big project. However, Harberger and Jenkins (1998) advise to keep the projects small and separable[7] to better estimate the most profitable and economical way to run the program. In addition, it would be easier to control and manage the small projects than bigger ones. In evaluation of a plan which includes several projects, there is danger that sustainable financial performance of a beneficial part of plan covered by unprofitable performance of unsuccessful activities and projects. Therefore plans should be divided into programs

[7] Harberger, A. C. and Jenkins G. P. (1998), Cost-Benefit Analysis Manual, Havard Institute for International Development, Unpublished.

to identify the profitability of each part independently. After detailed identification of projects, recognition of key variables (to which project's product, market, competition, required technology, facility and input are the examples) is necessary.

As Jenkins .P, (1998) states, there are three important modules, which should be identified in each project; market, technical, and financial. The potential price level and output demand are analyzed to estimate its potential domestic and international markets in market module. In this module, there will be number of researches carried out on current and potential competitors. All these market research are handled through primary data and secondary data, market surveys, and interviews. In the next module, possible and alternatives technological way to run the project are studied. This part of study shows whether project is technically feasible. The requirements to run the project like timing, scale, manpower, location and etc, are examined in this section. Number of workers, their skill and wage levels will be identified in addition to investment costs and operational expenses. It is very critical for a project to identify the possible risks and uncertainties, which may undermine its performance. Therefore, in technical module of project risk and contingency will be distinguished to help the project managers to search for appropriate protecting modes.

The financial module of appraisal attempts to recognize the ways through which the project will be financed, its debt to equity proportion (i.e., to what extent it is funded through debt or equity), and how free cash flow is distributed among shareholders (Dividend Policy). This module clarifies a concise schedule for receipt of the loan, and the payment of loan's principal and interest.

The cost-benefit analysis will be run in three major steps namely; the financial, economic and stakeholder analysis. Traditional approaches in cost-benefit analysis tended to run the financial appraisal separated from economic analysis of the project. However, in the new approach both the financial and economic, are run in an integrated analysis based on current prices. After accessing these two evaluations, stakeholder analysis illustrates the impact of project on different parties involving in the project. As it is illustrated in the technical module, the project may face unexpected events, which necessitate the definition of possible uncertainties and range of fluctuations in data and reassessment of project. This will be analyzed in the last part of the cost-benefit analysis.

3.2 Financial Appraisal

Harberger A.C, And Jenkins G. P. (1998) say, the financial evaluation determines the feasibility of the project. It is the most important part for any capital investment. For the financial analysis to commence, the first step is to obtain the relative financial data. In this step, information about the volume of production and sale form the foundation analysis. Information gathered at this step shape the basis for estimated profit and loss statement. The final product is the project's expected financial receipts and expenditures. In forecasting the project's financial revenues and expenditures, fluctuation in prices of inputs and outputs (i.e. due to demand and supply change), and foreign exchange (i.e. appreciation) must be considered.

All data on receipts and expenditures should be broken down into domestic and international. It is needed to measure the economic implication of foreign exchange in economic analysis. Information about project finance is the essential items to test the financial viability of project. The debt to equity ratio, duration of loans (long term, short term), level of interest rate and principal payments are fundamental issues, which have direct effect on project's tax payment. In development of financial cash flow for projects, it should be considered that there is a need for the value estimation of the value of assets that have economic lives more than the estimated lifetime of the project. In these cases, the value of asset should be measured based on the economic depreciation of asset. Land here is a non depreciable asset with indefinite life. The residual value of land in financial analysis that is recorded in financial cash flow statement should be equal to its value at the beginning of project and should also be adjusted for the general rate inflation over the life of project. The value of land should be adjusted in the case of any improvement or deterioration in the value of land caused by project.

The mentioned steps are fundamental points in preparing the financial cash flow of projects, which makes it possible to access its commercial viability. The project's success may be important for others than owners. Therefore, this is necessary to prepare a specific cash flow statement for special stakeholders. For instance, government related projects can be assessed differently (i.e. through the owners, bankers and government's point of view).

The financial cash flow from banker's perspective shows the ability to generate enough cash to cover the obligations such as principals and interest of loans over the project's lifetime. This cash flow statement begins with net cash flow before financing and debt service and concludes with deflating cash flows by the price index to find real cash flows statement from total investment (bankers) point of view. This statement serves as the foundation for undertaking the economic analysis of a project. Adding the inflows generated through financing activities and deducting the outflow of these activities (principal and interest) to net cash flow from the point of view of the bankers will produce cash flow statements from owner's point of view. The next step is to deflate the cash flows with a general price index to find the cash flow in the price level of each year. Owners of project expect to receive their own rate of return over the investment. Thus, these cash flows should be discounted by investor's required rate of return. The project will not be acceptable for the owners if the result becomes negative. The ideal discount rate should take into account the risk associated with nature of the project, the degree of financial leverage employed to its financing and the real rate of interest.

The several criteria can be used to evaluate the financial viability of project but net present value (NPV) is considered as the most efficient. In the financial evaluation of projects, owners expect to earn at least their own required rate of return so this rate is taken as discount rate. If the discounted value of net cash flows is greater than zero, it means the project is commercially viable and negative amounts shows that investors will earn less than their required rate of return.

In banker's point of view, loan life coverage ratio (LLCR) and annual debt service ratio (ADSCR) are used as the additional criteria to make sure the project is able to generate enough cash to service its debt. The annual debt service coverage ratio (ADSCR) is defined as net cash flow after tax divided by principal and interest together. Loan life coverage ratio (LLCR) is a cumulative measure and defined as the present value of net cash flow after tax during loan repayment period over the present value of interest and principal value of interest and principal repayment during loan repayment period

Formula 1.1 $$ADSCR_t = \frac{\text{Annual Net Cash Flow in Year}_t}{\text{Annual Debt Repayment in Year}_t}$$

Formula 1.2 $$LLCR_t = \frac{\text{Present value of Net Cash flow from Year}_0 \text{ to Year}_t}{\text{Present value of debt repayment from Year}_0 \text{ to Year}_t}$$

3.3 Risk Analysis on Project Outcomes

In the previous section, the financial analysis of project was based on deterministic data about inputs, outputs, exchange rate, inflation, wages etc. However, in real life there is no certainty that these data will be exactly same as the values, which are projected in analysis. Therefore, there be no assurance on the result of our financial evaluation like NPV and LLCR. Consequently, the project analysts should incorporate these risks as part of the evaluation.

In order to start the risk analysis, the identification of risky variables through sensitivity and scenario analysis is the first step. The identified risky variables should form a large proportion of the cash inflows and outflows. This is not the only condition and they should be subject to high degree of variation. After this step, based on historical data and opinions of experts about the mentioned variables, an appropriate probability distribution will be settled on with estimates of the relation (correlation) of variables inside the model.

The Monte Carlo simulation is the step to run the risk analysis of project outcomes (i.e. NPV, ADSCR). The cumulative probability of each items shows below or above given value and helps project managers to analyze the project under different situations. With the determination of the effect of different risks on the project outcomes, the task now is to eliminate or decrease the effects of them. Different risks from different sources such as commercial, production, technological and financial risks threaten the project. The use of contracts and arrangements can mitigate many of these risks. This increases the project's attraction, encourages different group's participation in the project and also enhances its performance and profitability. Risk analysis also helps to study how different arrangements and contracts mitigate or eliminate the risks[8].

3.4 Economic Appraisal

The economic evaluation of a project determines the effect of a project on society as a whole. Unlike the financial analysis, the market price of inputs and outputs do not reflect the economic value of these items when distortions (i.e. personal income tax, corporate income tax, value added tax, excise tax import duties and different subsidies) exist in the market. These distortions create considerable differences in the economic and financial values as well as market foreign and economic exchange rates. For example, the market price of an input used in a project measures its financial value yet its economic analysis should take into account the different taxes and subsidies. If implementation of the project creates any environmental externalities (e.g. pollution) these externalities should be assessed in an economic appraisal of a project. It should be mentioned that in many public sector projects such as road and water supply, where there is no competitive markets; in order to measure the economic cost and benefit, all services received by

[8] Jenkins, G.P., Kuo, C.Y., and Harberger, A.C., (2011). The Integrated Analysis of Investment Projects.

customer, the costs and expenses incurred by society need to be considered. Briefly, in an economic analysis of projects, all financial values (receipts and expenditures) are translated into the value of the benefits and costs from society's perspective.

In an economic evaluation, the understanding and the classification of tradable and non-tradable is one of the most important steps. A tradable input is a good or services that can meet the requirement of a project by more import or less export by a country. A tradable output will be recognized if it is sourced by more export or less export. Non-tradable goods and services have domestic prices higher than (freight on board) FOB export price and lower than (cost insurance and freight) CIF import price[9].

3.4.1 How to Determine the Economic Value of Tradable and Non-Tradable Goods and Services

The measurement of economic price of non-tradable input or output will be based on their impacts on additional market demand and supply. For instance, the production of a good project will decrease its market price hence leads to higher demand (increase in consumption motivation). At the same time, some producers react to this lower price and cut back in their production. Therefore, economic benefit of this additional production will be the weighted average of the value of an additional consumption by consumer plus value of resources released by old producers.

In case of non-tradable input, additional demand by project increases the prices of input so that some of old customers who cannot afford the new price cut back in their consumption and new producers will be motivated to produce more due to high price.

[9] Jenkins, G.P., Kuo, C.Y., and Harberger, A.C., (2011). Principles Underlying the Economic Analysis of Projects.

The economic cost of this input is equal to weighted average of forgone consumption plus the value of new resources to produce more unites of this good. In case, (input and output) taxes, subsidies and any other distortion should be inclusive in calculation of economic price. Economic price of tradable goods and services is determined based on their boarder prices (with taking into account all import and export duties and subsidies) plus the value of foreign exchange premium[10] (FEP).

3.4.2 How to build up an Economic Model

After calculating the economic value of project's inputs and outputs, then replace the values of receipts and expenditures in the financial model. Conversion factors are also used at this step to assess the economic values by multiplying financial price into conversion factors of each specific item[11].

The last step to find the economic viability of project is to use the economic opportunity cost of capital as the discount rate to find its NPV from the economic point of view. Projects with positive NPV means it is potentially worthwhile for society as a whole and should be undertaken. It means the benefits of such a project exceed its costs and consequently enhance and improve the economic situation of the society. The NPV, in contrast, lowers the society's economic resources due to consumption of higher amount of resources to create lower benefits[12].

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[10] The foreign exchange premium (FEP) shows how much in percentage term the economic cost of foreign exchange is divergent from the market for foreign exchange rate. The divergence is result of distortions such as tariffs, export taxes and subsidies. This conversion is used to estimate conversion factors for traded components of inputs and outputs item to reflect their world price in terms of the true economic value of foreign exchange.

[11] Conversion Factor = Economic value /Financial

[12] Jenkins, G.P., Kuo, C.Y., and Harberger, A.C., (2011-7). Principles Underlying the Economic Analysis of Projects.

3.5 Distributional Analysis of Project

In economic analysis of projects, we clarify how the project affects the economic situation of society and how it uses the resources to enhance the society's welfare. However, this analysis will only be completed when project analysts identify the impact of project on each participants or parties who will be affected by implementing the project.

The traditional financial evaluation shows financial feasibility of project from the owner's point of view. Therefore, the difference between economic and financial net present values indicates the costs and benefits of other parties other than owners as sponsors. This difference can represent the gain to customers (i.e. from the projects or its outcome) and loss incurred by competitors of project.

Formula 1.3: NPV Economics = NPV Financial + Present Value of Total Externalities

The distributional analysis if undertaken correctly, assures the analysts on financial and economic accuracy of their analysis, which in turn shows the externalities to other parties[13].

[13] Jenkins, G.P., Kuo, C.Y., and Harberger, A.C., (2011-7). Principles Underlying the Economic Analysis of Projects.

Chapter 4

PROJECT DISCRIPTION

4.1 Project Overview

The electricity sector in South America is experiencing rapid growth, with economic expansion stimulating an increasing demand for power following a decade of low growth and decline. The proportion of the population with access to electricity is rising steeply and growth in the consumption of electricity continually outpaces economic growth. Latin American countries facing the challenge of sustainable development have to look for new ways and uses new technologies and approaches for electricity generation, that is, the level of energy services has to become the indicator of development instead of the energy consumption measure[14].

The electricity sector in Nicaragua is managed by the Nicaraguan Electricity Utility Company (Empresa Nicaraguense de Electricidad (E.N.E.L.)) which owns and operates the National Interconnection System and Independent systems. Nicaragua relies so much on oil for generation of electricity. Compared to the 43% dependence on oil by other South American countries, Nicaragua's reliance on oil is measured to be 75%. It was recorded in 2006 that the country had 635 MW of nominal installed capacity, of which 74.5% was thermal, 14% hydroelectric and 11.5% geothermal. It will be good to stress

[14] Kurtz, D. Electricity Generation in Latin America: Sector Reform and Privatization, Management Report. November 1995

that, 70% of this total capacity was in private hands. Gross generation of electricity was 3,502 GWh, 69% came from traditional thermal sources, 10% from bagasse thermal plants, 10% from hydroelectricity, and 10% from geothermal sources. The remaining 1% corresponds to the electricity generated in the "isolated" systems. The installed capacity of ENEL is depicted in the table below.

Table 2: Installed Capacity in ENEL

Source	Generation (GWh)	Generation (%)
Hydroelectric (public)	307	9.80%
Thermal (public) – fuel oil	199	6.30%
Thermal (private) – fuel oil	1,883	60%
Thermal (private) – bagasse	323	10.30%
Gas turbines (public) – diesel	71	2.30%
Gas turbines (private) – diesel	0.82	0.02%
Geothermal	311	9.90%
Isolated systems	42	1.30%

Source: INE Statistics

The National Regulatory Agency (INE) is a government agency that regulates the economic and financial activities in the sector.

The Government of Nicaragua continues to implement the market oriented reforms and has approved privatization in all sectors. Special policies to encourage the development of a free market in the energy sector have been taken. The Parliament has approved the Law on Electricity Industry (Ley de la Industria Electrica) on April 20, 1998.

The privatization process in the energy sector started with the privatization of power generation. Several Independent Power Producers (IPP) have come into the market. The first contract to an independent power producer was granted in 1997.

The Government of Nicaragua is planning to increase the maximum energy capacity from 635 MW in 2006 to 1058 MW in 2015[15].

Table 3: Energy Capacity Increase Nicaragua

Year	**Demand MW**	**Demand GWH**
2006	635	3,502
2007	647	3,717
2008	717	3,954
2009	762	4,202
2010	811	4,472
2011	856	4,720
2012	903	4,979
2013	953	5,255
2014	1,005	5,542
2015	1,058	5,834

Source: INE Statistics

From 1985 to 2001, increased electricity consumption averaged 4.2 percent annually, while the population grew 2.6 percent per year. The National Energy Commission (Comisión Nacional de Enegía – CNE) expects an average growth rate of 4.4 - 6.6 percent over the next decade, leading to an annual increase in required generating capacity of 30-50 MW. According to CNE's forecasts, base load in 2014 could run 700

[15] Data from web site of Instituto Nicaraguense de Energia. www.ine.gob.ni/planes html

MW, with peak system demand of 1,005 MW. To satisfy the growth in the demand, the installed capacity has to grow by a factor 2.3/2.7 from 2006 to 2015. Sixty percent makes up the total amount of electricity generated in Nicaragua using bunker oil. Petroleum imports constitute 13% of all the imports in Nicaragua and 26% of all imported oil is consumed in the energy sector.

Nicaragua has experienced serious energy shortages especially during the dry season due to the significant share of hydro-electrical generation in the national electricity production (32%). A quick solution to the energy crisis in Nicaragua is to import electricity from the neighboring countries at very high prices or to get small scale Power Purchase Agreements (PPAs) (30-50 MW) with local and international IPPs, allowing more independent power producers to come into the market to relieve the deficit and to increase the capacity generation. With the application of modern technology for co-generation of heat and power, the sugar cane industry in developing countries could become a major power producer. In fact, the projected potential for sugar-cane-based power generation in developing countries in year 2027 is larger than the total amount of electricity generated in these countries today[16].

The sugar cane industry in Nicaragua was nationalized during the 80-ies. With the implementation of market oriented reforms, in the 90-ies the government has privatized all the sugar factories. Currently, there are seven sugar factories with a total production

[16] UNDP Initiative for Sustainable Energy, II. New Technologies, New Possibilities. www.undp.org/seed/energy/unise/chapter2.html

of around 300,000 metric tons of sugar, which is one of the most important export products of the country.

Sugar factories are self sufficient in terms of energy during the six months crop season. The rest of the year they buy the electricity demand from the national grid.

As the government of Nicaragua is liberalizing its trade policies that could result in lowering import tariffs of commodities, such as sugar, and the sugar prices in the world market being low, sugar factories are diversifying their production. Different alternatives are being looked into, one of them being power generation based on bagasse and chipwood. There are two initiatives of co-generation in Nicaragua, one in Ingenio San Antonio and the other one at Agroinsa. These two are the largest sugar factories in the country. Without doubt, the co-generation projects in Nicaragua will increase competitiveness in the domestic energy market and will contribute to the development of the Nicaraguan electricity infrastructure.

4.2 Project Objectives

The objectives of Agroinsa's Co-generation project are:

1. To obtain financial benefits to shareholders from the surplus of energy dispatched to the National Grid.

2. To improve the rate of return of the Agroinsa industrial complex.

3. To have a positive economic impact on the economy of the country by replacing imports, producing an economically high valued product, bringing new jobs, and using a low CO_2 emission system based on clean fuel.

By undertaking this project additional company specific objectives will be reached:

a. Maximize the usage of the plant's installed capacity to generate steam

b. Maximize utilization of bagasse

c. Eliminate the energy deficit of Agroinsa's industrial complex.

4.3 Project Scope

The Agroinsa Co-generation Expansion Project is designed to generate additional energy supplies by using local natural resources, environmentally friendly fuels to decrease Nicaragua's dependency on the imported energy. The co-generation expansion project at the sugar plant will increase the currently produced 12 MW capacity to 36 MW. There are three old 4 MW turbines and the project will add two more 12 MW turbines thus reaching the desired 36 MW capacity. The new generation system will provide a 24 MW gross capacity during the sugar cane processing season and 36 MW gross capacity during off-season. This project is only concerned with the additional 24 MW investment. This work does not appraise the total co-generation operation of the factory, but rather the expansion of it.

4.4 Project Cost and Financing

The total investment cost of the project is estimated at 9,138,000 million US dollars. The cost estimates are based on actual prices of materials and resources from a pre-feasibility study conducted at Agroinsa in 1997. See the investment cost table below.

Table 4: Investment Cost (Thousand US$)

	Percentage	Total	Year 0	Year 1
Swedish Turbo generator	50%	4573	4573	0
Electrical Installations	6%	532.5	159.75	372.75
18 MVA Transformer	2%	149	0	149
Buildings, Installation Complex	6%	587	187	400
Installation of Mechanical Complex	30%	2785	0	2785
Additional Costs	6%	511.8	0	511.8
TOTAL INVESTMENT COSTS		**9138.16**	**4920**	**4219**

75% of the total investment costs in year 0 and year 1 are $3,690 and $3,164.25 million respectively and are financed by debt. Also, 25% of the total investment costs in year 0 and year 1 are $1,230 and $1054.75 million and are financed by equity. There will be seven equal repayments of the loan starting on year three. See the table below.

Table 5: Loan Schedule, US$

Year	0	1	2	3	4	5	6	7	8	9
Foreign loan (U.S. dollars)										
Balance at start of year		5,534,561	11,063,224	12,390,811	11,162,662	9,787,135	8,246,545	6,521,083	4,588,567	2,424,149
Loan Disbursement	5,534,561	4,864,515								
Interest accrued		664,147	1,327,587	1,486,897	1,339,519	1,174,456	989,585	782,530	550,628	290,898
Total repayment				2,715,046	2,715,046	2,715,046	2,715,046	2,715,046	2,715,046	2,715,046
interest				1,486,897	1,339,519	1,174,456	989,585	782,530	550,628	290,898
principal				1,228,149	1,375,527	1,540,590	1,725,461	1,932,516	2,164,418	2,424,149
Balance at end of year	5,534,561	11,063,224	12,390,811	11,162,662	9,787,135	8,246,545	6,521,083	4,588,567	2,424,149	0
Loan flow	5,534,561	4,864,515	-	(2,715,046)	(2,715,046)	(2,715,046)	(2,715,046)	(2,715,046)	(2,715,046)	(2,715,046)
Foreign loan (Cordoba)										
Nominal Exchange Rate	23	23	24	25	26	27	28	28	29	30
Balance at start of year		128,779,791	266,212,367	308,338,850	287,262,070	260,464,229	226,958,539	185,599,275	135,056,533	73,786,984
Loan Disbursement	124,527,628	113,188,970								
Interest accrued		15,453,575	31,945,484	37,000,662	34,471,448	31,255,707	27,235,025	22,271,913	16,206,784	8,854,438
Total repayment				67,562,511	69,869,523	72,255,312	74,722,567	77,274,069	79,912,696	82,641,422
interest				37,000,662	34,471,448	31,255,707	27,235,025	22,271,913	16,206,784	8,854,438
principal				30,561,849	35,398,075	40,999,604	47,487,542	55,002,156	63,705,912	73,786,984
Balance at end of year	124,527,628	257,422,336	298,157,851	277,777,002	251,863,995	219,464,625	179,470,997	130,597,119	71,350,621	0
Loan flow	124,527,628	113,188,970	-	(67,562,511)	(69,869,523)	(72,255,312)	(74,722,567)	(77,274,069)	(79,912,696)	(82,641,422)

4.5 Project Life

The project life, for financial and economic evaluation purposes, is considered to be 15 years since the first investment. Although, the operational life of the improved existing and newly installed power generating equipment is 25 years, after 15 years of operation additional significant investments will be needed to upgrade the plant for new technologies.

4.6 Project Implementation and Management

The project will be implemented by Agroinsa as a private owner of the plant. A Power Purchase Agreement will be signed with the Government of Nicaragua at a fixed kWh price soon to be negotiated to ensure the uninterrupted demand of electricity. The project is expected to be implemented in two years and it will be managed by Agroinsa's professional staff.

4.7 Electricity Generation Projections

With the installment of the two new power generators, Agroinsa will produce an additional 24 MW amount of electricity for at least three hundred thirty days (330) of the year to be sold to the national grid. The electricity will be produced using environmentally friendly fuels (bunker oil), bagasse and chipwood. However, it is taken into consideration that there might be some shortfalls of needed fuels due to high humidity and rain in which case a ten days reserve of bunker oil might be used.

The amount of bagasse produced at the factory is an approximate 15 year average of 424,138 metric tons based on a 36 % bagasse in cane coefficient. This is sufficient to generate 65 % of the energy or 245 days; 30- 35 % of the energy is generated based on chipwood and bunker oil (119 days). 75 thousand tons of chipwood will be required yearly to satisfy the factory's demand.

The factory's season extends for about 150 days during which 11.6 MW are generated, the remaining 210 days the generation reaches 23.6 MW. The plant's factor used is 0.87 (this includes power and time losses as well as maintenance stops). There is a yearly decrease in plant factor of a 0.4%. The project will deliver between 135 to 140 million additional kWh. This will allow the whole co-generation system to deliver approximately 160 to 165 million kWh per year.

4.8 Power Purchase Agreement

The government of Nicaragua is privatizing power generation through Power Purchase Agreements that are developed in accordance with the Law on Electricity Industry (Ley de la Industria Electrica) adopted on April 20, 1998.

PPA's are signed with very competitive multinational energy providers, like AMFELS, CETRANS, COASTAL, etc., at very competitive prices. However, the kWh they deliver is based on non-renewable imported fuel. There can be different PPA's designed:

1. Based on a fixed rate of return of the independent power producer.
2. Based on an agreed fixed price of the kWh.
3. Firm electricity delivered versus non-firm electricity.

It is anticipated that in the case of Agroinsa, a PPA based on a fixed price per kWh will be signed. A significant effort is being made on behalf of Agroinsa's management to reach an agreement with a price of 6.999 (U.S. cents) per kWh, which is in between the range of prices Agroinsa has obtained from the old co-generation operation (5.5 – 6.99 cents).

Chapter 5

FINANCIAL AND ECONOMIC ANALYSIS

5.1 Financial Analysis of the Project

Under the base case scenario the equity NPV @ (17.2% real) discount rate is $ 14,636,164 U.S. dollars and the IRR (17.7 % real). The project, therefore, is financially attractive. The project pays its bills, the loan, and it still withstands the expected equity rate of return. On the side of the revenues I assume the most probable PPA price of c$ 6.999 (U.S. cents) per kWh.

On the side of expenditures I deal with a 9,138,000 million dollar investment which is 75 % loan (debt) and 25 % equity. The loan is to be repaid in seven years with a 9.3 % interest rate. I dealt with fuel costs, which is mainly chipwood and bunker oil (32 $/mt of chipwood and 1.48 U.S. dollars per gallon of bunker oil). I assume a zero financial price for bagasse since it is considered a waste without an opportunity cost in the foreseeable future. I have direct and indirect labor with competitive salaries and just the right size staff to manage the project, some reasonable administrative expenses, insurance, tax payments, and other expenses. The sugar factory installations used by the project will be paid for as a yearly rent. I also assume a 1.5 and a month lag in accounts receivable and accounts payable, respectively.

I assume no tax holidays are granted. Financial cash flow statements from the banker's perspective as well as equity perspective in nominal and real cordobas are prepared to account for the impact of inflation and other distortions that affect the financial performance of the project. All of the costs and revenues are calculated in cordobas for that purpose, however, for a better understanding of our shareholders and possible financiers of this project an equity cash flow statement in U.S. Dollars is included (Table 10).

5.2 Appraisal of the Project from Different Perspectives

The appraisal of the Agroinsa Co-generation project has been carried out from three different perspectives:

5.2.1 The Total Investment (Banker's) Point of View

This analysis answers the question: Can the project pay the loan? By looking at the behavior of the project net cash flow year by year in table 6 or 7 we can find the answer to that question. Since the banker's concern is to get his money back, the ADSCR and LLCR ratios are important. The ADSCR is the ratio of the annual real net cash flows before financing over the annual debt service amount. There are different ratios for different industries. The banker must be able to see a reasonable large ratio in the initial years. The LLCR is mainly calculated to see the generating cash ability of the project. When bankers see that the LLCR is greater than 1 even when the ADSCR in that particular year is not sufficient, the creditor will agree to give the loan because there is a possibility of bridge financing. See table 8 below.

Table 6: Cash Flow Statement from Total Investment's Point of View (nominal, cordobas)

Year	0	1	2	3	4	5	6	7	8	9
INFLOWS										
Total PPA Revenue	-	-	129,997,143	356,273,754	375,919,073	395,346,220	427,825,493	462,973,069	501,008,158	542,167,982
Change in Accounts Receivable	-	-	(16,249,643)	(28,284,576)	(2,455,665)	(2,428,393)	(4,059,909)	(4,393,447)	(4,754,386)	(5,144,978)
Liquidation Value										
Swedish Turbo generator	-	-	-	-	-	-	-	-	-	-
Electrical Installations	-	-	-	-	-	-	-	-	-	-
18 MVA Transformer	-	-	-	-	-	-	-	-	-	-
Buildings, Installation Complex	-	-	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	-	-	-	-	-	-	-	-	-
Additional Costs	-	-	-	-	-	-	-	-	-	-
Total Inflows	**-**	**-**	**113,747,500**	**327,989,178**	**373,463,408**	**392,917,827**	**423,765,584**	**458,579,622**	**496,253,772**	**537,023,004**
OUTFLOWS										
Investment Costs										
Swedish Turbo generator	154,334,025	-								
Electrical Installations	5,391,563	13,335,131								
18 MVA Transformer	-	5,330,475								
Buildings, Installation Complex	6,311,250	14,310,000								
Installation of Mechanical Complex	-	99,633,375								
Additional Costs	-	18,309,645								
Operating & Maintenance Costs										
Direct costs	-	-	54,279,571	131,778,328	124,634,467	115,653,263	119,869,734	124,246,222	128,789,154	133,505,233

Indirect costs	-	11,173,346	12,700,771	13,120,578	13,574,997	14,066,103	14,596,099	15,167,317	15,782,232	16,443,463
Management and sales expenses	-	-	1,412,152	3,681,649	3,885,236	4,087,071	4,419,880	4,779,853	5,169,211	5,590,357
Change in Accounts Payable	-	(931,112)	(4,362,661)	(6,658,002)	566,284	718,033	(394,288)	(411,583)	(429,700)	(448,684)
Change in Cash Balance	-	1,117,335	5,721,915	8,018,806	(648,585)	(828,826)	507,928	530,768	554,720	579,846
Corporate Income Tax	-	-	15,124,410	51,198,253	59,796,369	69,075,714	78,501,918	88,942,820	100,508,725	113,322,839
Total Cash Outflow	**166,036,838**	**162,278,195**	**84,876,158**	**201,139,611**	**201,808,767**	**202,771,357**	**217,501,270**	**233,255,398**	**250,374,342**	**268,993,054**
NET CASH FLOW BEFORE FINANCING	**(166,036,838)**	**(162,278,195)**	**28,871,343**	**126,849,567**	**171,654,641**	**190,146,469**	**206,264,314**	**225,324,224**	**245,879,430**	**268,029,950**

Table 7: Cash Flow Statement from Total Investment's Point Of View (real, cordobas)

Domestic Inflation Index -------->>>>	1.00	1.06	1.12	1.19	1.26	1.34	1.42	1.50	1.59	1.69
Year	0	1	2	3	4	5	6	7	8	9
INFLOWS										
Total PPA Revenue	-	-	115,696,995	299,134,314	297,763,116	295,425,694	301,600,091	307,903,533	314,338,717	320,908,396
Change in Accounts Receivable	-	-	(14,462,124)	(23,748,276)	(1,945,117)	(1,814,637)	(2,862,076)	(2,921,893)	(2,982,961)	(3,045,305)
Liquidation Value										
Swedish Turbo generator	-	-	-	-	-	-	-	-	-	-
Electrical Installations	-	-	-	-	-	-	-	-	-	-
18 MVA Transformer	-	-	-	-	-	-	-	-	-	-
Buildings, Installation Complex	-	-	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	-	-	-	-	-	-	-	-	-
Additional Costs	-	-	-	-	-	-	-	-	-	-
Total Inflows	**-**	**-**	**101,234,870**	**275,386,038**	**295,817,999**	**293,611,057**	**298,738,015**	**304,981,640**	**311,355,756**	**317,863,091**
OUTFLOWS										
Investment Costs										
Swedish Turbo generator	154,334,025	-	-	-	-	-	-	-	-	-
Electrical Installations	5,391,563	12,580,313	-	-	-	-	-	-	-	-
18 MVA Transformer	-	5,028,750	-	-	-	-	-	-	-	-
Buildings, Installation Complex	6,311,250	13,500,000	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	93,993,750	-	-	-	-	-	-	-	-
Additional Costs	-	17,273,250	-	-	-	-	-	-	-	-
Total Investments costs (real c$)	166,036,838	142,376,063								

Operating & Maintenance Costs										
Direct costs	-	-	48,308,625	110,643,625	98,722,171	86,422,846	84,503,432	82,630,834	80,803,908	79,021,542
Indirect costs	-	10,540,893	11,303,641	11,016,291	10,752,669	10,511,011	10,289,674	10,087,132	9,901,967	9,732,861
Management and sales expenses	-	-	1,256,810	3,091,183	3,077,471	3,054,097	3,115,841	3,178,875	3,243,227	3,308,924
Change in Accounts Payable	-	(878,408)	(3,882,752)	(5,590,187)	448,550	536,556	(277,958)	(273,726)	(269,599)	(265,575)
Change in Cash Balance	-	1,054,089	5,092,484	6,732,744	(513,740)	(619,347)	358,069	352,991	348,038	343,210
Corporate Income Tax	-	-	13,460,671	42,987,040	47,364,325	51,617,392	55,340,755	59,152,055	63,060,417	67,075,614
Total Cash Outflow	**332,073,675**	**295,468,699**	**75,539,478**	**168,880,696**	**159,851,446**	**151,522,554**	**153,329,813**	**155,128,162**	**157,087,960**	**159,216,575**
NET CASH FLOW BEFORE FINANCING, real cordobas	**(332,073,675)**	**(295,468,699)**	**25,695,392**	**106,505,342**	**135,966,553**	**142,088,503**	**145,408,202**	**149,853,478**	**154,267,796**	**158,646,516**

Table 8: Debt Service Ratios

Active Loan Years	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Net Cash Flow Before Financing (Real, Cordobas)	106,505,342	135,966,553	142,088,503	145,408,202	149,853,478	154,267,796	158,646,516
Annual Loan Repayment (Real, Cordobas)	67,562,511	69,869,523	72,255,312	74,722,567	77,274,069	79,912,696	82,641,422
Discounted @ lending rate of 9.3%							
Present Value of Net Cash Flow	758,772,702	712,721,407	630,210,182	533,362,225	423,910,737	299,457,688	158,646,516
Present Value of Loan Repayment	403,364,085	366,924,647	324,587,061	275,718,595	219,624,928	155,544,354	82,641,422
Annual Debt Service Coverage Ratio (ADSCR)	**1.58**	**1.95**	**1.97**	**1.95**	**1.94**	**1.93**	**1.92**
Loan Life Coverage Ratio (LLCR)	**1.88**	**1.94**	**1.94**	**1.93**	**1.93**	**1.93**	**1.92**

5.2.2 Equity Owner Point of View

The goal of an independent power producer is to provide reliable electricity at the lowest price and still have a reasonable financial return. Paying the bills, paying the loan and getting the expected return are the equity's concern. The first two years of this project as seen in tables 9 and 10 have negative cash flows because of the initial investment start up. However, there was an improvement later in the years when the when the loan disbursement to the project came into play. From year 3 onwards, the project becomes more profitable. The NPV was calculated and it is 14.6 million dollars. The IRR is also calculated and it is 54% which is 3 times higher than the project discount rate. With this NPV and IRR results, the project is attractive and can be undertaken.

The competition in the energy sector in Nicaragua is getting tougher and thus cost minimization and profit maximization is the key to success. This is presented in the cash flow statement from the independent power producer (IPP) or equity point of view both in cordobas and dollars in Tables below.

Table 9: Cash Flow Statement from Equity/IPP's Point Of View (nominal, cordobas)

Year	0	1	2	3	4	5	6	7	8	9
INFLOWS										
Total PPA Revenue	-	-	129,997,143	356,273,754	375,919,073	395,346,220	427,825,493	462,973,069	501,008,158	542,167,982
Change in Accounts Receivable	-	-	(16,249,643)	(28,284,576)	(2,455,665)	(2,428,393)	(4,059,909)	(4,393,447)	(4,754,386)	(5,144,978)
Liquidation Value										
Swedish Turbo generator	-	-	-	-	-	-	-	-	-	-
Electrical Installations	-	-	-	-	-	-	-	-	-	-
18 MVA Transformer	-	-	-	-	-	-	-	-	-	-
Buildings, Installation Complex	-	-	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	-	-	-	-	-	-	-	-	-
Additional Costs	-	-	-	-	-	-	-	-	-	-
Total Inflows	**-**	**-**	**113,747,500**	**327,989,178**	**373,463,408**	**392,917,827**	**423,765,584**	**458,579,622**	**496,253,772**	**537,023,004**
OUTFLOWS										
Investment Costs										
Swedish Turbo generator	154,334,025	-	-	-	-	-	-	-	-	-
Electrical Installations	5,391,563	13,335,131	-	-	-	-	-	-	-	-
18 MVA Transformer	-	5,330,475	-	-	-	-	-	-	-	-
Buildings, Installation Complex	6,311,250	14,310,000	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	99,633,375	-	-	-	-	-	-	-	-
Additional Costs	-	18,309,645	-	-	-	-	-	-	-	-
Operating & Maintenance Costs										
Direct costs	-	-	54,279,571	131,778,328	124,634,467	115,653,263	119,869,734	124,246,222	128,789,154	133,505,233
Indirect costs	-	11,173,346	12,700,771	13,120,578	13,574,997	14,066,103	14,596,099	15,167,317	15,782,232	16,443,463

Management and sales expenses	-	-	1,412,152	3,681,649	3,885,236	4,087,071	4,419,880	4,779,853	5,169,211	5,590,357
Change in Accounts Payable	-	(931,112)	(4,362,661)	(6,658,002)	566,284	718,033	(394,288)	(411,583)	(429,700)	(448,684)
Change in Cash Balance	-	1,117,335	5,721,915	8,018,806	(648,585)	(828,826)	507,928	530,768	554,720	579,846
Corporate Income Tax	-	-	15,124,410	51,198,253	59,796,369	69,075,714	78,501,918	88,942,820	100,508,725	113,322,839
Total Cash Outflow	**166,036,838**	**162,278,195**	**84,876,158**	**201,139,611**	**201,808,767**	**202,771,357**	**217,501,270**	**233,255,398**	**250,374,342**	**268,993,054**
NET CASH FLOW BEFORE FINANCING	**(166,036,838)**	**(162,278,195)**	**28,871,343**	**126,849,567**	**171,654,641**	**190,146,469**	**206,264,314**	**225,324,224**	**245,879,430**	**268,029,950**
Project Financing										
Loan proceeds (+)	**124,527,628**	**113,188,970**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Loan repayments (-)	**-**	**-**	**-**	**67,562,511**	**69,869,523**	**72,255,312**	**74,722,567**	**77,274,069**	**79,912,696**	**82,641,422**
NET CASH FLOW AFTER FINANCING	**(41,509,209)**	**(49,089,225)**	**28,871,343**	**59,287,056**	**101,785,118**	**117,891,157**	**131,541,747**	**148,050,155**	**165,966,735**	**185,388,529**

Table 10: Cash Flow Statement from Equity/IPP's Point Of View (real, cordobas)

Domestic Inflation Index -------->>>>	1.00	1.06	1.12	1.19	1.26	1.34	1.42	1.50	1.59	1.69
Year	0	1	2	3	4	5	6	7	8	9
INFLOWS										
Total PPA Revenue	-	-	115,696,995	299,134,314	297,763,116	295,425,694	301,600,091	307,903,533	314,338,717	320,908,396
Change in Accounts Receivable	-	-	(14,462,124)	(23,748,276)	(1,945,117)	(1,814,637)	(2,862,076)	(2,921,893)	(2,982,961)	(3,045,305)
Liquidation Value										
Swedish Turbo generator	-	-	-	-	-	-	-	-	-	-
Electrical Installations	-	-	-	-	-	-	-	-	-	-
18 MVA Transformer	-	-	-	-	-	-	-	-	-	-
Buildings, Installation Complex	-	-	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	-	-	-	-	-	-	-	-	-
Additional Costs	-	-	-	-	-	-	-	-	-	-
Total Inflows	**-**	**-**	**101,234,870**	**275,386,038**	**295,817,999**	**293,611,057**	**298,738,015**	**304,981,640**	**311,355,756**	**317,863,091**
OUTFLOWS										
Investment Costs										
Swedish Turbo generator	154,334,025	-	-	-	-	-	-	-	-	-
Electrical Installations	5,391,563	12,580,313	-	-	-	-	-	-	-	-
18 MVA Transformer	-	5,028,750	-	-	-	-	-	-	-	-
Buildings, Installation Complex	6,311,250	13,500,000	-	-	-	-	-	-	-	-
Installation of Mechanical Complex	-	93,993,750	-	-	-	-	-	-	-	-
Additional Costs	-	17,273,250	-	-	-	-	-	-	-	-
Operating & Maintenance Costs										
Direct costs	-	-	48,308,625	110,643,625	98,722,171	86,422,846	84,503,432	82,630,834	80,803,908	79,021,542

Indirect costs	-	10,540,893	11,303,641	11,016,291	10,752,669	10,511,011	10,289,674	10,087,132	9,901,967	9,732,861
Management and sales expenses	-	-	1,256,810	3,091,183	3,077,471	3,054,097	3,115,841	3,178,875	3,243,227	3,308,924
Change in Accounts Payable	-	(878,408)	(3,882,752)	(5,590,187)	448,550	536,556	(277,958)	(273,726)	(269,599)	(265,575)
Change in Cash Balance	-	1,054,089	5,092,484	6,732,744	(513,740)	(619,347)	358,069	352,991	348,038	343,210
Corporate Income Tax	-	-	13,460,671	42,987,040	47,364,325	51,617,392	55,340,755	59,152,055	63,060,417	67,075,614
Total Cash Outflow	**166,036,838**	**153,092,637**	**75,539,478**	**168,880,696**	**159,851,446**	**151,522,554**	**153,329,813**	**155,128,162**	**157,087,960**	**159,216,575**
NET CASH FLOW BEFORE FINANCING	**(166,036,838)**	**(153,092,637)**	**25,695,392**	**106,505,342**	**135,966,553**	**142,088,503**	**145,408,202**	**149,853,478**	**154,267,796**	**158,646,516**
Project Financing										
Loan proceeds (+)	**124,527,628**	**106,782,047**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Loan repayments (-)	**-**	**-**	**-**	**56,726,787**	**55,343,207**	**53,993,372**	**52,676,461**	**51,391,669**	**50,138,214**	**48,915,331**
NET CASH FLOW AFTER FINANCING, real C$	**(41,509,209)**	**(46,310,590)**	**25,695,392**	**49,778,555**	**80,623,347**	**88,095,131**	**92,731,741**	**98,461,809**	**104,129,583**	**109,731,185**
NET CASH FLOW AFTER FINANCING, real US$	**(1,844,854)**	**(2,058,248)**	**1,142,017**	**2,212,380**	**3,583,260**	**3,915,339**	**4,121,411**	**4,376,080**	**4,627,981**	**4,876,942**

IPP_NPV @	17%	**329,313,686**	Cordobas
IPP_NPV @	17%	**14,636,164**	US Dollars
IPP_IRR @		**54%**	

5.3 Economic Analysis

Any power projects make use of fuel such as coal, natural gas and oil. More efficient way of generating electricity such as combined heat and power, in this case bagasse cogeneration reduces the amount of fuel required to produce a unit of energy output compared to alternative sources of electricity generation. This term is called economic value fuel savings. It is calculated by dividing the fuel cost in liters by annual the power generation. The most common source of alternative electricity in Nicaragua is diesel or gasoline generator. To compensate for reliability, a back-up generator should be considered when calculating the cost of the alternative source kWh. I have calculated the figures and obtained this result from the (cost of alternative generation from conventional thermal) table:

Economic value of fuel savings ($/kWh)	US$ 12.5 cents
Average avoided cost ($/kWh)	US$ 15.94 cents

In this case, however, the price of electricity sold cannot be compared to the consumer price directly since the kWh cost is net of transmission and distribution costs.

This implies that a direct usage of the conversion factor below cannot be applied directly in our economic resource flow.

Table 11: Conversion Factor Table

Sales of Electricity to End Users	0.000	
Change inAccounts Receivable	0.000	
Swedish Turbo generator	0.918	Same as imported capital items
Electrical Installations	0.936	Average tradable and non-tradable investment cost
18 MVA Transformer	0.918	Same as imported capital items
Buildings,Installation Complex	0.846	
Installation of Mechanical Complex	0.936	Average tradable and non-tradable investment cost
Additional Costs	0.936	Average tradable and non-tradable investment cost
Financing Costs	1.000	no distortion
Operating & Maintenance Costs		
direct wages	1.000	
indirect wages	0.852	
Cost of Bagasse	1.000	
Cost Chipwood	0.995	
Cost of bunker	0.838	
Materials and Spare parts	0.910	Same as O&M materials
leasing plants	1.053	
insurance of assets	1.053	
Administrative and sales expenses	0.974	Same as non-tradable good
Change in Accounts Payable	1.053	Average of CFs for Materials & Spare parts, O&M Items except labor expenses
Change in Desired Cash Balance _IPP	1.000	
Change in Desired Cash Balance _Utility	1.000	

Instead, I calculated the economic costs and benefits by adjusting the cash flow using 25 percent power losses and a 30 percent proportion of electricity consumed by sugar plant over the total cost of the kWh. Those two figures are assumed. (Note how high the losses are in Nicaragua). Please refer to Table 12 and 13 below.

5.3.1 The Nicaraguan Economy Point of View

This analysis answers the question: Is the Nicaraguan economy better off or worse off with the implementation of this project? This is presented in the economic resource flow statement in Table below which reflects the value that the economy as a whole assigns to both benefits and costs of the project. The NPV using the economic opportunity costs of funds reflects the net worth of the project.

Table 12: Statement of Economic Resource Flows

OPERATING RESOURCE COSTS (nominal in Córdobas)

Year	0	1	2	3	4	5	6	7	8	9
Domestic Inflation Index	1.00	1.06	1.12	1.19	1.26	1.34	1.42	1.50	1.59	1.69
Direct costs:										
wages			3,737,004	3,961,224	4,198,897	4,450,831	4,717,881	5,000,954	5,301,011	5,619,072
cost of Bagasse			0	0	0	0	0	0	0	0
cost Chipwood			38,846,097	102,110,203	93,344,407	82,593,827	85,414,104	88,330,683	91,346,853	94,466,014
cost of bunker			8,296,414	17,455,265	18,051,298	18,667,684	19,305,117	19,964,316	20,646,025	21,351,011
materials and spare parts			1,444,941	3,941,187	4,595,425	5,358,265	5,679,761	6,020,547	6,381,779	6,764,686
Total Direct Costs			**52,324,456**	**127,467,879**	**120,190,027**	**111,070,607**	**115,116,863**	**119,316,500**	**123,675,668**	**128,200,783**
Indirect costs:										
wages		-	963,161	1,020,951	1,082,208	1,147,140	1,215,969	1,288,927	1,366,263	1,448,238
leasing plants		8,428,693	8,934,415	9,470,479	10,038,708	10,641,031	11,279,493	11,956,262	12,673,638	13,434,056
insurance of assets		3,337,818	3,250,393	3,085,009	2,919,625	2,754,241	2,588,857	2,423,473	2,258,089	2,092,705
Total Indirect Costs		**11,766,511**	**13,147,969**	**13,576,439**	**14,040,541**	**14,542,412**	**15,084,318**	**15,668,662**	**16,297,990**	**16,975,000**
Management and sales expenses:										
administrative expenses			109,229	118,911	126,046	133,608	141,625	150,122	159,130	168,678
municipal tax (% of sales)			-	-	-	-	-	-	-	-
Total Management and sales expenses			**109,229**	**118,911**	**126,046**	**133,608**	**141,625**	**150,122**	**159,130**	**168,678**
Total operating costs		**11,766,511**	**65,581,653**	**141,163,229**	**134,356,614**	**125,746,628**	**130,342,807**	**135,135,285**	**140,132,787**	**145,344,460**
Consolidate conversion factors		**1.05**	**0.96**	**0.95**	**0.95**	**0.94**	**0.94**	**0.94**	**0.94**	**0.93**

Table 13: Statement of Economic Resource Flows (Cont'd of Table 9)

ECONOMIC RESOURCE FLOW IN real C$

years	0	1	2	3	4	5	6	7	8	9
Nominal Exchange Rate	23	23	24	25	26	27	28	28	29	30
Real Exchange Rate (cordobas/US$)	23	23	23	23	23	23	23	23	23	23
Economic value of fuel savings	-	-	169,970,462	443,379,638	445,285,491	445,732,235	459,108,551	472,886,286	487,077,489	501,694,565
Revenues Sugar Plant	-	-	-	-	-	-	-	-	-	-
Liquidation values										
Change in accounts receivables	-	-	(14,462,124)	(23,748,276)	(1,945,117)	(1,814,637)	(2,862,076)	(2,921,893)	(2,982,961)	(3,045,305)
Receipts	**-**	**-**	**155,508,337**	**419,631,362**	**443,340,375**	**443,917,598**	**456,246,475**	**469,964,393**	**484,094,528**	**498,649,261**
Direct costs	-	-	46,568,579	107,024,489	95,201,759	82,998,419	81,152,846	79,352,287	77,595,644	75,881,846
Indirect costs	-	11,100,482	11,701,645	11,399,040	11,121,424	10,866,936	10,633,849	10,420,555	10,225,560	10,047,476
Management & sales expenses	-	-	94,655	97,213	97,213	97,213	97,213	97,213	97,213	97,213
Change in accounts payables	-	(925,040)	(4,088,878)	(5,886,956)	472,363	565,040	(292,714)	(288,258)	(283,911)	(279,674)
Change in cash balance	-	1,054,089	5,092,484	6,732,744	(513,740)	(619,347)	358,069	352,991	348,038	343,210
Investment (real C$)	155,451,910	133,299,521								
Expenditures	**155,451,910**	**144,529,052**	**59,368,485**	**119,366,530**	**106,379,018**	**93,908,261**	**91,949,264**	**89,934,789**	**87,982,545**	**86,090,072**
Before tax net cash flow	**(155,451,910)**	**(144,529,052)**	**96,139,852**	**300,264,832**	**336,961,357**	**350,009,337**	**364,297,211**	**380,029,604**	**396,111,983**	**412,559,189**
Tax payments										
After tax net cash flow	**(155,451,910)**	**(144,529,052)**	**96,139,852**	**300,264,832**	**336,961,357**	**350,009,337**	**364,297,211**	**380,029,604**	**396,111,983**	**412,559,189**

NPV @ ECOK C$	**12.00%**	**1,795,483,740**
US$		**79,799,277**

As can be seen the economic benefits are significant. The NPV @ the EOCK (12%) is around 79.7 million U.S. dollars. The benefits mainly come from a rather high economic fuel savings that led to an avoided cost. Note that Nicaragua has a power deficit in peak hours of 40-70 MW, and suffers from serious shortages during the dry season. This implies that almost any power producer project could be economically sound, so the Nicaraguan government's approach is to choose those projects which have the highest economic NPVs, that is, the lowest possible financial prices and, hence, the lowest costs of the kWh.

I calculated the economic opportunity cost of public funds in Nicaragua obtaining 12 % and the foreign exchange premium (FEP) obtaining 5.41 %. See the table below.

Table 14: Foreign Exchange Premium For Nicaragua, 2008-2010

	2008	2009	2010
Tariff[17]	5701	5362	6732
Imports Million USD[18]	3907	3224.5	3923.2
Exports Million USD	1472.7	1392.9	1845.2
Imports Million LCU	77553.95	67198.58	85839.616
Exports Million LCU	29233.095	29028.036	40372.976
Total Imp & Exp LCU	**106787.05**	**96226.616**	**126212.592**
FEP	5.34%	5.57%	5.33%
Exchange rate	19.85	20.84	21.88

[17] Sources: International Monetary Fund, Government Finance Statistics Yearbook, (2011).
[18] Sources: International Monetary Fund, International Financial Statistics Yearbook, (2012).

I calculated FEP by dividing Tariff revenue with the sum of total value and imports since Nicaragua does not have export taxes and subsidy due to the fact that they are under the free trade zones. The average of three years which is 5.41% was taken as the Foreign exchange premium. The reason for using this formula to calculate foreign exchange premium is because the elasticity of demand and supply is one.

5.4 Environmental Impact

The Agroinsa's co-generation expansion project will provide a cleaner kWh than the kWh provided by its toughest competitors in the market. The CO_2 emissions of this project are 30 times lower than the emissions from those systems based on fuel oil such as the ones used by other IPPs. However, the project emits significant amount of dust into the atmosphere. This dust emission could be almost eliminated by 0.2 U.S. cents per kWh investment. The cost of reducing CO_2 emissions for our competitors would be significantly higher. I do not include a quantitative cost analysis of the environmental aspects since it implies a more accurate and sophisticated work, but this will turn into an important competitive advantage as environmental issues move up in the Nicaraguan's government priority list.

5.5 Distributive Analysis

The distributive analysis which is the difference between the net resources flows at economic opportunity cost of capital of 12% and financial net present value discounted at the same rate shows that there is 1 billion C$ externalities in this project. These externalities are shared among three major groups. They are labor government and the consumers. The big winners are the Nicaraguan consumers who earn C$923 million in an account of a very high conversion factor, the Nicaraguan government collecting C$71 million of taxes and gains from foreign exchange premium, and the labor force which gets C$14 million benefits from running the project. See the table below.

Table 15: Distributive Analysis (Real C$)

	NPV @ EOCK	Labor	Government	Consumers
Revenues	923,990,671			923,990,671
Revenues Sugar Plant	-			
Liquidation values	(5,947,741)		(5,947,741)	
Change in accounts receivables	-			-
Total Revenue	**918,042,930**			
Investment	274,469,340		(274,469,340)	
Direct Costs	(18,103,972)		18,103,972	
Indirect costs	2,527,823		(2,527,823)	
Management & sales expenses	(17,068,928)		17,068,928	
Change in accounts payables	(430,773)		430,773	
Change in cash balance	-		-	
Labor	(14,165,611)	14,165,611		
Income Taxes	(319,181,392)		319,181,392	
Total Cost	**(91,953,512)**			
Total	**1,009,996,442**	**14,165,611**	**71,840,160**	**923,990,671**

Chapter 6

SENSITIVITY AND RISK ANALYSIS

6.1 Sensitivity Analysis

A sensitivity analysis has been conducted to determine the impact of changes in key variables on the financial NPV of the co-generation plant. The variables tested on the technical side of the project are as follows:

6.1.1 Bagasse in Cane versus Number of Generation Days by Other Sources of Fuel

Percentage of Bagasse in Cane VS. # days to generate with other sources of fuel

	131	**164**	**145**	**124**
32%	156	187	170	152
34%	144	175	157	138
36%	**131**	**164**	**145**	**124**
38%	119	152	132	110
40%	106	141	120	96

The percentage of bagasse in sugarcane is sensitive to the days of generation of all other sources of fuel. The higher the percentage of bagasse in sugarcane, the lesser the numbers of days required to generate other sources of fuel and vice versa.

6.1.2 Bagasse in Cane versus NPV

Percentage of Bagasse in Cane Vs.NPV

	329,313,686
32%	295,438,359
34%	312,376,023
36%	**329,313,686**
38%	346,251,350
40%	363,189,014

The sensitivity result above shows that the higher the percentage of bagasse in sugarcane, the higher the NPV. It means if the percentage of bagasse should increase above 36% then the net present value will shoot up.

6.1.3 New Plant Factor versus NPV

New Plant Factor VS. NPV

	329,313,686
0.75	215,032,007
0.8	262,649,373
0.87	**329,313,686**
0.9	357,884,106
0.95	405,501,473

Plant factor is the net capacity of a power plant. It is calculated by total amount of energy the plant produced in a period of time divided by the amount of energy the plant would have produced at a full capacity. From the above sensitivity analysis we can see that the higher percentage of the plant factor, the higher the net present value and vice versa.

6.1.4 Number of Days Using Bunker Oil versus NPV

Number of Days using bunker oil VS. NPV

		329,313,686
0	361,474,428	
5	345,394,057	
10	**329,313,686**	
20	297,152,944	
30	264,992,203	

In the analysis above, the result shows that if bunker oil is not used at all then the net present value increases and also if the bunker oil is used above the 10 days as a substitute to chipwood then there will be reduction in the NPV.

6.1.5 Number of Days Using Chipwood versus NPV

Number of days using Chipwood VS. NPV

		329,313,686
104	332,491,903	
114	330,897,800	
124	**329,313,686**	
134	327,709,594	
144	326,115,490	

The result in the above analysis tells us that if chipwood is used above 124 days there will be reduction in the NPV but if it is used below 124 days it will increase the NPV.

6.1.6 Efficiency of Bagasse During Season and Off-Season NPV

Efficiency of bagasse during season and off-season Vs NPV

329,313,686	0.35	0.4	0.5	0.55	0.6	0.65
0.1	265,875,129	265,875,129	265,875,129	265,875,129	265,875,129	265,875,129
0.2	265,875,129	265,875,129	265,875,129	265,875,129	265,875,129	265,875,129
0.3	**310,282,119**	**316,625,975**	**329,313,686**	**335,657,542**	**342,001,398**	**348,345,253**
0.4	347,495,561	359,155,623	382,475,747	394,135,808	405,795,870	417,455,932
0.5	369,823,627	384,673,412	414,372,983	429,222,768	444,072,553	458,922,339

The analysis above shows that if the efficiency of bagasse increases from 0.3 to 0.5 during the season, then there will be increase in the NPV and vice versa. The same also goes for off-season scenario. If the efficiency of bagasse during off-season increases from 0.5 to 0.65 then it will positively affects the NPV as it will increase as seen in this analysis above.

The variables tested on the financial side of the project are as follows:

6.1.7 Loan Interest Rate versus NPV

Loan Interest Rate VS. NPV

	329,313,686
10.0%	339,156,112
10.5%	336,750,264
11.0%	334,308,063
11.5%	331,829,280
12.0%	**329,313,686**
12.5%	326,761,056
13.0%	324,171,167
13.5%	321,543,797
14.0%	318,878,727

In this analysis we can notice that an increase in the loan interest rate decreases the NPV and decrease in the loan interest rate increases the NPV.

6.1.8 Real Increase in Salaries versus NPV

Real Increase in Salaries VS. NPV

	329,313,686
0%	**329,313,686**
5%	324,213,761
10%	316,776,106

In the above analysis, since the salaries in the sugar industry are competitive with respect to the rest of the country, I assume no real increases in salaries in our base case scenario. Moreover, it would require an improbable 5 % increase in real salaries for the impact to be significant. The real increase in salaries automatically decreases the NPV when it increases to 5% and it is even worse if it increases more than 5%.

6.1.9 Loan Proportion versus NPV

Loan Proportion VS. NPV

	329,313,686
65%	318,426,029
70%	323,869,858
75%	**329,313,686**
80%	334,757,515
85%	340,201,344
90%	345,645,172

The analysis above shows that an increase in the debt proportion increases the NPV while a decrease in debt proportion reduces NPV.

6.1.10 PPA Price versus NPV

Price PPA vs. NPV

	329,313,686
0.0600	262,823,069
0.0620	276,255,517
0.0640	289,687,965
0.0660	303,120,413
0.0680	316,552,861
0.0699	**329,313,686**
0.0720	343,417,757
0.0740	356,850,205
0.0760	370,282,653
0.0780	383,715,101
0.0800	397,147,549

In the sensitivity analysis above, the PPA price is sensitive to the NPV movement. Though the agreement is a fixed price of 6.999 cents but I tested worst and best case scenario and found out that when there is an increase in the PPA price, the NPV increases and when there is a decrease in the PPA price, the NPV decreases. I also calculated the levelized cost and found it to be 2.1 cents. Assuming the cost of bagasse is zero, the value 4.899 which is the difference between 6.999 and 2.1 reflects the implicit value of bagasse.

The variables tested on the cost side of the project are as follows:

6.1.11 Investment Costs versus NPV

Investment Costs Overruns VS. NPV

	$329,313,686
-10%	350,661,429
-5%	339,987,557
0%	**329,313,686**
5.0%	318,639,815
10%	307,965,944

From the sensitivity analysis above, I assume a zero percent cost overrun in this base case. However, the projects NPV could not withstand a 5% or 10% cost overrun over the estimated value.

6.1.12 Price of Gallon of Bunker Oil versus NPV

Price of Gallon of Bunker Oil VS. NPV

	329,313,686
1.42	331,028,443
1.44	330,404,895
1.46	329,781,347
1.48	**329,157,799**
1.50	328,534,251
1.52	327,910,704
1.54	327,287,156

In above analysis, the increase in the price of bunker oil affects the NPV negatively but the decrease in price of bunker oil increases the NPV. I calculated the break even cost and found it to be $12.01. This means that as you use a very little bunker oil, the overall project is not very sensitive to the price of bunker oil. However, if for some reason the plant was using more bunker fuel then it would be highly sensitive.

6.1.13 Price of Metric Ton of Chipwood versus NPV

Price of metric ton of Chipwood VS. NPV

	329,313,686
26.0	364,098,706
28.0	352,503,700
30.0	340,908,693
32.0	**329,313,686**
34.0	317,718,680
36.0	306,123,673
38.0	294,528,666

The analysis above shows that the higher the price of chipwood, the lesser the NPV and the lower the price of chipwood the higher the NPV. I also calculated the breakeven price of chipwood and found $89 which means that not very much chipwood is used as compared to bagasse; hence, the price can be increased a lot before the overall project is not worth doing.

6.1.14 Price of Metric Ton of Bagasse versus NPV

Price of metric ton of Bagasse Vs. NPV

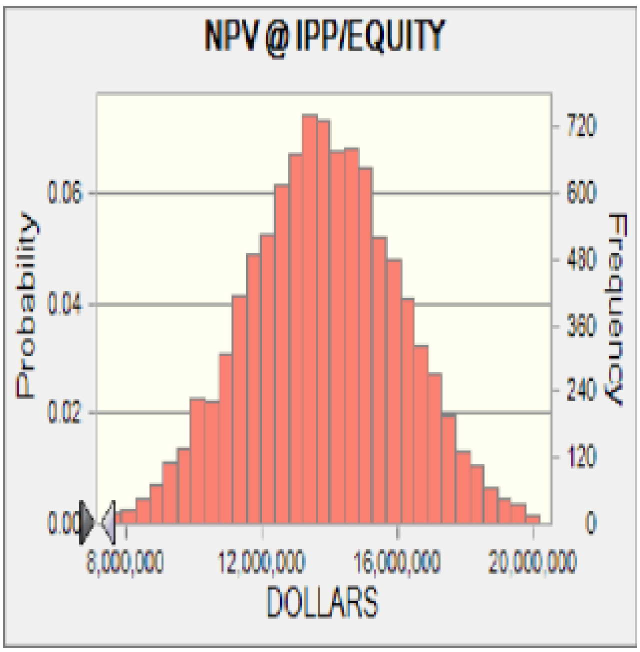
	329,313,686
0.00	**329,313,686**
5.00	291,535,575
10.00	253,757,464
20.00	178,201,242
30.00	102,645,020

Bagasse has no financial price; therefore it's better for the project because it yields better NPV compared to if it had a financial price.

6.2 Risk Analysis

Risk analysis, using the Monte Carlo simulation technique, is applied to test how the financial NPV of the project responds to possible variations in the values of the critical variables. As I have identified the most sensitive variables, I assumed for each of them the most probable range of variation with the best possible approximation to reality through a probability distribution. The results are shown on tables below.

6.2.1 Forecast Result for the Net Present Value and Internal Rate of Return

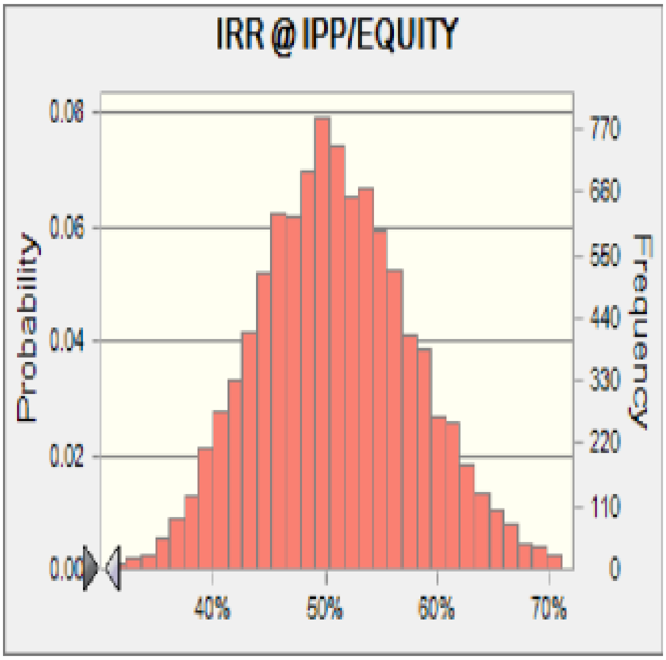


Statistics:	Forecast values
Trials	10,000
Base Case	14.6
Mean	13
Median	13.8
Mode	---
Standard Deviation	2.2
Variance	5,128
Skewness	-0.0016
Kurtosis	2.98
Coeff. of Variability	0.1640
Minimum	4.7
Maximum	22.4
Mean Std. Error	22,646

Figure 5: Forecast chart and statistic result for NPV

Note that the expected value of the NPV obtained is just a little bit lower than the one obtained in the base case. This finds its explanation in the fact that the probability of things improving for this project is much higher than the probability of things getting worse. Also, the deviation from the mean is very low. Even the minimum value is positive (4.7 million dollars). This also reassures us that the project is not risky at all.

The certainty level is 0% which means there is 100% probability that the project will generate a positive NPV.

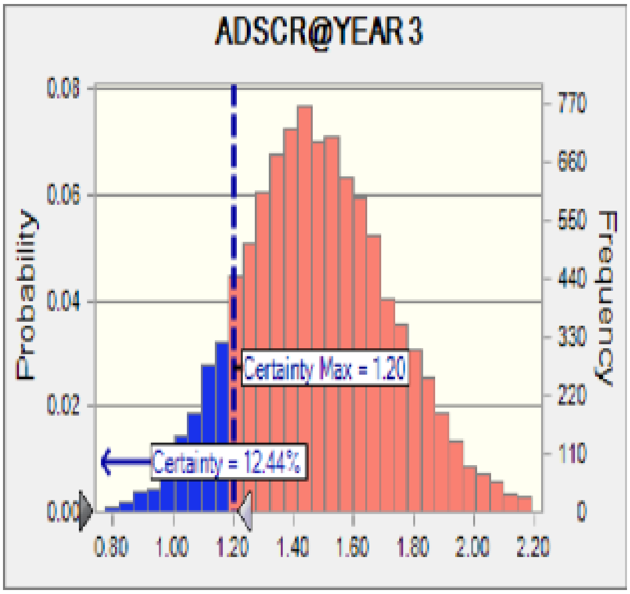


Statistics:	Forecast values
Trials	10,000
Base Case	54%
Mean	51%
Median	51%
Mode	---
Standard Deviation	7%
Variance	1%
Skewness	0.2790
Kurtosis	3.21
Coeff. of Variability	0.1396
Minimum	27%
Maximum	82%
Range Width	56%
Mean Std. Error	0%

Figure 6: Forecast chart and statistic result for IRR

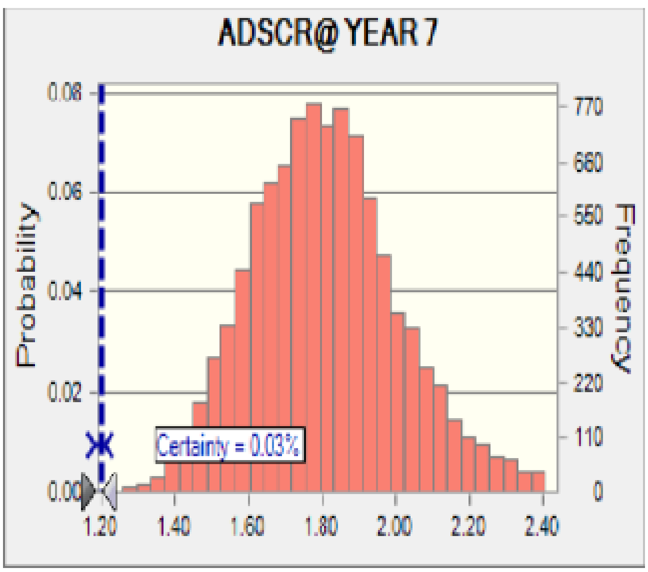
The above figure shows the forecast and statistics of Internal Rate of Return. The certainty level is 0% which means that the project's IRR is going to be higher than the project's discount rate that is 17%. The standard deviation is 7% away from the mean at 51% which very low and not risky at all. The minimum value for this project is 27% which is an excess of the discount rate.

6.2.2 Forecast Results for ADSCR and LLCR Ratios



Statistics: Forecast values	
Trials	10,000
Base Case	1.58
Mean	1.48
Median	1.47
Mode	---
Standard Deviation	0.25
Variance	0.06
Skewness	0.3196
Kurtosis	3.32
Coeff. of Variability	0.1699
Minimum	0.67
Maximum	2.67
Range Width	2.00
Mean Std. Error	0.00

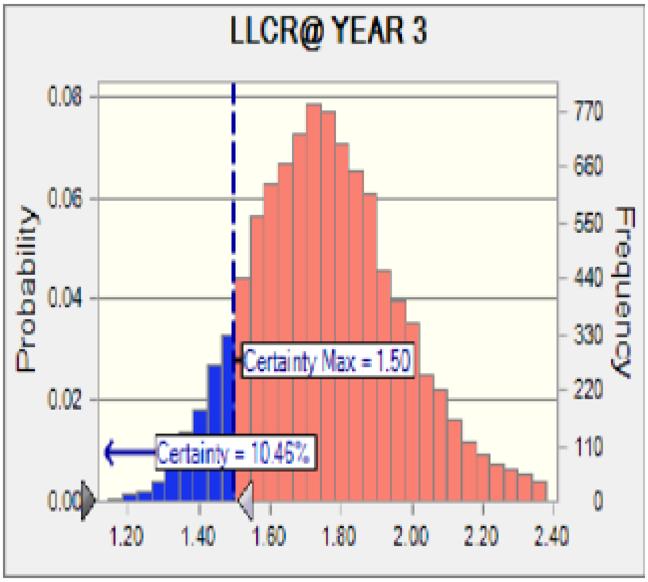
Figure 7: Forecast chart and statistic result for ADSCR in Year 3



Statistics:	Forecast values
Trials	10,000
Base Case	1.94
Mean	1.81
Median	1.80
Mode	---
Standard Deviation	0.21
Variance	0.04
Skewness	0.5402
Kurtosis	3.72
Coeff. of Variability	0.1169
Minimum	1.14
Maximum	2.87
Range Width	1.73
Mean Std. Error	0.00

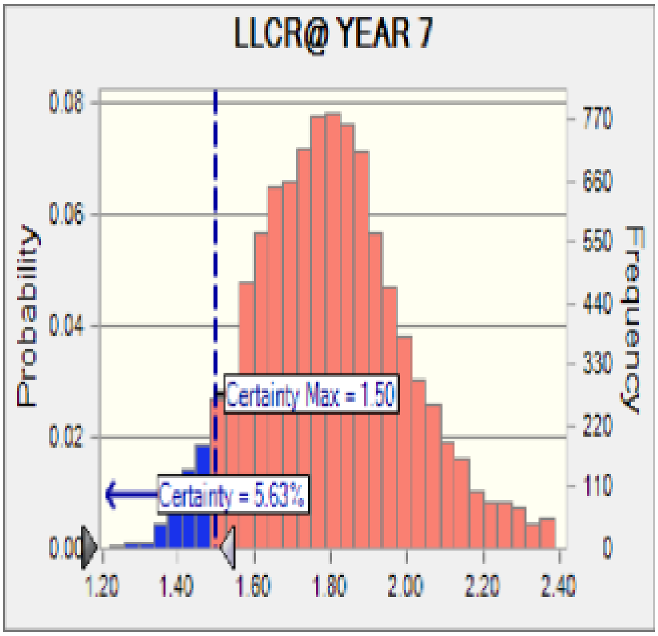
Figure 8: Forecast chart and statistic result for ADSCR in Year 7

The above ADSCR figures show that the projects ability to cover its debt obligation is high and less risky. There are low standard deviations from the mean values of both years signifying low level of riskiness for these ratios. Therefore, the banker can loan the debt to this bagasse project because of its ability to pay back and cover its debt service obligations.



Statistics:	Forecast values
Trials	10,000
Base Case	1.88
Mean	1.76
Median	1.75
Mode	---
Standard Deviation	0.22
Variance	0.05
Skewness	0.4932
Kurtosis	3.64
Coeff. of Variability	0.1248
Minimum	1.05
Maximum	2.84
Range Width	1.78
Mean Std. Error	0.00

Figure 9: Forecast chart and statistic result for LLCR in Year 3



Statistics:	Forecast values
Trials	10,000
Base Case	1.93
Mean	1.80
Median	1.79
Mode	---
Standard Deviation	0.21
Variance	0.04
Skewness	0.5685
Kurtosis	3.78
Coeff. of Variability	0.1151
Minimum	1.16
Maximum	2.79
Range Width	1.63
Mean Std. Error	0.00

Figure 10: Forecast chart and statistic result for LLCR in Year 7

The above LLCR results show the project ability to carry out bridge financing. This is because there is a low standard deviation from the mean values. With this, the project can cover its problematic years with the cash flows that are in excess in the following years.

In general, from the simulated forecasted Monte Carlo results. It can be concluded that the ratios are not risky. Therefore, the project has almost zero level of riskiness from the banker and the project owner point of views.

Chapter 7

CONCLUSION

The main conclusions that can be drawn from integrated financial-economic-distributive analysis are as follows:

1. The project is financially attractive. It pays the bills, repays the loan, and meets the expected equity rate of return.
2. There is a 12 % probability of negative return. The riskier variables are: (a) PPA price, (b) production of bagasse, (c) plant factor, and (d) number of generation days with bunker oil. The expected value of the NPV in probabilistic terms is much higher than the base case value since the probability of things improving for this project are higher than the probability of things remaining as they are or getting worse.
3. The Nicaraguan economy is better off by 79.7 million U.S. dollars with the project. In account of a significantly high economic fuel savings for the kWh.

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