FINANCIAL AND ECONOMIC ANALYSIS OF SMALL HYDROPOWER IN ETHIOPIA

By Ermias Tenkir

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DECLARATION

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any other university and that all sources of materials used for the thesis have been duly acknowledged.

Name Ermias Tenkir

Signature _____

Addis Ababa Institute of Technology

Addis Ababa University

Acknowledgment

First of all I would like to glorify the Almighty God for carrying me through all the stages of life including my master's study. He is good to me in all the time and in all things.

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Description of Abbreviations

SHP---Small Hydro Power
EEA---Ethiopian Electricity Agency
EREDPC---Ethiopian Rural Energy Development and Promotion Center
ESCOs---Energy Service Companies
IAEA---International Atomic Energy Agency
IHA---International Hydropower Association
MME---Ministry of Mines & Energy
PASDEP---Plan for Accelerated and Sustained Development to End Poverty
REES---Rural Electrification Executive Secretariat
REF---Rural Electrification Fund
UEAP---Universal Electricity Access Program
UF---Utilization Factor
UNEP---United Nations Environment Program
WBISPP---Woody Biomass Inventory and Strategic Planning Project
IPPs---Independent Power Producers
FIT---Feed-in Tariff
ART---Advanced Renewable tariff

Abstract

Ethiopia has a vast amount of hydropower potential despite the fact that its people are not yet benefited as required, especially those in the remote scattered rural villages. The people in these areas have a great tendency of using traditional energy production methods, which result in deforestation, environmental degradation, health problems, and so many other unpleasant life styles. Small hydropower plants can solve the above mentioned problems. But their installation has not come into reality as required. Even though they are installed at some places, they stop functioning before their service period. There may be many reasons behind the above problems. One of the problems which results in slow growth of small hydropower construction has been discussed in this study, which is the unclear financial and economic analysis that results in financial and economic infeasibility. Before the installation of any Engineering structure, it is crucial to analyze the financial and economic analysis of the installed project. Financial analysis is usually undertaken in order to evaluate the cost and benefit brought about by the project to a person or business, while the economic analysis is undertaken in order to assess the overall impact of the project on the economic welfare of the residents of a specific region. This paper discusses the financial and economic status of small hydro powers in Ethiopia. Four small hydro power projects which are found in different regions of Ethiopia have been analyzed in order to assess their financial feasibility and economic efficiency. The analyses have been carried out first at existing conditions which showed infeasibility. Then different possible ways and new approaches have been searched and discussed in order to check whether they bring financial and economic feasibility. By the different alternative approaches the projects have got appreciable results in financial viability and economic efficiency. Therefore, the approaches can be applied to both the case study sites and other small hydro power sites.

CHAPTER ONE

INTRODUCTION

1.1 Background

The theoretical potential of hydropower in Ethiopia is estimated to be 30,000-45,000 MW which would enable an annual energy of 160,000 GWh. The economically exploitable hydropower potential is estimated to be between 15,000 and 30,000 MW. Large hydro power makes up 98% of Ethiopia's power production. The government has large expansion plans for large hydropower plants to reduce energy shortages and to eventually become an energy exporter (GTZ, 2010).

In Ethiopia, enough SHP potentials exist near or at rural and semi-urban areas, which can change developmental equation of the rural areas. They could also provide considerable help to the country, by meeting the power deficit in the main interconnected grid system, substituting thermal plants in the main grid or isolated grids, helping reduce fuel imports and electrifying remote rural areas (Leonard, et al. 2005).

Rural electrification through conventional means such as grid connection or diesel generators is very costly.

The SHP has different advantages as compared to larger plants such that it is simple in design, construction and operation, it has very minimal adverse impacts on environment, and it has minimal costs for transmission from generation point to load centers (Smail & Andrew, 2000).

1.2 Statement of the Problem

In Ethiopia, the energy demand of rural dwellers is not yet satisfied. In view of this, small hydropower projects seem to be giving one of the promising solutions for electrifying rural areas. Private investment on this sector could play a great role. However, the interest of the private sector in making substantial investments in power generation has not yet been materialized. One of the potential reasons for this is observed to be lack of information about the financial and economic analyses of the plants.

1.3 Objective

The general objective of this study is to analyze the financial and economic feasibility of SHP plants in Ethiopia.

The Specific objectives are

- To assess the financial and economic feasibility of SHP plants at their existing situations
- To demonstrate different approaches that can improve economic & financial feasibility of SHP plants

CHAPTER TWO

LITERATURE REVIEW

2.1 Small Hydropower

Small-scale hydropower systems are those that generate between 10KW and 30 MW of electricity. Hydropower systems that generate up to 100 kW of electricity are often called micro hydro systems (U.S. DOE, 2001).

2.1.1 Basic Hydropower Operation

Hydropower systems convert the energy in flowing water to electrical energy. Although there are several ways to harness energy from the moving water; run-of-the-river systems, which do not require large storage reservoirs, are often used for micro hydro and sometimes for small-scale hydro projects. For run-of-the-river hydro projects, a portion of river water is diverted to a channel, pipeline, or pressurized pipeline (penstock) that delivers it to a waterwheel or turbine.

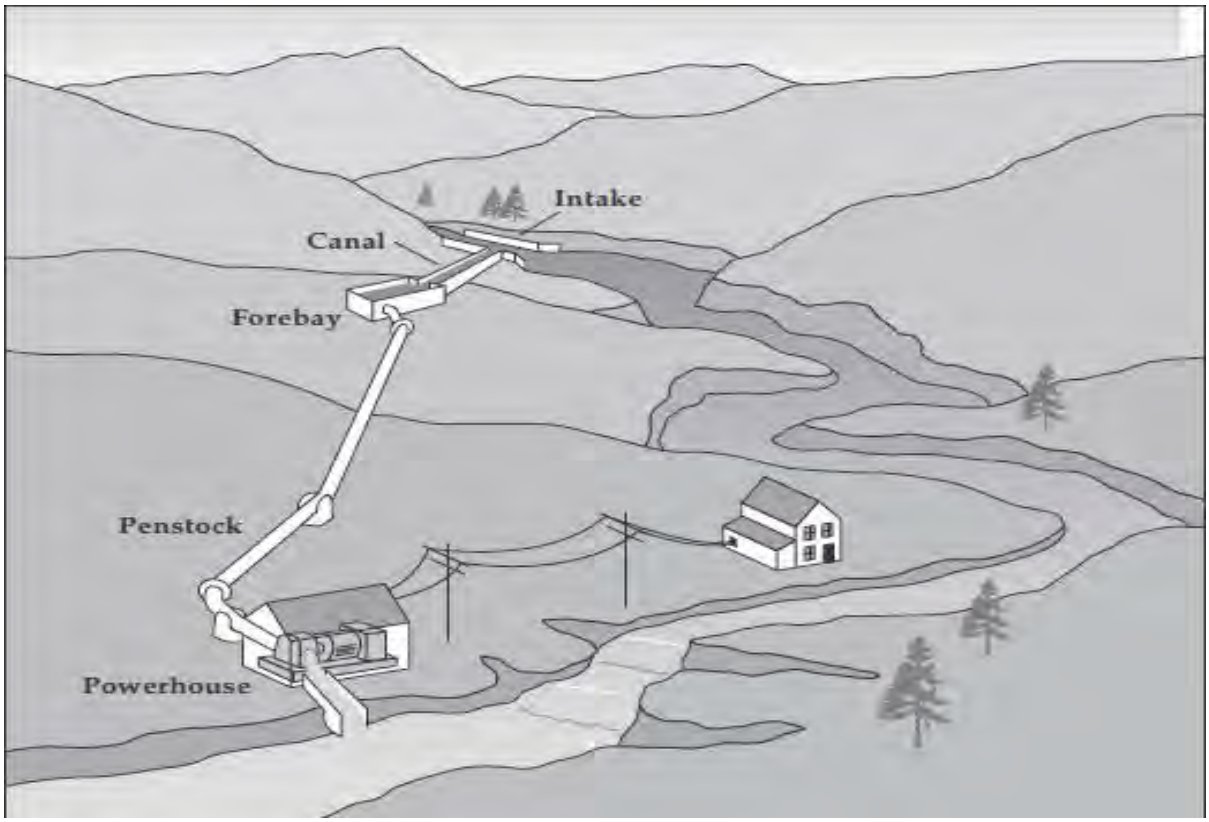

Figure 2.1-1: A general scheme of hydropower

The moving water rotates the wheel or turbine, which spins a shaft. The motion of the shaft can be used for mechanical processes, such as pumping water, or it can be used to power an alternator or generator to generate electricity.

To build a small hydropower system, access to flowing water is needed. A sufficient quantity of falling water must be available, which means that usually hilly or mountainous sites are best. Next it is required to determine the amount of power that can be obtained from the flowing water on a site.

The power available at any instant is the product of flow volume and head. The units of power can be put in terms of Watts, kilowatts, or Megawatts.

Most small hydropower sites are categorized as low or high head. It is better to have high head because you'll need less water to produce a given amount of power and you can use smaller, less expensive equipment. Low head refers to a change in elevation of less than 3 meters. A vertical drop of less than 0.6 meters will probably make a small scale hydroelectric system unfeasible (U.S. DOE, 2001).

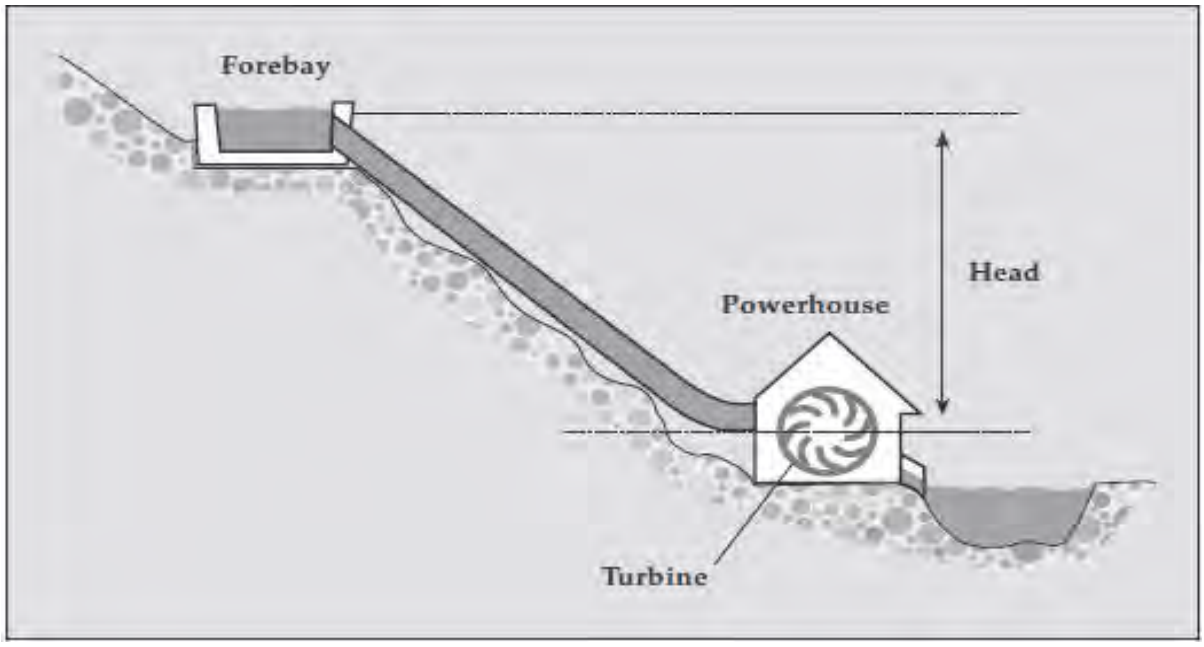

Figure 2.1-2: flow and head of hydropower

2.1.2 Technical Aspects

Energy

Energy is one of the four fundamental requirements (food, water, energy and environment) which challenge the human life. It is critical in developing countries not only for social development and human welfare but also as a catalyst for overall development. Energy in the form of electricity provides the basic infrastructural input to the national economic growth. The per capita electric consumption is considered as an index of a nation's progress and development (Sharma, 2003).

Renewable Energy

The three main sources of energy are water, fossil fuels and nuclear. For renewable energy the primary source is water. In addition there are non-conventional and renewable sources like wind, tidal, solar and geothermal energies. The conventional hydropower generation uses a renewable energy source and currently supplies about 20% of the electricity generation worldwide. It plays an important role in a variety of long term scenarios for sustainable development (Sharma, 2003).

Firm power and secondary power

A hydro power station generates firm power for consumer needs with firm flow that guarantees the consumers highly dependable supply of energy.
In run-off-river plants which are generally designed for Q90 (the discharge available 90% of the time), the firm power would be available for 90% of the time. When the available discharge is more than Q90, the power available in excess of the firm power is called secondary power. It is the additional power which can be generated at a plant in excess of the primary power depending upon the spare capacity provided over the constant load.

Firm power (MW) $=9.81QH\eta*10^{-3}$ …….……. (Eqn2.1)

Q = the average inflow (cumecs) during the lean months of 90% dependable year.
H = the average net head (m) during the period.
η = the combined efficiency of turbine and generator (%).

Annual firm energy (GWH) = Firm power (GW)*Time (hr)…….…… (Eqn2.2)

Time = time within a year when energy is available at all times

Capacity Utilization

It is a measure of plant water use as determined by water supply. Utilization factor is the ratio of water actually utilized for power generation in the plant to that available in the river. With

constant head, utilization factor is also the ratio of power utilized to the power available (Sharma, 2003).

2.2 Major Aspects of Economics

2.2.1 Definition and Uses of Economics

Economics is the social science concerned with the efficient use of scarce resources to achieve the maximum satisfaction of economic needs. People's economic needs are multitudinous and diverse. Biologically, humans need only air, water, food, clothing and shelter. But in contemporary society we also seek the many goods and services associated with a comfortable standard of living. Fortunately society is blessed with productive resources-labor and managerial talent, tools and machinery, land and mineral deposits that are used to produce goods and services. This production satisfies many of our economic needs and occurs through the organizational mechanism called the economic system or, more simply, the economy (McConnell, 2005).

2.2.2 Economic Terminologies

Demand and Supply

Demand and Supply are the most fundamental tools of economic analysis. Most applications of economic reasoning involve demand and supply in one form or another.
Demand is a schedule that shows the various amounts of a product that consumers are willing or able to purchase at each of a series of possible prices during a specified period of time. Demand shows the quantity of a product that will be purchased at various possible prices, other things taken equal. Supply is a schedule showing the amounts of a product that producers are willing and able to make available for sale at each of a series of possible prices during a specified period (McConnell, 2005).

Payback period

It is the time in years from the beginning of a project until the time when the sum of the revenues from sales (and other income) equals the capital invested for the project (LH White, 2008).

Net Present Value (NPV)

The NPV of an investment project at a time point equal to zero is the sum of the present values of all cash inflows and outflows linked to the investment. When applying the NPV method of an investment it counts as profitable when its NPV is at least equal to zero. A negative NPV would indicate that the desired minimum interest rate will not be reached. On the other hand a positive NPV means that the interest rate on capital is greater than the assumed discount rate, and the greater the NPV the more profitable the investment (Zelalem, 1991).

$$NPV = \sum_{i=0}^{n} \frac{Bi}{(1+K)^i} - [CC + \sum_{i=0}^{n} \frac{Ci}{(1+K)^i}] \quad \text{(Eqn2.3)}$$

Bi, Ci - Benefit and cost in year i
CC – Capital cost
n – Project life
K – Discount rate

Each future income amount in the stream is discounted, meaning that it is divided by a number representing the opportunity cost of holding capital from now (year zero) until the year when income is received or the outgo is spent. Opportunity cost is the cost of any activity measured in terms of the best alternative forgone. It can either be how much you would have earned investing the money someplace else, or how much interest you would have had to pay if you borrowed money. The word "net" in "net present value" indicates that our calculation includes the initial costs as well as the subsequent profits. It also reminds us that all the amounts in the income stream are net profits, revenues minus cost (Samuel L. Baker, 2009).

Internal rate of return (IRR)

The IRR of an investment expresses the achievable interest on the capital tied-up in investment. The numerical value of the IRR is obtained by setting the value of the NPV as zero and calculating the interest rate.

$$0 = \sum_{i=0}^{n} \frac{Bi}{(1+IRR)^i} - [CC + \sum_{i=0}^{n} \frac{Ci}{(1+IRR)^i}] \quad \text{(Eqn2.4)}$$

The IRR is calculated by a trial and error process starting with a guess at the IRR. The process is as follows:

i. The NPV is calculated using discount rate r.
ii. If the NPV is close to zero then r is the IRR.
iii. If the NPV is positive r is increased.
iv. If the NPV is negative r is decreased.
v. Go back to step 1.

This is more tedious than calculating NPV, but the extra work can be automated. When applying the IRR method, an investment is viewed favorably if the IRR is either equal to or greater than the pre-determined minimum acceptable interest rate. The IRR does not require predicting future discount rates. That would seem to make the IRR the more useful (or less uncertain) measure (Pietersz, 2010).

Benefit to cost ratio (B/C)

The B/C is calculated as the ratio of the present value of project benefits and the present value of the project capital cost and annual costs. The B/C is the most commonly used decisive rule for project screening and ranking. The decisive rule is to reject projects that have B/C ratios less than one.

$$B/C = \frac{\sum_{i=0}^{Yi} \frac{Bi}{(1+K)^i}}{CC + \sum_{i=0}^{n} \frac{Ci}{(1+K)^i}} \quad \text{(Eqn2.5)}$$

Discount Factor

$$Discount\ factor = \frac{1}{(1+i)^n} \quad \text{(Eqn2.6)}$$

i = discount rate, must be absolute, not in % (i.e. 10% = 0.1)
n = number of years from the present (year zero) to year n when the value occurs (end of that year)

2.2.3 Sensitivity analysis

All projects should be subjected to sensitivity analysis as it is the most effective tool for analyzing the risks and uncertainties of projects**.** For the sensitivity analysis, the economic or financial analysis is simply recomputed using the new estimates of project costs, discount rates, energy sales, etc., one after the other (AGMHP, 2008).

2.2.4 Financial Analysis

Financial analysis is the process of evaluating businesses, projects, budgets and other finance-related entities to determine their suitability for investment. Typically, financial

analysis is used to analyze whether an entity is profitable enough to be invested in. Financial analyst will often focus on the income statement, balance sheet, and cash flow statement.

An income statement reports the financial performance over a specified period of time. It summarizes all revenue earned and expenses incurred during a specified accounting period so that it can determine its net profit or loss (the difference between revenue and expenses). Revenue refers to money earned for goods sold and services rendered during an accounting period and expenses represent costs incurred for goods and services used in the process of earning revenue (CGAP, 2005).

2.2.5 Economic Analysis

An economic analysis is undertaken in order to assess the overall impact of projects on the economic welfare of societies. The economic analysis estimates returns to the national economy as a whole. Thus, the scope of the economic analysis is larger than the financial analysis as it assesses a project in the context of regional or national economy.

There are two methods of Economic Analysis, the static and dynamic method.

Static methods look at a project and the associated costs and benefits independent of time; they do not consider the time value of money.

Dynamic methods on the other hand treat costs and benefits which occur at different points in time of a project with different values. This method is used to analyze the economics of power projects (AGMHP, 2008).

Subsidies by the government to reduce prices of goods or services must be added to market prices to reflect the true cost of these goods to society. If a government subsidizes production of a good, it in effect lowers the producer's costs and increases supply. The subsidy can also be to consumers in order to increase demand (McConnell, 2005).

2.2.6 Costs and Benefits of SHP Projects

Costs of small hydro power projects

Costs for small hydro power projects may include the following.

During project preparation and construction:

- Capital investment for civil works, equipment, etc. (including transport, installation and commissioning costs)

- Cost for project preparation, supervision and administration
- Land acquisition and compensation
- Costs for licenses, water rights and other regulatory requirements

During project operation:
- Operation and maintenance costs of equipment
- Administrative costs and overheads of power distribution company including taxes
- Replacement costs

Economic costs:

Economic costs are analyzed as foreign and local. For economic analysis we should only consider the foreign costs. Local costs are considered as benefits within the same society. If all civil works are undertaken by local personnel, then civil work will have low foreign component. Wages of domestic laborers and costs of construction materials are included in local costs (Tropics-Keto, 1999).

Benefits of small hydro power projects

Benefits of small hydro power projects may include:
- Revenue from electricity sales
- Avoided cost of energy generation substituted by the new project
- Subsidies from Government for providing electricity services to a specific area or consumer groups (AGMHP, 2008).

Economic benefit:

Concerning Economic Analysis, some benefits come indirectly and are difficult to analyze in their monetary value. Therefore, the costs and benefits should be measured both in terms of their monetary and non-monetary values.

If a cost to an individual is a benefit to another in the same society such a cost is not included in the total capital or O&M cost since the society neither gains nor losses from such cost. This helps us to arrive at the real economic cost.

Concerning capital cost, only non-local costs which are spent on purchasing components outside the community are considered.

If the operators of the system are from the same community, the operation cost will be deducted from the O&M cost. Therefore, the O&M cost results only from the maintenance cost.

Economic benefit is the net benefit which all individuals in the society gain from the installation of the SHP system.

2.3 Hydropower in Ethiopian Development Programs

There are different hydropower development programs in Ethiopa, which aim to promote the achievement of national socio-economic goals through efficient and sustainable development of water resources to produce Electricity. In line with that, various hydropower projects that are geared towards meeting the local demand, the export demand and small hydro development for rural areas are envisaged to be done at different level. This is to enhance efficient and sustainable development of the water resources and meet the national energy demands as well as cater for external markets to earn foreign exchange (MoWE, 2010).

2.4 Electric Power Resources in Ethiopia

Ethiopia has a number of options for diversifying the power generation mix. In addition to hydropower, Ethiopia has considerable resources in geothermal, wind, biomass, solar, coal, and natural gas. It also has the option of power exchange with neighboring countries (ERG, 2009).

2.4.1 Overview of the Ethiopian Power Sector

In Ethiopia electricity is provided by the state power utility EEPCO, and much smaller private, cooperative and municipal power suppliers. In terms of total capacity and energy generated, EEPCO far surpasses the combined output from all other suppliers. EEPCO runs two systems: the Interconnected System (ICS), which accounts for 98% of capacity and generation, and the Self-Contained System (SCS). National electricity access (meaning the population that is within reach of low-voltage distribution lines) is 22% and actual customer connection is only about 15%; rural customer connection is less than 5%.

Since recent years, government investment in the power sector has increased substantially. As a result, both supply and demand are growing rapidly. Power capacity and generated energy are planned to increase to 4,681MW and 20,000GWh by 2015.

Beside the ICS and SCS systems run by EEPCO, the government is also promoting off-grid rural electrification through a separate agency (EREDPC). With this program the government

provides concessionary loans to companies to develop small decentralized systems for electrification of areas outside the ICS and SCS. The off-grid electrification program is progressing at a much slower pace than the grid based program. The resources available for the program are also less than 1% of the grid based program (ERG, 2009).

2.4.2 Some Potential Sources of Energy in Ethiopia

Existing power generation on the Ethiopian Interconnected System (ICS) is highly dominated by hydropower resources (98% of total generation on the ICS). Committed and planned additions into the ICS are also almost exclusively hydro from the planned addition of 14,000MW to the year 2027 less than 5% will be from non-hydro resources. The abundance of the resource and its relatively low cost of energy production make hydropower the first choice for system expansion. However, Ethiopia also has other renewable and non-renewable energy resources that may be utilized for power generation. The renewable resources include geothermal, wind, solar, and biomass (including biofuels and biogas).

The economically exploitable power generation resource in Ethiopia is 54GW. Eighty four percent of the resource is from hydropower and 13% is from wind. Only 7% of the economically exploitable resource is either developed or committed to be developed (ERG, 2009).

Hydro energy

The hydro energy resource potential of Ethiopia is estimated to be 30 to 45GW (159TWh/year). National level resource estimates are not exhaustive or recent and there is considerable uncertainty regarding the potential. However, the fact that committed and planned additions alone add up to 14GW point to the probability that the gross potential would be at least 45GW. Ethiopia is divided into nine river basins. Two river basins, Abay and Omo-Gibe, account for 72 percent of the total hydro energy potential. The Baro-Akobo and Genale-Dawa river basins contribute much of the rest.

Hydropower development in Ethiopia started with mini to small power plants but current and planned development is almost exclusively for large plants. Existing and committed hydropower plants use multi-purpose dams (power and irrigation). There are no pumped storage hydropower plants in Ethiopia and there appears to be none planned for the future. (ERG, 2009).

2.4.3 Rural Electrification in Ethiopia

The three most important rural energy sources, in their order of importance, are fuel wood, dung and agri-residue; while the three most important end-uses are “mitad” baking, other cooking and lighting. The implication of this is that, if rural households are provided with electricity, even for lighting, the gain in terms of environmental protection of rural areas is significant.

In view of the above there is a huge market for investors in the area of rural electrification. And the huge market could be taken as the other opportunity for the development of the energy sector in general and rural electrification in particular.

But the rural electrification is facing some problems. In extending electrical power to low income areas where domestic consumers are poor and the demand of electricity for productive purposes is absent; low levels of demand, low revenues, and high initial costs are obstacle to investment. Studies indicate that the key constraint to energy supply for rural communities is access to the initial capital needed to buy the equipment to harness the resource. This forced rural communities to choose energy options that are cheap on a day-to-day basis, but offer poor quality energy and are expensive over the longer term (Aklilu, 2010).

2.4.4 Decentralized and Non-Utility Power Supplies

At the present time in Ethiopia on-grid supplies are a monopoly of EEPCO and all generating, transmission and distribution facilities on the grid are owned by the utility. EEPCO, municipalities, ESCOs, private companies, agricultural producers’ cooperatives are all involved in off-grid electricity supplies. Even in the off-grid system EEPCO has the dominant position as its SCS system (31.5MW) is several times larger than the combined output from the other suppliers (ERG, 2009).

Non-utility supplies are promoted in many countries for the expressed purpose of improving efficiency and competition in the power sector. In developing countries non-utility supplies are also promoted because states may not have sufficient financial, managerial and technical capacity to develop their resources. Other objectives include diversity, power market development in as yet un-served areas, and support to local enterprise. Non-utility supplies can be on or off-grid. If on grid, Independent Power Producers (IPPs) sell power to the transmission and distribution operator which provides the power to customers. For off-grid applications power producers or suppliers provide service directly to final users as either sale of product or fee for service (ERG, 2009).

The electricity sell is as per the electricity law. The Ethiopia Electricity law allows increase on tariff with the following General Principles:

i. Electricity pricing shall be based on the principle of efficient allocation of resources where customers and producers receive the true costs associated with consuming and producing one additional unit of energy respectively.
ii. The price that customers get charged for shall be computed in consideration of the cost incurred by the total system, and the energy consumption shall as much as possible, be made fair taking the production cost into account.
iii. The rate level shall be made sufficient enough to support continuing investments and sustainable services, and shall include a system of pricing that guarantees improved service efficiency.
iv. Tariff structures shall be kept simple enough to avoid or minimize implementation difficulties (Electricity Law, 2007).

2.4.5 Feed-in Tariff Law

Feed-in tariffs (FITs), also known as 'advanced renewable tariffs' (ARTs) pay renewable energy producers a set rate (tariff) for each unit of electricity fed into the grid, and generally oblige power companies to purchase all electricity from eligible producers in their service area over a long period of time usually 15–20 years. This policy has proven to be remarkably adaptable and effective, gaining popularity in both developed and developing countries. Interest in exploiting renewable energy sources as well as the new industrial opportunities they offer has been prompted by the emerging crises relating to energy and economics. And the implementation of best policies to support the deployment of renewable energies has received greater priority (Miguel & David, 2009).

2.4.5.1 Feed-in Tariff for Diverse Economy

Feed-in tariffs become the policy instrument of choice for so many diverse economies around the world because feed-in-tariffs:

- Are empirically proven to promote the fastest expansion of renewable electric power, at the lowest cost transparently and democratically.
- Cost governments nothing, being usually funded through costs spread among all electric utility customers, as part of their regular bill.
- Work so well because they are simple and inclusive, allowing all players to invest.
- Have lower administration costs, and when designed properly and supported by appropriate planning laws can get deployment moving very quickly.
- Accelerate the cost reduction of renewable energy technologies, making them cost-competitive with conventional energy sources at a much faster pace.
- Can foster technological development through rapid deployment and economies of scale.

2.4.5.2 Feed -in Tariff Worldwide

Feed-in tariffs are now in use in around 50 countries, states and provinces. Feed-in laws are also under discussion or in development in many developed countries. Experience in Germany shows that the feed-in tariff was instrumental in increasing the power generated by renewable energy resources from 6.3% in 2000 to more than 15% in 2008.

Many developing countries and emerging economies have also currently implemented, or plan to implement, feed-in tariff schemes, including Argentina, Brazil, China, Ghana, Malaysia, Kenya, Nigeria, Pakistan and South Africa. Renewable energies have an incredible potential in those countries, considering the fact that 1.6 billion people around the world have no access to electricity. African countries are especially interesting in this respect, as they show that nowadays renewable energy sources are an essential part of each and every energy mix. Feed-in tariffs can also be adopted to promote renewable energies in mini-grids small-scale electricity networks based on a local and often isolated distribution system (Miguel & David, 2009).

2.4.5.3 Feed-in Tariff in Ethiopia

In Ethiopia IPP power supply to the grid is promoted through policies, strategies and legislation. Despite interest by some potential IPPs, no Power Purchase Agreement (PPA) has been signed. Since the rationale for IPPs is that they fill government resource gap and that they foster efficiency, the feed-in tariff should come to practice as fast as possible. IPPs should be encouraged to develop resources and contribute to the total power sector development of the country both in small and large scale power developments. Appropriate laws need to be formulated so that private investments in the power sector will be encouraged and protected. Access to the grid should be permitted for IPPs through power purchase agreements and encouraging feed-in-tariff law (ERG, 2009).

2.4.5.4 The Feed-in Tariff Goal

Despite the fact that feed-in tariffs have proven to be the most successful support mechanism in bringing about new renewable power at low costs, the specific design is crucial for effective and efficient support. Today, many countries have overcome their ideological barriers towards ‘fixed price’ support mechanisms as their performance is clearly superior to other support instruments. The 50 countries, states and provinces all over the world that already operate with feed-in tariffs play an important role in the global transition to a renewable energy-based system. They can also contribute to overcoming the current economic crisis and powering the green economy (Miguel & David, 2009).

CHAPTER THREE

RESEARCH METHODOLOGY

The aim of this study is to analyze the financial and economic feasibility of SHP plants. for this purpose the general overview of the SHP plants and their financial condition are described first. Then the different data are analyzed to evaluate the basic financial and economic conditions.

3.1 Description of Study Areas

In the following sections, the general overview of four different SHP schemes (Keto, Bonora, Weni and Mogor) located in different rural regions of Ethiopia will be discussed.

3.1.1 Keto SHP System

General Description of Keto SHP system:

Keto SHP project is situated on Keto river in Gawo dale Wereda West Wellega zone of Oromia Region, about 592km south-west of Addis Ababa. There is a paved all weather road 335km from Addis Ababa to Nekemte followed by an all weather gravel road 243km to Chanka. After this 13 km of all weather gravel road connects Chanka to the project site. Based on the 1994 census figures and the national urban growth rate of 4.11%, the projected populations of the demand centers (for the year 1998) was 4317 for Chanka town and 3598 for Alem Teferi (Tropics-Keto, 1999)

The existing financial condition of Keto:

The different financial values of Keto SHP at its initial condition are the following:

The capacity of the system is 400 KW.

The capital cost is *10,804,220Birr* (Appendix 3.1-4)

The annual O & M costs are taken as 1.5% of the capital cost. Therefore, the annual O&M cost is *162,063Birr* (Appendix 3.1-4)

The tariff adopted is the second phase average EEPCO's tariff due on July 1999 which is *0.518 Birr/KWH*.

Based on the field data collection made in the two towns of Chanka and Alem Teferi, the number of potential consumers and their load characteristics are worked out for the year 2000. Two years of construction and 20 years of economic life of the project are assumed.

The forecast period is from the year 2001 to 2020. The electricity demand forecast for the towns of Alem Teferi and Chanka was made and the annual energy sales for the residential and non-residential (commercial, small-industrial and street lighting) categories of customers are forecasted using appropriate energy growth rates. The total sum of energy sales in each category are, then, converted to energy generation requirements and to the peak demand requirements using load factors (Tropics-Keto, 1999).

3.1.2 Bonora SHP System

General Description of Bonora SHP system:

Bonora SHP project is located in the Sidama administration region at about 400km of road distance to the southwest of Addis Ababa. The site is located in the immediate vicinity of the Genale River and the nearby town is Daye town. Originating from the highlands of Jido Kombolcha, the Bonora river drains leaf shaped basin with average elevation of 2000 masl. The site is situated about 45km from the river origin. The overall length of the Bonora River is 65 km. According to the 1994 Census, the population of Daye town was 5879. According to 2002 data the population was 21036. The town of Daye is surrounded by the following villages: Bona Kebalanka, Bensa Kebado, and Werancha. As rural area, the economic activity of Daye and of the surrounding villages is dominated by agriculture (Tropics-Bonora, 2002).

The existing financial condition of Bonora:

The different financial values of Bonora SHP at its initial condition are the following:

The capacity of the system is 930 KW.

The capital cost is *17,154,050 Birr* (Appendix 3.2-4)

The annual O & M costs are taken as 1.5% of the capital cost. Therefore, the annual O&M cost is *214,426 Birr* (Appendix 3.2-4)

Since the online date of the project is 2000, the tariff adopted is the second phase average EEPCO's tariff due at July 1999 which is *0.518Birr/KWH*.

Capacity of the plants corresponds to the firm power since the plants are assumed to be run-off-river plants which are generally designed for Q_{90}. The benefits are based on the power market in each year. Two years of construction and 20 years of economic life of the project are assumed. The forecast period started from the year 2001 till 2020.

3.1.3 Weni SHP System

General Description of Weni SHP system:

Weni SHP project is situated on Weni River, in Nono Wereda, West Shoa Zone of the Oromia region, about 220 km south west of Addis Ababa. Roads in the vicinity of the proposed site are more or less accessible until Shenen. Paved all weather road 135km run from Addis Ababa to Guder followed by an all weather gravel road 75km to Shenen. After this 31km of dry weather road connects Shenen, Silkamba and the project site. At initial condition energy supply system was not available in the two demand centers of Shenen and Silkamba. According to the 1994 Census, the population of Shenen town was 2368 with a growth rate of 4.11%, the projected population in the year 1998 is 2782. Since national census data was not available for Silkamba town the population figure of the towns administration was taken as 1530 projected for the year 1998 (Tropics-Weni, 1998).

The existing financial condition of Weni:

The different financial values of Weni SHP at its initial condition are the following:

The capacity of the system is 120 KW.

The capital cost is *6,695,600Birr* (appendix 3.3-4)

The annual O & M costs are taken as 1.5% of the capital cost. Therefore, the annual O&M cost is *100,434 Birr* (Appendix 3.3-4)

Since the online date of the project is 2000, the tariff adopted is the second phase average EEPCO's tariff due at July 1999 which is *0.518Birr/KWH*.

The benefits are based on the power market in each year. Two years of construction and 20 years of economic life of the project are assumed. The forecast period starts from the year 2001 till 2020.

3.1.4 Mogor SHP System

General Description of Mogor SHP system:

Mogor SHP project is situated on Mogor River, in Ibantu Wereda, East Wellega Zone of the Oromia Region, about 482 km south west of Addis Ababa. Roads in the vicinity of the proposed site are more or less accessible until Gida Ayana. Paved all weather road 335km run from Addis Ababa to Nekemte followed by an all weather gravel road 112km to Gida Ayana. After this 38km of dry weather road connects Gida Ayana, Hinde and the project site. At initial condition energy supply system was not available in the Hindi town (the demand center). According to the 1994 Census, the population of Hindi town was 1466 with a growth rate of 4.11%, the projected population in the year 1998 was 1722 (Tropics-Mogor, 1999).

The existing financial condition of Mogor:

The different financial values of Mogor SHP at its initial condition are the following:

The capacity of the system is 170 KW.

The capital cost is *7,233,220Birr* (Appendix 3.4-4)

The annual O & M costs are taken as 1.5% of the capital cost. Therefore, the annual O&M cost is *108,500 Birr* (Appendix 3.4-4)

Since the online date of the project is 2000, the tariff adopted is the second phase average EEPCO's tariff due at July 1999 which is *0.518Birr/KWH*.

The benefits are based on the power market in each year. Two years of construction and 20 years of economic life of the project are assumed. The forecast period starts from the year 2001 till 2020.

3.2 Data Collection and Analysis

The data were secondary data collected mainly from the feasibility report review and update report review of the four small hydro power projects. Then the data have been analyzed.

Data Analysis includes:

- Financial cost and benefit calculation as well as net benefit discounting to find the NPV, B/C and IRR of SHP plants using financial and economic equations
- Analysis of the economic and financial merit of the SHP plants by comparison of the net benefit for a scenario with the existing condition of the projects and for another without the projects

The project with the highest incremental net benefit is the preferred option from the economics point of view. Present values are better than the same values in the future, and early returns are better than later returns. In other words, we need less money in our pocket today if the investment is due next year as compared with the same investment payable now. In order to take account of these facts in our economic and financial analysis the concept of discounting project worth is used.

There are two major methods of economic analysis: Static methods and Dynamic methods.

i. *Static methods* look at a project and the associated costs and benefits independent of time; they do not consider the time value of money.
ii. *Dynamic methods* on the other hand treat costs and benefits which occur at different points in time of a project with different values. Static methods should not be used to analyze the economics of a power project (AGMHP, 2008). Therefore, in this research dynamic method is used.

CHAPTER FOUR

FINANACIAL ANALYSIS OF THE SHP PLANTS

For all the projects, the period of financial analysis is 20 years. The discount rate of 10% is applied since the average borrowing rate of capital in the Commercial Bank of Ethiopia during the system installations was 10%.

For the evaluation of the financial viability of the system, all the costs and revenues are discounted into the present value in order to arrive at the net present value (NPV).

4.1 Assessment of Financial Feasibility

The values of NPV, IRR and B/C are referred from the feasibility reports of the projects and put concisely in Table 4-1. This study, then, analyzes the data to check whether the sites are financially feasible or not at their initial condition.

If the NPV is zero or positive, a project can be said safe or feasible, otherwise the investment is incurring losses. With negative NPV the long term sustainability of projects will be in danger.

The Benefit to Cost ratio can be found by dividing the discounted revenue to the discounted cost.

The results of the NPV, IRR and B/C at initial conditions are presented in detail in the appendices (Appendix 4.1-1, 4.1-2, 4.2-1, 4.2-2, 4.3-1, 4.3-2, 4.4-1 and 4.4-2)

Table 4-1: NPV, IRR and B/C values at initial condition for all the sites

Financial parameters	Sites			
	Keto	Bonora	Weni	Mogor
NPV(Birr)	-5,274,479	-6,077,287	-4,425,268	-3,777,707
IRR (%)	2.4	5.5	-1.5	2.3
B/C	0.55	0.67	0.39	0.52
Capacity of plant (KW)	400	930	120	170

4.1.1 Relationship of Plant Capacity with B/C and IRR

Putting the sites in order of increasing capacity, the observation will be traced in whether the B/C and IRR is increasing or decreasing. The graphs of capacity v B/C and IRR are then drawn.

Table 4-2: IRR and B/C values at initial condition for all the sites with increasing order of capacity

Plants	Capacity (KW)	B/C	IRR (%)
Weni	120	0.39	-1.5
Mogor	170	0.52	2.3
Keto	400	0.55	2.4
Bonora	930	0.67	5.5

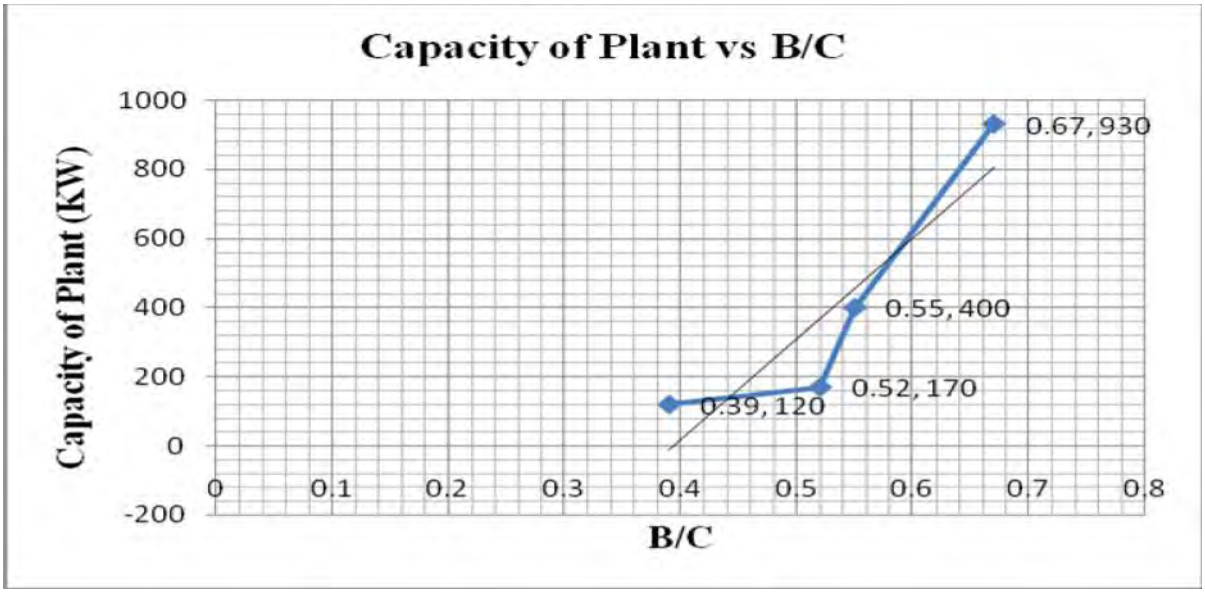

Figure 4.1-1: Capacity of plant vs B/C graph at Initial Condition

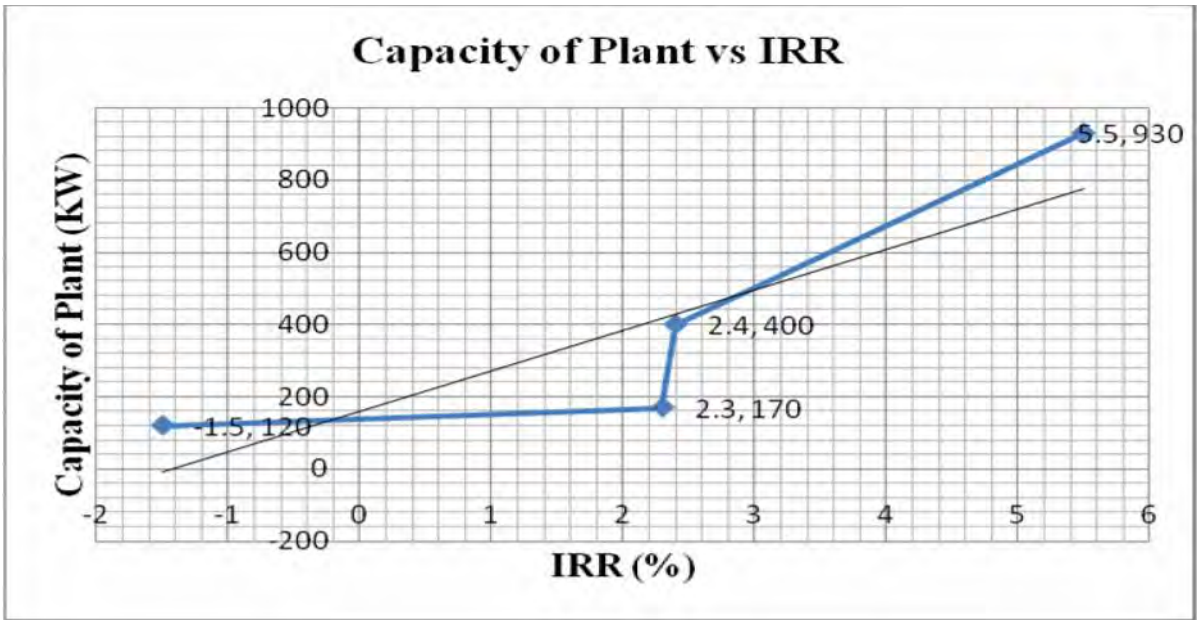

Figure 4.1-2: Capacity of plant vs IRR graph at Initial Condition

Discussion by observing the above analyses:

- Originally, all the SHP plants are found with negative NPV, B/C ratio of less than 1 and IRR of less than 10%. This indicates that at initial existing condition, all the SHP systems were financially infeasible.
- From the graphs of Capacity of Plant vs B/C & IRR, we observe that the curves are upward sloping. This indicates that at initial condition plants of higher capacity are more feasible than plants of lower capacity.
- We observe that the SHP plants are functioning under their potential. From the energy demand forecast, it is observed that the SHP plants were constructed only for the household demands. This in turn resulted in infeasibility.

4.2 Description of Ways of Bringing Financial Feasibility

As can been seen from above, NPV values are negative, IRR less than 10%, B/C less than 1. With this initial condition the projects cannot continue to be feasible. For the towns to continue to be electrified, different remedial measures should be taken by looking into sensitive parameters.

This section presents different alternative measures and new approaches in order to bring financial viability throughout the economic life of the projects. Therefore, different values are assumed to determine the degree of sensitivity of assumed parameters.

Sensitivity analysis is carried out in this study to quantify the financial consequences with given important input parameters. Different assumptions made in the analysis are given in the following sections.

4.2.1 Increase on Tariff for Keto SHP

Before we recommend on the increase of tariff, we have to assess the ability to pay of the consumers who are beneficiaries of the project. The ability to pay is evaluated with respect to the expenses of estimated energy in the absence of the project both in households and business enterprises.

Other than the inconveniences and waste of time caused by collecting fuel wood in the towns of Chanka and Alem Teferi, the average monthly expense for lighting by using privately owned generator, kerosene, "fanos" or "masho" was estimated to be *Birr 17* for households and *Birr 72* for business enterprises.The average monthly charge of a residential and non-residential consumer is calculated taking the average energy consumption of a residential consumer *280kwh* and a non-residential consumer *685khw* per annum from the load forecast (Tropics-Keto, 1999)

With the tariff we used for the initial condition of Keto SHP project the average monthly expense of a residential consumer will be:

(280kwh/year*0.518Birr/kwh*1year/12months)=*12Birr/month*
And that of a non-residential consumer will be around *30 Birr/month*.

As we can see in the calculation above, the expenses of the people after the SHP construction is very less than before the SHP construction. The advantage will be significant in the case of application of electricity for cooking especially for non-residential consumers.
Therefore, we can assume that the tariff is low and the people can afford more tariffs since the area is a coffee growing area. Considering this fact, we can conclude that the people can afford the different tariff increases. As per the electricity price law, the tariff increase can be considered.

Therefore, the following sensitivity analyses can be considered with respect to tariff increases. If the tariff is brought to 0.95Birr per kWh, the NPV will just be positive with a benefit to cost ratio of 1 (Appendix 3.1-1 & 4.1-3)

4.2.2 Increase on Capacity Utilization for All Systems

The other option is to increase the capacity of utilization of the system, which is directly related to the utilization factor. Most of the time household uses are at their peak during the morning and evening time. This indicates that the plants are idle in the day time if there are no other energy demands other than household uses. If we think about industrial uses in the day time, electricity demand in the community will increase. This is in order to increase the utilization factor, which is the ratio of water actually utilized for power generation in the plant to that available in the river.

If we install different industrial activities in the region with different annual percentage increase on the forecasted energy sell, different values of NPV, IRR and B/C ratio will be observed.

The values and graphical representations are presented in the following tables and figures. The detailed results are presented in the appendices (Appendix 3.1-2, 3.2-2, 3.3-2, 3.4-2, [4.1-4 up to 4.1-8], [4.2-3 up to 4.2-7], [4.3-3 up to 4.3-7], 4.4-3 & 4.4-4)

The percentage increase on the capacity utilization has been considered only to the max value of the annual firm energy, which is the main continuous energy which can be generated for 100% of the time. The assumption of the increase of capacity utilization from the 11^{th} year is because it is the present year; therefore, it will be suitable for its practical application.

Table 4-3: B/C at different values of capacity utilization for all the sites

Percentage Increase on Capacity Utilization (%)	B/C			
	Keto	Bonora	Weni	Mogor
10	0.57	0.69	0.4	0.53
20	0.58	0.72	0.41	0.53
30	0.6	0.75	0.42	0.53
40	0.62	0.77	0.42	0.53
50	0.63	0.79	0.42	0.53

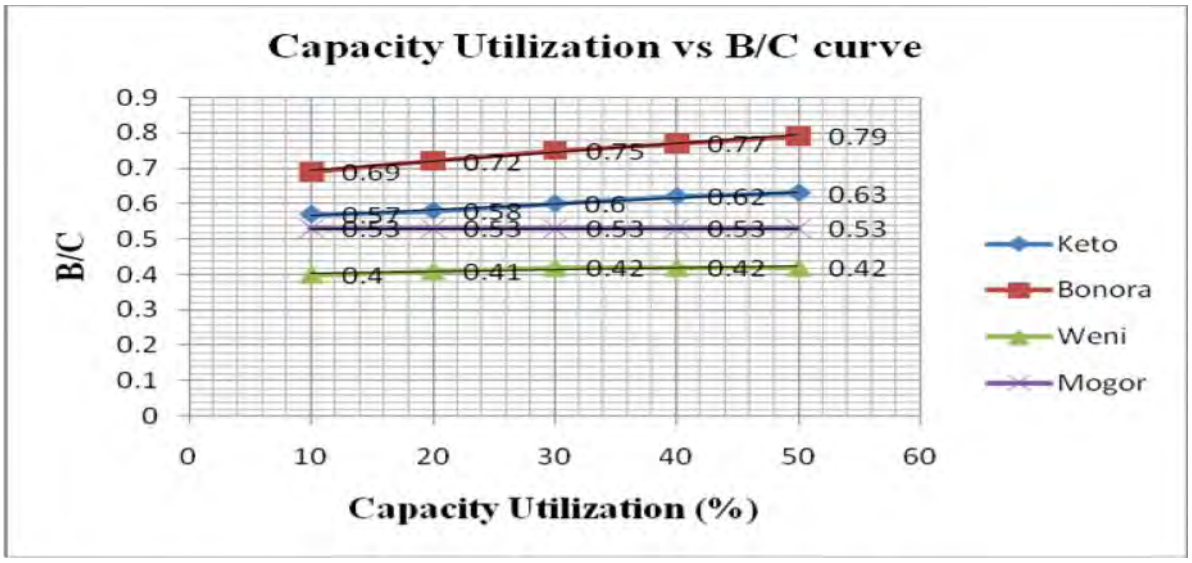

Figure 4.2-1: Capacity Utilization vs B/C graph

Table 4-4: IRR at different values of capacity utilization for all the sites

Percentage Increase on Capacity Utilization (%)	IRR (%)			
	Keto	Bonora	Weni	Mogor
10	3	6	-0.9	2.7
20	3.4	6.5	-0.4	2.7
30	3.9	6.9	0	2.7
40	4.3	7.3	0.05	2.7
50	7.6	7.6	0.05	2.7

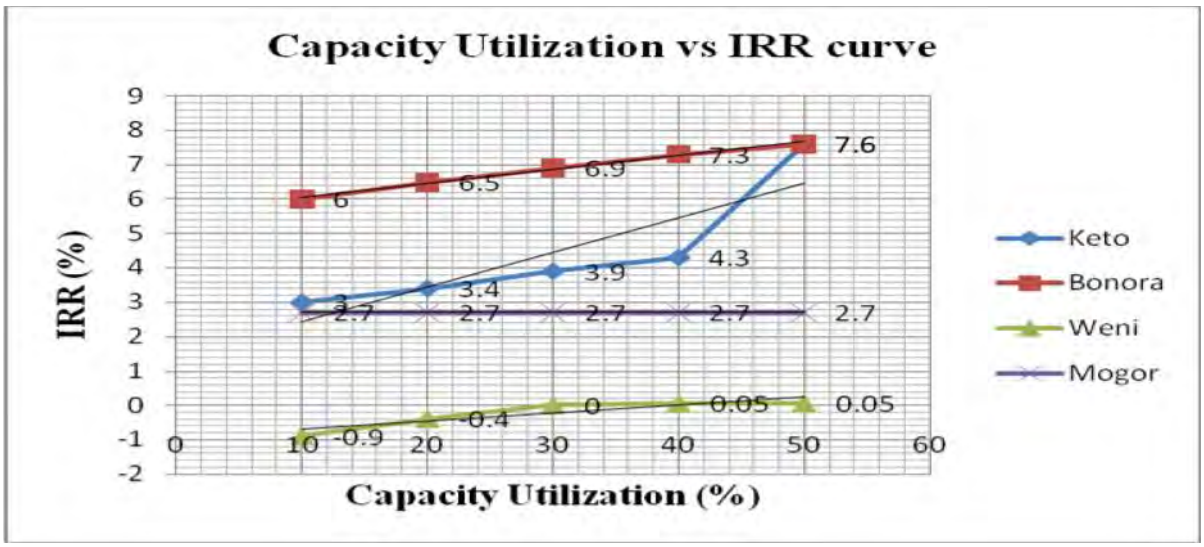

Figure 4.2-2: Capacity Utilization vs IRR graph

Table 4-5: NPV at different values of capacity utilization for all the sites

Capacity Utilization (%)	NPV (Birr)			
	Keto	Bonora	Weni	Mogor
10	-5073905	-5,576,605	-4,338,487	-3,659,819
20	-4672763	-5075923	-4,251,706	-3,649,603
30	-4672763	-4582171	-4,181,770	-3,649,603
40	-4472192	-4139698	-4,178,616	-3,649,603
50	-4271621	-3732190	-4,178,616	-3,649,603

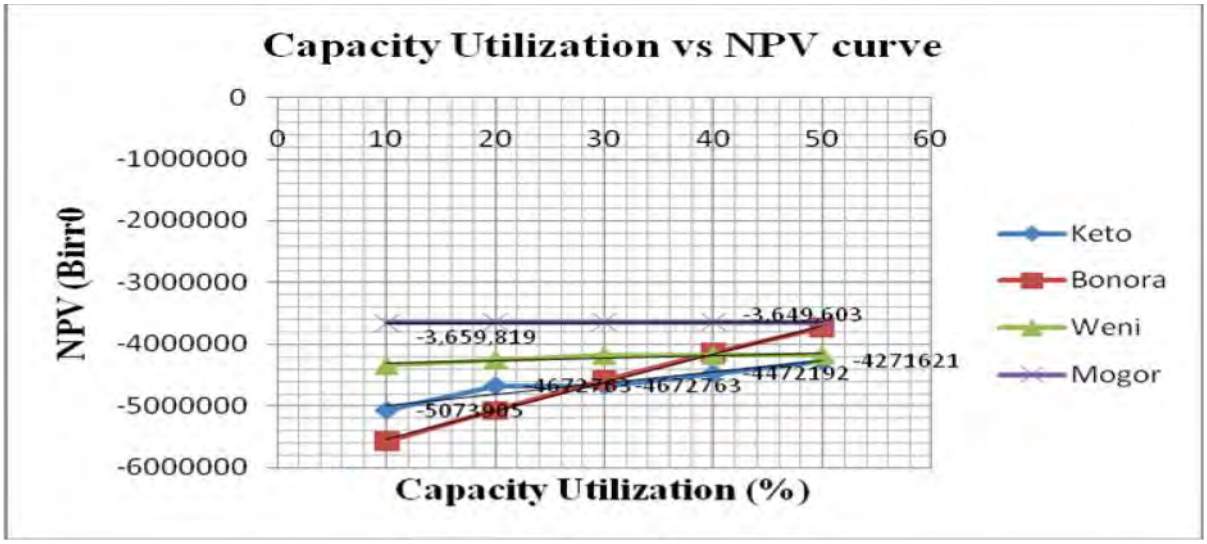

Figure 4.2-3: Capacity Utilization vs NPV graph

4.2.3 Consideration of Feed-in Tariff for All Systems

But what if there is lack of industrial installation which results in lower capacity utilization? The power potential should not be wasted but instead applied on something else. As we discussed earlier the feed-in tariff strategy can be the other option which helps to sell the excess power produced to the national grid. If the government of Ethiopia installs the strategy, the financial viability of many power systems would be secured.

When we are considering a feed in tariff we are assuming the plant functioning with its max potential (this paper assumes a utilization factor of 90%) and the load from the 11th year was calculated annually.

The financial values and graphical presentations are found in the following tables and figures. The detailed results are presented in the appendices (Appendix 3.1-3, 3.2-3, 3.3-3, 3.4-3, [4.1-9 up to 4.1-13], [4.2-8 up to 4.2-12], [4.3-8 up to 4.3-12], [4.4-5 up to 4.4-9])

Table 4-6: B/C at different values of feed-in tariff for all the sites

Feed-in tariff (Birr/kwh)	B/C			
	Keto	Bonora	Weni	Mogor
0.6	0.73	0.91	0.44	0.55
0.7	0.78	1	0.47	0.59
0.8	0.84	1.09	0.49	0.63
1	0.96	1.26	0.55	0.7
1.1	1.02	1.35	0.58	0.74

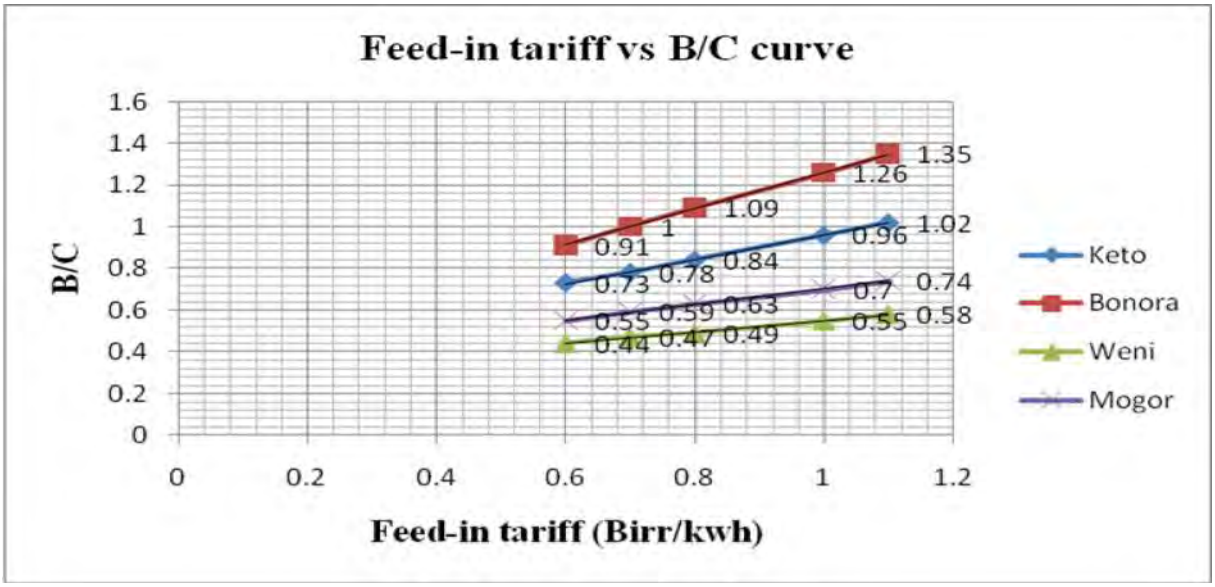

Figure 4.2-4: Feed-in tariff vs B/C graph

Table 4-7: IRR at different values of feed-in tariff for all the sites

Feed-in tariff (Birr/kwh)	IRR(%)			
	Keto	Bonora	Weni	Mogor
0.6	6.4	9.0	0.6	3.3
0.7	7.4	10.0	1.5	4.2
0.8	8.2	10.8	2.4	5.0
1.0	9.6	12.2	3.8	6.3
1.1	10.2	12.8	4.4	6.9

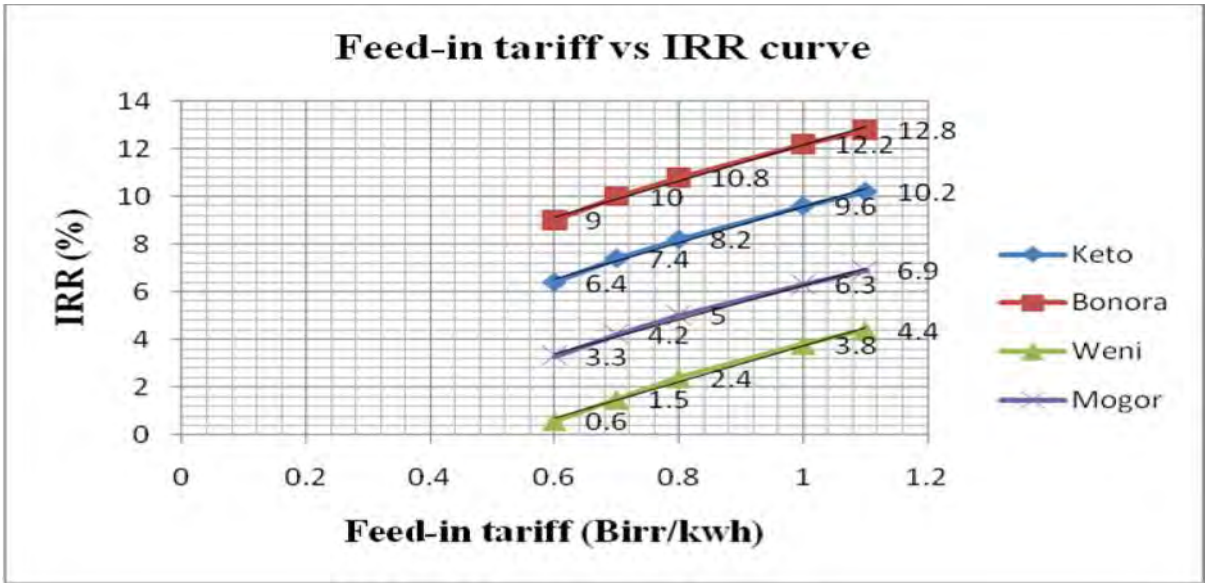

Figure 4.2-5: Feed-in tariff vs IRR graph

Table 4-8: NPV at different values of feed-in tariff for all the sites

Feed-in tariff (Birr/kwh)	NPV (Birr)			
	Keto	Bonora	Weni	Mogor
0.6	-3,204,652	-1,609,842	-4,070,680	-3,495,515
0.7	-2,525,396	-30,798	-3,866,947	-3,206,928
0.8	-1,846,140	1,548,246	-3,663,213	-2,918,341
1.0	-487,628	4,706,333	-3,255,746	-2,341,168
1.1	191,628	6,285,377	-3052,012	-2,052,581

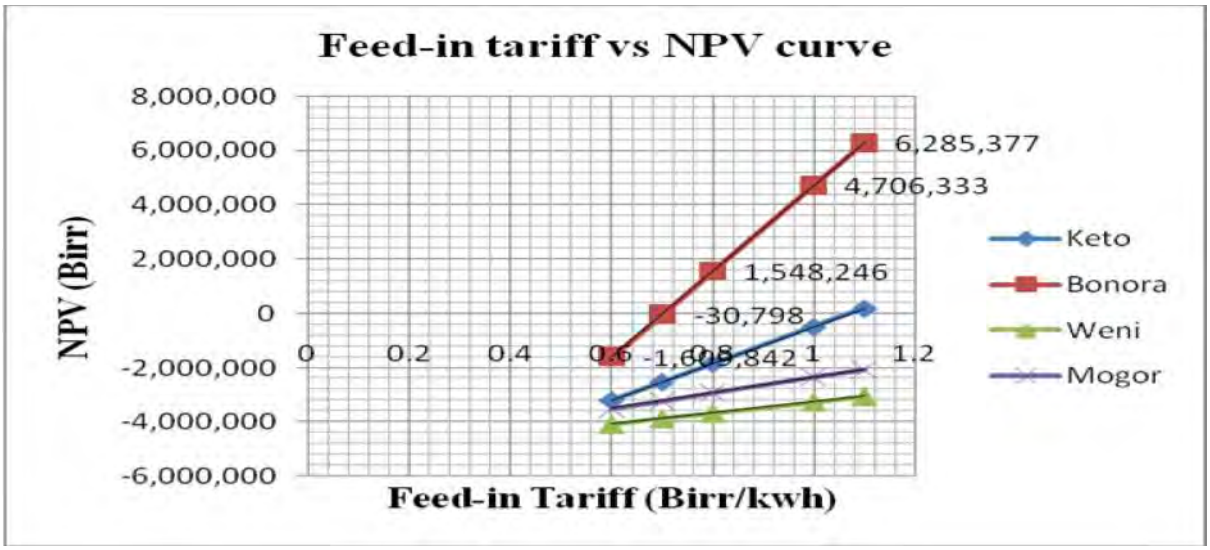

Figure 4.2-6: Feed-in tariff vs NPV graph

Discussion by observing the above analyses:

- The curves of capacity utilization & feed-in tariff v B/C, IRR & NPV are upward sloping with positive slope. This indicates that for the systems to continue to function some adjustments on sensitive parameters are required.
- For similar increase in the values of capacity utilization and feed-in tariff, we observe that the values of B/C and IRR are greater for large plants than small ones. This can be seen from the graphs that the curves of large plants are above small ones. This indicates that larger plants are more sensitive to adjustments than smaller plants.
- On some curves of capacity utilization v B/C, IRR & NPV there is an abrupt change of slope. This is because of the complete consumption of the plants' capacity at lower values of capacity utilization. In the case of Mogor we observe a zero slope for the curve of capacity utilization v B/C, IRR & NPV. This is because there is a complete consumption of the energy supplied at 10% increase in capacity utilization. The above observation indicates that it is hardly to consider capacity utilization as sensitive parameter when there is high energy demand and consumption at initial condition.
- The slopes of the curves for feed-in tariff v B/C and IRR are gentle and almost similar for all the systems. This means that a similar percentage increase in feed-in tariff will proportionally increase the B/C and IRR values of all the systems of different capacities. This indicates that Feed-in tariff is equally sensitive to all plants.
- The slopes of the curves for feed-in tariff v NPV are steeper for large plants like Bonora than the small plants like Weni. This indicates that a similar percentage increase in feed-in tariff will increase the value of NPV for large plants rapidly and for small plants gradually, meaning, larger plants are more sensitive.

4.2.4 Aggregation of Parameters

In order to observe significant effect with little focus on reduction of tariff, we have to aggregate different options. This means that we are considering more than one parameter at a time for the sensitivity analysis.
For this purpose Keto hydro power has been taken with 90% UF, 10% annual tariff increase, reduction of O&M cost to 1% of capital cost and 15% subsidy on capital cost. With all the above considerations that it only came to B/C value of nearly 1, IRR value of nearly 10% and a positive NPV value (Appendix 4.1-14)

Table 4-9: NPV, B/C and IRR at different values of aggregating parameters for Keto site

Scenarios for sensitivity	Keto		
	NPV(Birr)	B/C	IRR (%)
i. Energy at 90% UF	425,887	1.04	10.4
ii. 10% annual tariff increase			
iii. reduction of O&M cost to 1% of capital Cost			
iv. 15% subsidy on capital cost			

As we could observe above, sensitivity analysis was used to bring positive NPV, B/C greater than one, and IRR of greater than 10%. Consideration of one parameter at a time in the sensitivity analysis could succeed for Keto and Bonora just in feed-in tariff. But in the case of Weni and Mogor we couldn't succeed either in feed-in tariff or capacity utilization.

Therefore, we may aggregate different parameters together. The financial values are presented in the following tables and discussed in detail in appendices (Appendix 4.2-12, 4.3-13 & 4.4-10)

Table 4-10: NPV, B/C & IRR at different values of aggregating parameters for Bonora site

Scenarios for sensitivity	Bonora		
	NPV(Birr)	B/C	IRR (%)
i. 1.1birr/kwh of tariff	6,285,377	1.35	12.81
ii. Energy at 90% UF			

Table 4-11: NPV, B/C & IRR at different values of aggregating parameters for Weni site

Scenarios for sensitivity	Weni		
	NPV(Birr)	B/C	IRR (%)
i. 1.1birr/kwh of tariff	174,050	1.04	10.5
ii. 50% subsidy on capital cost			

Table 4-12: NPV, B/C & IRR at different values of aggregating parameters for Mogor site

Scenarios for sensitivity	Mogor		
	NPV(Birr)	B/C	IRR (%)
i. 1.1birr/kwh of tariff ii. 30% subsidy on capital cost	38,477	1.01	10.1

Discussion by observing the above analyses:

- In sensitivity analysis, aggregating different parameters together results in immediate financial feasibility. This indicates that consideration of sensitive parameters play a major role in bringing SHP plants to financial feasibility.
- From the different parameters changed to bring a positive NPV, feed-in tariff, subsidy and capacity utilization have brought significant effects. A reduction in the O&M cost has the least effect. This indicates that selecting sensitive parameters, which bring rapid change, helps in practical application.

4.3 Remarks based on the discussion of financial analyses

As we can see above in the different analyses to arrive at a positive NPV, we used different changes on important parameters. We applied an increase in utilization factor starting from the 11th year (2011), a reduction in O&M cost, subsidy, and application of feed-in tariff. The following remarks are drawn from the above analytical, tabular and graphical analyses:

The infeasible financial condition of SHP plants at initial condition may discourage investment from the side of IPPs (Independent power producers). In order to encourage private investment on the sector the following things should be done:

- The government should consider a substantial amount of subsidy to such constructions at initial stage.
- Different state holders other than the government may consider supporting such projects in combination with government subsidy to share the higher capital cost of investment.
- The community should involve contributing to the capital cost as well as the O&M cost.
- Tariff increase should be considered if communities can afford.
- EEPCO should consider the feed-in tariff strategy as much as possible which has a mutual benefit not only to IPPs but also to the government.

CHAPTER FIVE

ECONOMIC ANALYSIS OF KETO SHP PLANT

In this section, we will assess whether Keto SHP plant is economically feasible or not at initial existing condition. The economic analysis is carried out both in monetary and non-monetary values in the subsequent sections.

5.1 Assessment of Economic Feasibility

Economic Benefit:

The population of Chanka and Alem Teferi are given in Table 5.1.

Table 5-1: Census data of Chanka and Alem Teferi (Tropics-Keto, 1999)

Source	Town	Year-2000	Year-2005	Year-2010	Year-2015
CSA	Chanka	4680	5727	7001	8562
CSA	Alem Teferi	3900	4770	5834	7137

We observe that every year there is increase of population. Since we are going to analyze the economic benefit of the system installation to each individual at each year throughout the economic life of the project, we have to consider the average population. From the above data the average population is *6493* for Chanka and *5411* for Alem Teferi.

In the zone the average number of people in a household is *5*, therefore, the total number of households in the two towns are *1299* in Chanka and *1083* in Alem Teferi, a total of *2382* for both towns.

The towns had major economic establishments at initial condition on non-residential activities as given in Table 5-2 (Tropics-Keto, 1999).

Table 5-2: Major economic establishments in the towns of chanka and Alem Teferi

Economic establishments	Town	
	Chanka	Alem Teferi
Coffee processing	3	-
Oil Mills	3	1
Grain Mills	11	9
Bakeries	12	8
Wood Work and Carpentry	-	11
Small hotels, bars and restaurants	20	13
Shops (general merchandize and retail)	45	150
Total	94	192

A total of 286 major economic establishments were found in the towns of Chanka and Alem Teferi.

Using the above data, the residential and non-residential monthly and annual savings in both towns have been analyzed (see Table 5.3).

Table 5-3: Economic Benefit of Keto SHP system based on annual savings

	Expenses		Savings			
Item	Previous monthly (Birr/HH) A	Present monthly (Birr/HH) B	Saving (Birr/HH) C=A-B	HH/ Industries (No.) D	Total monthly (Birr/All HH) E=C*D	Total annual (Birr/All HH) F=12*E
Residential	17	12	5	2382	11910	142920
Non-residential	72	30	42	286	12012	144144
Residential+ Nonresidential						287064

Economic Cost:

In the case of Keto SHP all civil works are undertaken by local personnel and have low foreign component whereas the electro-mechanical portions have high foreign components. For each component of electro-mechanical equipment, the foreign and local portions have been estimated separately. Wages of domestic laborers and costs of construction materials are included in local costs. Items like hydraulic turbines and transmission line are foreign costs.

The foreign cost which is considered as the economic is 63% of the capital cost (Tropics 1999).

Therefore,

Economic Cost (in Birr) = 63% x (Capital Cost in Birr)

= 63% X (6,482,530 for 1st yr+4,321,690 for 2^{nd} yr)

= 0.63*10,804,220 = 6,806,659

Assuming the maintenance cost to be equal to 1.5% of the capital cost:

Maintenance Cost =162,063 Birr
Therefore, with the initial values of Keto SHP system:
Economic cost= 6,806,659Birr
Economic Benefit=287,064Birr
Maintenance cost=162,063Birr

Therefore,
NPV=-5,591,686
B/C=0.28 (see Appendix 5.1-1 for further details)

Discussion:

The above values show that the economic benefit of Keto SHP system has quite low monetary value at initial condition. Therefore, consideration of sensitivity analyses at different possible conditions is required to find the specific condition where the system will be economically efficient.

5.2 Propositions for Economic Feasibility of Keto SHP plant

The different options on possible changes of important parameters are discussed in the following sections. The objective is to come up with different alternative measures for economic efficiency throughout the economic life of Keto project on the basis of reasonable approaches and assumptions considered here.

5.2.1 Subsidy on Foreign Cost of Capital

If there had been a consideration of subsidy from government, a considerable amount of economic benefit would have been observed. This analysis is being done to show what should be done in the future for better economical status of other projects. In the following table some analyses have been presented in the form of table and the details are presented in appendices (Appendix 5.1-2 up to 5.1-5)

Table 5-4: B/C and NPV at different values of subsidy for Keto site

Subsidy on capital cost	B/C	NPV (Birr)
10% subsidy	0.33	-4,517,670
50% subsidy	0.54	-1,894,013
75% subsidy	0.9	-254,227
80% subsidy	1.03	73,730

Discussion:

For better impact of the plants especially on the monetary value of the economic benefit, support from the government through subsidy on foreign cost of capital plays a considerable role.

5.2.2 Aggregating Subsidy and Capacity Utilization

The NPV value brought by the 8o % subsidy can further increase if there are different economic establishments by the local community both in medium and small scale investments.

For example there were a total of 286 economic establishments in coffee processing, oil mills, grain mills, bakeries, wood working and carpentry, small hotels, bars and restaurants. Each of the economic establishments saves 42Birr per month and 504Birr per year (Tropics-Keto, 1999).

If the number of these industries or their capacity increases the capacity utilization of the plant increases. This further increases the savings on money of each individual in the society.

Let us first calculate the maximum amount of total yearly saving from Keto SHP plant.
The maximum firm energy with UF of 90%=3154Mwh=3,154,000kwh/year (refer chapter 4)

Energy for residential and industrial use is as follows:
Residential use=280kwh/yr/HH*2382HH=666,960kwh/yr
Industrial use=685kwh/yr/industry*286industries=195,910kwh/yr
Residential + Industrial use=862,870kwh/year
Energy left for further industrial use= (3,154,000-862,870) =2,291,130kwh/yr
From 286 industries (195,910 kwh/yr), it could be saved 144,144Birr
Therefore, from the remaining energy it can be saved
Birr=2,291,130kwh*144,144Birr/195,910kwh= 1,685,736Birr

Therefore, the max saving will be as follows:
Max saving with UF of 90% = 1,685,736+ 287064=1,972,800Birr

When the economic establishments grow the capacity utilization of the plant grows and the economic feasibility with respect to the monetary value will also be secured. For detail analyses refer the appendices (Appendix 5.1-6 up to 5.1-8)

Table 5-5: B/C and NPV at different values of capacity utilization for Keto site

Increase in Economic Establishments (%)	B/C	NPV (Birr)
10%	1.26	567,344
20%	1.35	751,149
30%	1.35	751,149

The percentage increase in economic establishment has directly related to the increase in annual revenue i.e. 10% annual increase in economic establishment means 10% annual increase in revenue.

Discussion:

It is observed that socio-economic benefit is directly proportional to capacity utilization. Therefore, the community and administrators, if they apply optimum usage of the supplied energy they will keep on benefiting more throughout the service life of the project.

5.3 Observations and Remarks from Socio-economic Analysis

The socio-economic benefits are wide, and therefore, cannot be easily measured. The impacts can be resulted both to the individual and national level. Individuals in the society benefit directly in monetary value from the system installation. There are also different socio-economic benefits which do not have direct monetary values.
Then the collection of individual benefits brings national development.

Therefore, the following benefits can be traced from SHP development

- There can be town development through commercial activities and investment, therefore, resulting in modern style of living.
- The educational services can be upgraded through modern facilities and availability of evening lessons, therefore, increased productivity resulting from quality of education.
- Employment opportunity can increase because of the establishment of manufacturing plants, which are not possible without electric power.

- There can be savings on energy. To produce thermal energy it took the people too much time while carrying the woods from the market to their place but hydropower is easily accessible.
- There can be savings on time. A lot of hours were required for collection of fire wood for the poor households.

Based on the above observations we can remark the following:

- Construction of SHP plants has high socio-economic benefit. Therefore, the efforts in supporting such projects through subsidy should be given high attention from the side of all stakeholders, both governmental and non-governmental.
- The socio-economic benefits should be maximized through establishment of industries in order to utilize the maximum energy supply of the plant.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Rural villages in Ethiopia are very scattered, therefore, difficult to supply them power from the national grid. But SHP plants are very convenient in this regard. Upon understanding these facts and others we can see the development of SHP plants is inevitable.

In this study the net present value (NPV), benefit to cost ratio (B/C), and internal rate of return (IRR) of four SHP sites at initial existing condition both for financial and economic features have been carried out.

The objective of carrying out the above activity was to check whether the sites are financially and economically feasible or not. The economic efficiency has two expressions with regard to the monetary and non-monetary value. The monetary value of the system installation can be expressed by the benefit to cost ratio of the system installation. The non-monetary benefits of the systems to the community have a lot of expressions such as modern style of living, access to digital electronics, better health and education, and others.

Therefore, all the system installations were found to be financially infeasible, economically (in its monetary value) infeasible but efficient in the non-monetary value of economic feasibility.

The study then achieved its objective in presenting different alternative measures and new approaches to bring financial viability and economic efficiency. This is done to show the alternative techniques which can be done both to the case study sites and other SHP sites.

6.2 Recommendations

In order to take advantage of SHP potential in Ethiopia, joint effort of government organizations and individual investors should be considered. But private investors are mainly interested in the benefit of their investment. Therefore, government bodies should think about the alternative measures which satisfy the financial stability of the private investors in order to promote SHP construction.

It can be observed that the bigger the SHP plant is the more efficient the financial and economic feasibility. Therefore, investors should take advantage of aggregating their financial resources to construct few bigger SHP plants than many smaller ones individually. This results in higher benefit to the investors.

Among feed-in tariff law, capacity utilization and subsidy consideration dealt in this work, special attention should be given to feed-in tariff law. This is because it is a newly emerging system in the world and its positive effect found to be significant. Therefore, those stakeholders especially from the government side should consider the application of this newly emerging strategy for power development.

Finally, looking at the enormous benefits of electrifying rural villages by SHP installation, it is recommended that the government of Ethiopia should give attention to promote the development of SHP plants. To fulfill the above before to long, private investors should be encouraged in various ways to pursue SHP development.

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APPENDICES

BONORA HYDROPOER-FINANCIAL ANALYSIS

Appendix 3.2-1: Energy sells with different given tariffs

No	Energy Sales (MWH)	Revenue (Birr) (tariff=0.518Birr/kwh)
1	1765	914,270
2	1970	1,020,460
3	2212	1,145,816
4	2354	1,219,372
5	2506	1,298,108
6	2661	1,378,398
7	2829	1,465,422
8	3013	1,560,734
9	3215	1,665,370
10	3393	1,757,574
11	3584	1,856,512
12	3788	1,962,184
13	4005	2,074,590
14	4238	2,195,284
15	4488	2,324,784
16	4755	2,463,090
17	5041	2,611,238
18	5348	2,770,264
19	5677	2,940,686
20	6030	3,123,540

Appendix 3.2-2: Energy sells and the corresponding revenues with different values of capacity utilization for BONORA

No	Energy Sales (MWH)	Energy Sales by 10% increase from 11th year (MWH)	Energy Sales by 20% increase from 11th year (MWH)	Energy Sales by 30% increase from 11th year (MWH)	Energy Sales by 40% increase from 11th year (MWH)	Energy Sales by 50% increase from 11th year (MWH)	Revenue by 10% increase in energy sell (Birr)	Revenue by 20% increase in energy sell (Birr)	Revenue by 30% increase in energy sell (Birr)	Revenue by 40% increase in energy sell (Birr)	Revenue by 50% increase in energy sell (Birr)
1	1765	1765	1765	1765	1765	1765	914,270	914,270	914,270	914,270	914,270
2	1970	1970	1970	1970	1970	1970	1,020,460	1,020,460	1,020,460	1,020,460	1,020,460
3	2212	2212	2212	2212	2212	2212	1,145,816	1,145,816	1,145,816	1,145,816	1,145,816
4	2354	2354	2354	2354	2354	2354	1,219,372	1,219,372	1,219,372	1,219,372	1,219,372
5	2506	2506	2506	2506	2506	2506	1,298,108	1,298,108	1,298,108	1,298,108	1,298,108
6	2661	2661	2661	2661	2661	2661	1,378,398	1,378,398	1,378,398	1,378,398	1,378,398
7	2829	2829	2829	2829	2829	2829	1,465,422	1,465,422	1,465,422	1,465,422	1,465,422
8	3013	3013	3013	3013	3013	3013	1,560,734	1,560,734	1,560,734	1,560,734	1,560,734
9	3215	3215	3215	3215	3215	3215	1,665,370	1,665,370	1,665,370	1,665,370	1,665,370
10	3393	3393	3393	3393	3393	3393	1,757,574	1,757,574	1,757,574	1,757,574	1,757,574
11	3584	3942	4301	4659	5018	5376	2,042,163	2,227,814	2,413,466	2,599,117	2,784,768
12	3788	4167	4546	4924	5303	5682	2,158,402	2,354,621	2,550,839	2,747,058	2,943,276
13	4005	4406	4806	5207	5607	6008	2,282,049	2,489,508	2,696,967	2,904,426	3,111,885
14	4238	4662	5086	5509	5933	6357	2,414,812	2,634,341	2,853,869	3,073,398	3,292,926
15	4488	4937	5386	5834	6283	6732	2,557,262	2,789,741	3,022,219	3,254,698	3,487,176
16	4755	5231	5706	6182	6657	7133	2,709,399	2,955,708	3,202,017	3,448,326	3,694,635
17	5041	5545	6049	6553	7057	7740	2,872,362	3,133,486	3,394,609	3,655,733	4,009,320
18	5348	5883	6418	6952	7487	7740	3,047,290	3,324,317	3,601,343	3,878,370	4,009,320
19	5677	6245	6812	7380	7740	7740	3,234,755	3,528,823	3,822,892	4,009,320	4,009,320
20	6030	6633	7236	7740	7740	7740	3,435,894	3,748,248	4,009,320	4,009,320	4,009,320

The max. energy sell at ideal condition=930kw*365days*24hr/day=8147MWh. Therefore, limit all values of energy sell under this value. Assume max. energy sell with 95% UF (utilization factor) as 7740MWh

Appendix 3.2-3: Energy Sell with 90% utilization factor starting from the 11th year and the corresponding revenues at different feed-in tariffs for BONORA

No	Energy Sales (MWH)	Revenue (Birr) [rate:0.518Birr /kwh]	Revenue (Birr) [10 % increase in tariff from 11th year]	Revenue (Birr) [rate: 0.6Birr/kwh]	Revenue (Birr) [rate: 0.7Birr/kwh]	Revenue (Birr) [rate: 0.8Birr/kwh]	Revenue (Birr) [rate: 1Birr/kwh]	Revenue (Birr) [rate: 1.1Birr/kwh]
1	1765	914,270	914,270	914,270	914,270	914,270	914,270	914,270
2	1970	1,020,460	1,020,460	1,020,460	1,020,460	1,020,460	1,020,460	1,020,460
3	2212	1,145,816	1,145,816	1,145,816	1,145,816	1,145,816	1,145,816	1,145,816
4	2354	1,219,372	1,219,372	1,219,372	1,219,372	1,219,372	1,219,372	1,219,372
5	2506	1,298,108	1,298,108	1,298,108	1,298,108	1,298,108	1,298,108	1,298,108
6	2661	1,378,398	1,378,398	1,378,398	1,378,398	1,378,398	1,378,398	1,378,398
7	2829	1,465,422	1,465,422	1,465,422	1,465,422	1,465,422	1,465,422	1,465,422
8	3013	1,560,734	1,560,734	1,560,734	1,560,734	1,560,734	1,560,734	1,560,734
9	3215	1,665,370	1,665,370	1,665,370	1,665,370	1,665,370	1,665,370	1,665,370
10	3393	1,757,574	1,757,574	1,757,574	1,757,574	1,757,574	1,757,574	1,757,574
11	7,332	3,797,976	4,177,774	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
12	7,332	3,797,976	4,595,551	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
13	7,332	3,797,976	5,055,106	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
14	7,332	3,797,976	5,560,617	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
15	7,332	3,797,976	6,116,678	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
16	7,332	3,797,976	6,728,346	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
17	7,332	3,797,976	7,401,181	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
18	7,332	3,797,976	8,141,299	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
19	7,332	3,797,976	8,955,429	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200
20	7,332	3,797,976	9,850,972	4,399,200	5,132,400	5,865,600	7,332,000	8,065,200

Energy Sell with 90% UF=930kw*365days*24hr/day*0.9=7332MWh

Appendix 3.2-4: Financial Analysis of BONORA SHP at initial condition considering 1year of construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	17,154,050	-17,154,050	1	0	17,154,050	-17,154,050	-17,154,050
1	914,270	214,426	699,844	0.909	831,155	194,933	636,222	-16,517,828
2	1,020,460	214,426	806,034	0.826	843,355	177,212	666,144	-15,851,684
3	1,145,816	214,426	931,390	0.751	860,869	161,101	699,767	-15,151,917
4	1,219,372	214,426	1,004,946	0.683	832,847	146,456	686,392	-14,465,526
5	1,298,108	214,426	1,083,682	0.621	806,023	133,142	672,881	-13,792,644
6	1,378,398	214,426	1,163,972	0.564	778,070	121,038	657,032	-13,135,613
7	1,465,422	214,426	1,250,996	0.513	751,993	110,034	641,959	-12,493,654
8	1,560,734	214,426	1,346,308	0.467	728,094	100,031	628,063	-11,865,591
9	1,665,370	214,426	1,450,944	0.424	706,279	90,938	615,342	-11,250,249
10	1,757,574	214,426	1,543,148	0.386	677,621	82,671	594,950	-10,655,299
11	1,856,512	214,426	1,642,086	0.350	650,696	75,155	575,541	-10,079,758
12	1,962,184	214,426	1,747,758	0.319	625,212	68,323	556,890	-9,522,868
13	2,074,590	214,426	1,860,164	0.290	600,935	62,112	538,823	-8,984,045
14	2,195,284	214,426	1,980,858	0.263	578,087	56,465	521,622	-8,462,423
15	2,324,784	214,426	2,110,358	0.239	556,535	51,332	505,203	-7,957,220
16	2,463,090	214,426	2,248,664	0.218	536,040	46,665	489,375	-7,467,845
17	2,611,238	214,426	2,396,812	0.198	516,620	42,423	474,196	-6,993,649
18	2,770,264	214,426	2,555,838	0.180	498,256	38,566	459,690	-6,533,959
19	2,940,686	214,426	2,726,260	0.164	480,826	35,060	445,765	-6,088,194
20	3,123,540	214,426	2,909,114	0.149	464,294	31,873	432,421	-5,655,772
	Sum				13,323,807	18,979,579	-5,655,772	

NPV = -5,655,772
B/C = 0.70

Appendix 4.2-1: Financial Analysis of BONORA SHP at Initial Condition considering 2years of construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	1,856,512	214,426	1,642,086	0.319	591,542	68,323	523,219	-10,099,092
13	1,962,184	214,426	1,747,758	0.290	568,375	62,112	506,263	-9,592,828
14	2,074,590	214,426	1,860,164	0.263	546,304	56,465	489,839	-9,102,989
15	2,195,284	214,426	1,980,858	0.239	525,534	51,332	474,202	-8,628,787
16	2,324,784	214,426	2,110,358	0.218	505,941	46,665	459,275	-8,169,512
17	2,463,090	214,426	2,248,664	0.198	487,309	42,423	444,886	-7,724,626
18	2,611,238	214,426	2,396,812	0.180	469,654	38,566	431,088	-7,293,538
19	2,770,264	214,426	2,555,838	0.164	452,960	35,060	417,900	-6,875,638
20	2,940,686	214,426	2,726,260	0.149	437,114	31,873	405,241	-6,470,397
21	3,123,540	214,426	2,909,114	0.135	422,086	28,976	393,110	-6,077,287
	Sum				12,112,552	18,189,839	-6,077,287	

NPV = -6,077,287
B/C = 0.67

Appendix 4.2-2: Financial Analysis of Bonora SHP: Calculation of IRR

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=5.5 % per annum (for IRR)	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.947867299	0	6,503,905	-6,503,905	-16,796,335
2	914,270	214,426	699,844	0.898452416	821,428	192,652	628,777	-16,167,559
3	1,020,460	214,426	806,034	0.851613664	869,038	182,608	686,430	-15,481,129
4	1,145,816	214,426	931,390	0.807216743	924,922	173,088	751,834	-14,729,296
5	1,219,372	214,426	1,004,946	0.765134354	932,983	164,065	768,919	-13,960,377
6	1,298,108	214,426	1,083,682	0.725245833	941,447	155,512	785,936	-13,174,441
7	1,378,398	214,426	1,163,972	0.687436809	947,562	147,404	800,157	-12,374,284
8	1,465,422	214,426	1,250,996	0.651598871	954,867	139,720	815,148	-11,559,136
9	1,560,734	214,426	1,346,308	0.617629261	963,955	132,436	831,519	-10,727,617
10	1,665,370	214,426	1,450,944	0.585430579	974,959	125,532	849,427	-9,878,190
11	1,757,574	214,426	1,543,148	0.554910502	975,296	118,987	856,309	-9,021,881
12	1,856,512	214,426	1,642,086	0.525981518	976,491	112,784	863,707	-8,158,174
13	1,962,184	214,426	1,747,758	0.498560681	978,268	106,904	871,363	-7,286,811
14	2,074,590	214,426	1,860,164	0.472569366	980,388	101,331	879,057	-6,407,754
15	2,195,284	214,426	1,980,858	0.447933048	983,340	96,048	887,292	-5,520,462
16	2,324,784	214,426	2,110,358	0.424581088	987,059	91,041	896,018	-4,624,444
17	2,463,090	214,426	2,248,664	0.402446529	991,262	86,295	904,967	-3,719,477
18	2,611,238	214,426	2,396,812	0.381465904	996,098	81,796	914,302	-2,805,175
19	2,770,264	214,426	2,555,838	0.361579056	1,001,669	77,532	924,137	-1,881,038
20	2,940,686	214,426	2,726,260	0.342728963	1,007,858	73,490	934,368	-946,669
21	3,123,540	214,426	2,909,114	0.324861577	1,014,718	69,659	945,059	-1,610
	Sum				19,223,609	19,225,219	-1,610	

NPV = -1,610
B/C = 1.00

Appendix 4.2-3: Financial Analysis of BONORA SHP with 10% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	2,042,163	214,426	1,827,737	0.319	650,696	68,323	582,373	-10,039,937
13	2,158,402	214,426	1,943,976	0.290	625,212	62,112	563,101	-9,476,837
14	2,282,049	214,426	2,067,623	0.263	600,935	56,465	544,470	-8,932,367
15	2,414,812	214,426	2,200,386	0.239	578,087	51,332	526,755	-8,405,612
16	2,557,262	214,426	2,342,836	0.218	556,535	46,665	509,869	-7,895,742
17	2,709,399	214,426	2,494,973	0.198	536,040	42,423	493,617	-7,402,125
18	2,872,362	214,426	2,657,936	0.180	516,620	38,566	478,053	-6,924,072
19	3,047,290	214,426	2,832,864	0.164	498,256	35,060	463,196	-6,460,876
20	3,234,755	214,426	3,020,329	0.149	480,826	31,873	448,953	-6,011,924
21	3,435,894	214,426	3,221,468	0.135	464,294	28,976	435,319	-5,576,605
	Sum				12,613,234	18,189,839	-5,576,605	

NPV = -5,576,605
B/C = 0.69
IRR = 6.0%

Appendix 4.2-4: Financial Analysis of BONORA SHP with 20% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	2,227,814	214,426	2,013,388	0.319	709,850	68,323	641,528	-9,980,783
13	2,354,621	214,426	2,140,195	0.290	682,050	62,112	619,938	-9,360,845
14	2,489,508	214,426	2,275,082	0.263	655,565	56,465	599,100	-8,761,745
15	2,634,341	214,426	2,419,915	0.239	630,640	51,332	579,308	-8,182,436
16	2,789,741	214,426	2,575,315	0.218	607,129	46,665	560,464	-7,621,973
17	2,955,708	214,426	2,741,282	0.198	584,771	42,423	542,348	-7,079,625
18	3,133,486	214,426	2,919,060	0.180	563,585	38,566	525,019	-6,554,606
19	3,324,317	214,426	3,109,891	0.164	543,552	35,060	508,492	-6,046,114
20	3,528,823	214,426	3,314,397	0.149	524,537	31,873	492,664	-5,553,450
21	3,748,248	214,426	3,533,822	0.135	506,503	28,976	477,527	-5,075,923
	Sum				13,113,916	18,189,839	-5,075,923	

NPV = -5,075,923
B/C = 0.72
IRR = 6.5%

Appendix 4.2-5: Financial Analysis of BONORA SHP with 30% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	2,413,466	214,426	2,199,040	0.319	769,005	68,323	700,682	-9,921,629
13	2,550,839	214,426	2,336,413	0.290	738,887	62,112	676,776	-9,244,853
14	2,696,967	214,426	2,482,541	0.263	710,196	56,465	653,731	-8,591,123
15	2,853,869	214,426	2,639,443	0.239	683,194	51,332	631,862	-7,959,261
16	3,022,219	214,426	2,807,793	0.218	657,723	46,665	611,058	-7,348,203
17	3,202,017	214,426	2,987,591	0.198	633,502	42,423	591,079	-6,757,124
18	3,394,609	214,426	3,180,183	0.180	610,550	38,566	571,984	-6,185,141
19	3,601,343	214,426	3,386,917	0.164	588,848	35,060	553,788	-5,631,352
20	3,822,892	214,426	3,608,466	0.149	568,249	31,873	536,375	-5,094,977
21	4,009,320	214,426	3,794,894	0.135	541,782	28,976	512,806	-4,582,171
	Sum				13,607,668	18,189,839	-4,582,171	

NPV = -4,582,171
B/C = 0.75
IRR = 6.90%

Appendix 4.2-6: Financial Analysis of BONORA SHP with 40% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	2,599,117	214,426	2,384,691	0.319	828,159	68,323	759,836	-9,862,475
13	2,747,058	214,426	2,532,632	0.290	795,725	62,112	733,613	-9,128,862
14	2,904,426	214,426	2,690,000	0.263	764,826	56,465	708,361	-8,420,501
15	3,073,398	214,426	2,858,972	0.239	735,747	51,332	684,415	-7,736,086
16	3,254,698	214,426	3,040,272	0.218	708,317	46,665	661,652	-7,074,434
17	3,448,326	214,426	3,233,900	0.198	682,233	42,423	639,810	-6,434,624
18	3,655,733	214,426	3,441,307	0.180	657,516	38,566	618,949	-5,815,675
19	3,878,370	214,426	3,663,944	0.164	634,144	35,060	599,084	-5,216,591
20	4,009,320	214,426	3,794,894	0.149	595,960	31,873	564,087	-4,652,504
21	4,009,320	214,426	3,794,894	0.135	541,782	28,976	512,806	-4,139,698
	Sum				14,050,141	18,189,839	-4,139,698	

NPV = -4,139,698
B/C = 0.77
IRR = 7.30%

Appendix 4.2-7: Financial Analysis of Bonora SHP with 50% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	2,784,768	214,426	2,570,342	0.319	887,313	68,323	818,990	-9,803,321
13	2,943,276	214,426	2,728,850	0.290	852,562	62,112	790,451	-9,012,870
14	3,111,885	214,426	2,897,459	0.263	819,457	56,465	762,992	-8,249,879
15	3,292,926	214,426	3,078,500	0.239	788,300	51,332	736,968	-7,512,910
16	3,487,176	214,426	3,272,750	0.218	758,911	46,665	712,246	-6,800,664
17	3,694,635	214,426	3,480,209	0.198	730,964	42,423	688,541	-6,112,124
18	4,009,320	214,426	3,794,894	0.180	721,111	38,566	682,545	-5,429,578
19	4,009,320	214,426	3,794,894	0.164	655,556	35,060	620,495	-4,809,083
20	4,009,320	214,426	3,794,894	0.149	595,960	31,873	564,087	-4,244,996
21	4,009,320	214,426	3,794,894	0.135	541,782	28,976	512,806	-3,732,190
	Sum				14,457,649	18,189,839	-3,732,190	

NPV = -3,732,190
B/C = 0.79
IRR = 7.6%

Appendix 4.2-8: Financial Analysis of Bonora SHP with 90% UF and feed-in tariff of 0.6Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	4,399,200	214,426	4,184,774	0.319	1,401,721	68,323	1,333,398	-9,288,913
13	4,399,200	214,426	4,184,774	0.290	1,274,292	62,112	1,212,180	-8,076,733
14	4,399,200	214,426	4,184,774	0.263	1,158,447	56,465	1,101,982	-6,974,751
15	4,399,200	214,426	4,184,774	0.239	1,053,134	51,332	1,001,802	-5,972,949
16	4,399,200	214,426	4,184,774	0.218	957,394	46,665	910,729	-5,062,221
17	4,399,200	214,426	4,184,774	0.198	870,358	42,423	827,935	-4,234,286
18	4,399,200	214,426	4,184,774	0.180	791,235	38,566	752,668	-3,481,617
19	4,399,200	214,426	4,184,774	0.164	719,304	35,060	684,244	-2,797,373
20	4,399,200	214,426	4,184,774	0.149	653,913	31,873	622,040	-2,175,333
21	4,399,200	214,426	4,184,774	0.135	594,466	28,976	565,491	-1,609,842
	Sum				16,579,996	18,189,839	-1,609,842	

NPV = -1,609,842
B/C = 0.91
IRR = 9%

Appendix 4.2-9: Financial Analysis of BONORA SHP with 90% UF and feed-in tariff of 0.7Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	5,132,400	214,426	4,917,974	0.319	1,635,341	68,323	1,567,018	-9,055,293
13	5,132,400	214,426	4,917,974	0.290	1,486,673	62,112	1,424,562	-7,630,731
14	5,132,400	214,426	4,917,974	0.263	1,351,521	56,465	1,295,056	-6,335,675
15	5,132,400	214,426	4,917,974	0.239	1,228,656	51,332	1,177,324	-5,158,351
16	5,132,400	214,426	4,917,974	0.218	1,116,960	46,665	1,070,294	-4,088,056
17	5,132,400	214,426	4,917,974	0.198	1,015,418	42,423	972,995	-3,115,061
18	5,132,400	214,426	4,917,974	0.180	923,107	38,566	884,541	-2,230,521
19	5,132,400	214,426	4,917,974	0.164	839,188	35,060	804,128	-1,426,392
20	5,132,400	214,426	4,917,974	0.149	762,899	31,873	731,025	-695,367
21	5,132,400	214,426	4,917,974	0.135	693,544	28,976	664,569	-30,798
	Sum				18,159,040	18,189,839	-30,798	

NPV = -30,798
B/C = 1.00
IRR = 10%

Appendix 4.2-10: Financial Analysis of BONORA SHP with 90% UF and feed-in tariff of 0.8Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	5,865,600	214,426	5,651,174	0.319	1,868,961	68,323	1,800,638	-8,821,673
13	5,865,600	214,426	5,651,174	0.290	1,699,055	62,112	1,636,944	-7,184,729
14	5,865,600	214,426	5,651,174	0.263	1,544,596	56,465	1,488,131	-5,696,598
15	5,865,600	214,426	5,651,174	0.239	1,404,178	51,332	1,352,846	-4,343,752
16	5,865,600	214,426	5,651,174	0.218	1,276,525	46,665	1,229,860	-3,113,892
17	5,865,600	214,426	5,651,174	0.198	1,160,478	42,423	1,118,055	-1,995,837
18	5,865,600	214,426	5,651,174	0.180	1,054,980	38,566	1,016,413	-979,424
19	5,865,600	214,426	5,651,174	0.164	959,072	35,060	924,012	-55,412
20	5,865,600	214,426	5,651,174	0.149	871,884	31,873	840,011	784,599
21	5,865,600	214,426	5,651,174	0.135	792,622	28,976	763,646	1,548,246
	Sum				19,738,084	18,189,839	1,548,246	

NPV = 1,548,246
B/C = 1.09
IRR = 10.80%

Appendix 4.2-11: Financial Analysis of BONORA SHP with 90% UF and feed-in tariff of 1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	7,332,000	214,426	7,117,574	0.319	2,336,201	68,323	2,267,878	-8,354,432
13	7,332,000	214,426	7,117,574	0.290	2,123,819	62,112	2,061,708	-6,292,725
14	7,332,000	214,426	7,117,574	0.263	1,930,745	56,465	1,874,280	-4,418,445
15	7,332,000	214,426	7,117,574	0.239	1,755,223	51,332	1,703,891	-2,714,554
16	7,332,000	214,426	7,117,574	0.218	1,595,657	46,665	1,548,991	-1,165,563
17	7,332,000	214,426	7,117,574	0.198	1,450,597	42,423	1,408,174	242,611
18	7,332,000	214,426	7,117,574	0.180	1,318,725	38,566	1,280,158	1,522,769
19	7,332,000	214,426	7,117,574	0.164	1,198,841	35,060	1,163,780	2,686,550
20	7,332,000	214,426	7,117,574	0.149	1,089,855	31,873	1,057,982	3,744,532
21	7,332,000	214,426	7,117,574	0.135	990,777	28,976	961,802	4,706,333
	Sum				22,896,172	18,189,839	4,706,333	

NPV = 4,706,333
B/C = 1.26
IRR = 12.20%

Appendix 4.2-12: Financial Analysis of BONORA SHP with 90% UF and feed-in tariff of 1.1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,292,430	-10,292,430	1	0	10,292,430	-10,292,430	-10,292,430
1	0	6,861,620	-6,861,620	0.909	0	6,237,836	-6,237,836	-16,530,266
2	914,270	214,426	699,844	0.826	755,595	177,212	578,383	-15,951,883
3	1,020,460	214,426	806,034	0.751	766,687	161,101	605,585	-15,346,298
4	1,145,816	214,426	931,390	0.683	782,608	146,456	636,152	-14,710,146
5	1,219,372	214,426	1,004,946	0.621	757,134	133,142	623,992	-14,086,153
6	1,298,108	214,426	1,083,682	0.564	732,748	121,038	611,710	-13,474,443
7	1,378,398	214,426	1,163,972	0.513	707,336	110,034	597,302	-12,877,141
8	1,465,422	214,426	1,250,996	0.467	683,630	100,031	583,599	-12,293,543
9	1,560,734	214,426	1,346,308	0.424	661,904	90,938	570,966	-11,722,577
10	1,665,370	214,426	1,450,944	0.386	642,072	82,671	559,402	-11,163,175
11	1,757,574	214,426	1,543,148	0.350	616,019	75,155	540,864	-10,622,311
12	8,065,200	214,426	7,850,774	0.319	2,569,821	68,323	2,501,499	-8,120,812
13	8,065,200	214,426	7,850,774	0.290	2,336,201	62,112	2,274,090	-5,846,723
14	8,065,200	214,426	7,850,774	0.263	2,123,819	56,465	2,067,354	-3,779,369
15	8,065,200	214,426	7,850,774	0.239	1,930,745	51,332	1,879,413	-1,899,956
16	8,065,200	214,426	7,850,774	0.218	1,755,223	46,665	1,708,557	-191,399
17	8,065,200	214,426	7,850,774	0.198	1,595,657	42,423	1,553,234	1,361,835
18	8,065,200	214,426	7,850,774	0.180	1,450,597	38,566	1,412,031	2,773,866
19	8,065,200	214,426	7,850,774	0.164	1,318,725	35,060	1,283,664	4,057,530
20	8,065,200	214,426	7,850,774	0.149	1,198,841	31,873	1,166,968	5,224,498
21	8,065,200	214,426	7,850,774	0.135	1,089,855	28,976	1,060,880	6,285,377
	Sum				24,475,216	18,189,839	6,285,377	

NPV = 6,285,377
B/C = 1.35
IRR = 12.80%

KETO HYDROPOWER-ECONOMIC ANALYSIS

Appendix 5.1-1: Economic Analysis of KETO SHP at Initial Condition

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,083,994	-4,083,994	1	0	4,083,994	-4,083,994	-4,083,994
1	0	2,722,665	-2,722,665	0.909	0	2,475,150	-2,475,150	-6,559,144
2	287,064	162,063	125,001	0.826	237,243	133,936	103,307	-6,455,837
3	287,064	162,063	125,001	0.751	215,675	121,760	93,915	-6,361,922
4	287,064	162,063	125,001	0.683	196,069	110,691	85,377	-6,276,545
5	287,064	162,063	125,001	0.621	178,244	100,628	77,616	-6,198,929
6	287,064	162,063	125,001	0.564	162,040	91,480	70,560	-6,128,369
7	287,064	162,063	125,001	0.513	147,309	83,164	64,145	-6,064,224
8	287,064	162,063	125,001	0.467	133,917	75,604	58,314	-6,005,910
9	287,064	162,063	125,001	0.424	121,743	68,731	53,013	-5,952,898
10	287,064	162,063	125,001	0.386	110,676	62,482	48,193	-5,904,704
11	287,064	162,063	125,001	0.350	100,614	56,802	43,812	-5,860,892
12	287,064	162,063	125,001	0.319	91,467	51,638	39,829	-5,821,063
13	287,064	162,063	125,001	0.290	83,152	46,944	36,208	-5,784,855
14	287,064	162,063	125,001	0.263	75,593	42,676	32,917	-5,751,938
15	287,064	162,063	125,001	0.239	68,721	38,797	29,924	-5,722,014
16	287,064	162,063	125,001	0.218	62,473	35,270	27,204	-5,694,810
17	287,064	162,063	125,001	0.198	56,794	32,063	24,731	-5,670,079
18	287,064	162,063	125,001	0.180	51,631	29,148	22,483	-5,647,597
19	287,064	162,063	125,001	0.164	46,937	26,499	20,439	-5,627,158
20	287,064	162,063	125,001	0.149	42,670	24,090	18,581	-5,608,577
21	287,064	162,063	125,001	0.135	38,791	21,900	16,891	-5,591,686
	Sum				2,221,762	7,813,447	-5,591,686	

NPV = -5,591,686

B/C = 0.28

Appendix 5.1-2: Economic Analysis of KETO SHP with 10% subsidy on the foreign cost of capital investment

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	3,675,595	-3,675,595	1	0	3,675,595	-3,675,595	-3,675,595
1	0	2,450,399	-2,450,399	0.909	0	2,227,635	-2,227,635	-5,903,230
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-5,755,278
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-5,620,776
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-5,498,501
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-5,387,343
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-5,286,289
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-5,194,423
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-5,110,908
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-5,034,985
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-4,965,964
11	287,064	108,042	179,022	0.350	100,614	37,868	62,746	-4,903,218
12	287,064	108,042	179,022	0.319	91,467	34,426	57,042	-4,846,176
13	287,064	108,042	179,022	0.290	83,152	31,296	51,856	-4,794,320
14	287,064	108,042	179,022	0.263	75,593	28,451	47,142	-4,747,178
15	287,064	108,042	179,022	0.239	68,721	25,864	42,856	-4,704,321
16	287,064	108,042	179,022	0.218	62,473	23,513	38,960	-4,665,361
17	287,064	108,042	179,022	0.198	56,794	21,376	35,419	-4,629,942
18	287,064	108,042	179,022	0.180	51,631	19,432	32,199	-4,597,744
19	287,064	108,042	179,022	0.164	46,937	17,666	29,272	-4,568,472
20	287,064	108,042	179,022	0.149	42,670	16,060	26,610	-4,541,862
21	287,064	108,042	179,022	0.135	38,791	14,600	24,191	-4,517,670
	Su,m				2,221,762	6,739,432	-4,517,670	

NPV = -4,517,670

B/C = 0.33

Economic	10% subsidy
4,083,994	3,675,595
2,722,665	2,450,399

Appendix 5.1-3: Economic Analysis of KETO SHP with 50% subsidy on the foreign cost of capital investment

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	2,041,997	-2,041,997	1	0	2,041,997	-2,041,997	-2,041,997
1	0	1,361,333	-1,361,333	0.909	0	1,237,575	-1,237,575	-3,279,572
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-3,131,620
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-2,997,118
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-2,874,844
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-2,763,685
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-2,662,632
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-2,570,765
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-2,487,250
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-2,411,327
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-2,342,307
11	287,064	108,042	179,022	0.350	100,614	37,868	62,746	-2,279,560
12	287,064	108,042	179,022	0.319	91,467	34,426	57,042	-2,222,519
13	287,064	108,042	179,022	0.290	83,152	31,296	51,856	-2,170,662
14	287,064	108,042	179,022	0.263	75,593	28,451	47,142	-2,123,520
15	287,064	108,042	179,022	0.239	68,721	25,864	42,856	-2,080,664
16	287,064	108,042	179,022	0.218	62,473	23,513	38,960	-2,041,703
17	287,064	108,042	179,022	0.198	56,794	21,376	35,419	-2,006,285
18	287,064	108,042	179,022	0.180	51,631	19,432	32,199	-1,974,086
19	287,064	108,042	179,022	0.164	46,937	17,666	29,272	-1,944,815
20	287,064	108,042	179,022	0.149	42,670	16,060	26,610	-1,918,204
21	287,064	108,042	179,022	0.135	38,791	14,600	24,191	-1,894,013
	Sum				2,221,762	4,115,774	-1,894,013	

NPV = -1,894,013

B/C = 0.54

Economic	50% subsidy
4,083,994	2,041,997
2,722,665	1,361,333

Appendix 5.1-4: Economic Analysis of KETO SHP with 75% subsidy on the foreign cost of capital investment

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	1,020,999	-1,020,999	1	0	1,020,999	-1,020,999	-1,020,999
1	0	680,666	-680,666	0.909	0	618,788	-618,788	-1,639,786
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-1,491,834
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-1,357,332
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-1,235,058
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-1,123,899
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-1,022,846
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-930,979
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-847,464
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-771,541
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-702,521
11	287,064	108,042	179,022	0.350	100,614	37,868	62,746	-639,774
12	287,064	108,042	179,022	0.319	91,467	34,426	57,042	-582,733
13	287,064	108,042	179,022	0.290	83,152	31,296	51,856	-530,876
14	287,064	108,042	179,022	0.263	75,593	28,451	47,142	-483,734
15	287,064	108,042	179,022	0.239	68,721	25,864	42,856	-440,878
16	287,064	108,042	179,022	0.218	62,473	23,513	38,960	-401,917
17	287,064	108,042	179,022	0.198	56,794	21,376	35,419	-366,499
18	287,064	108,042	179,022	0.180	51,631	19,432	32,199	-334,300
19	287,064	108,042	179,022	0.164	46,937	17,666	29,272	-305,029
20	287,064	108,042	179,022	0.149	42,670	16,060	26,610	-278,418
21	287,064	108,042	179,022	0.135	38,791	14,600	24,191	-254,227
	Sum				2,221,762	2,475,988	-254,227	

NPV = -254,227

B/C = 0.90

Economic	50% subsidy
4,083,994	1,020,999
2,722,665	680,666

Appendix 5.1-5: Economic Analysis of KETO SHP with 80% subsidy on the foreign cost of capital investment

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	816,799	-816,799	1	0	816,799	-816,799	-816,799
1	0	544,533	-544,533	0.909	0	495,030	-495,030	-1,311,829
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-1,163,877
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-1,029,375
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-907,100
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-795,942
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-694,889
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-603,022
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-519,507
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-443,584
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-374,563
11	287,064	108,042	179,022	0.350	100,614	37,868	62,746	-311,817
12	287,064	108,042	179,022	0.319	91,467	34,426	57,042	-254,775
13	287,064	108,042	179,022	0.290	83,152	31,296	51,856	-202,919
14	287,064	108,042	179,022	0.263	75,593	28,451	47,142	-155,777
15	287,064	108,042	179,022	0.239	68,721	25,864	42,856	-112,921
16	287,064	108,042	179,022	0.218	62,473	23,513	38,960	-73,960
17	287,064	108,042	179,022	0.198	56,794	21,376	35,419	-38,542
18	287,064	108,042	179,022	0.180	51,631	19,432	32,199	-6,343
19	287,064	108,042	179,022	0.164	46,937	17,666	29,272	22,929
20	287,064	108,042	179,022	0.149	42,670	16,060	26,610	49,539
21	287,064	108,042	179,022	0.135	38,791	14,600	24,191	73,730
	Sum				2,221,762	2,148,031	73,730	

NPV = 73,730

B/C = 1.03

Cost	50% subsidy
4,083,994	816,799
2,722,665	544,533

Appendix 5.1-6: Economic Analysis of KETO SHP with 80% subsidy and 10% increase in economic estabishments from the 11th year

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	816,799	-816,799	1	0	816,799	-816,799	-816,799
1	0	544,533	-544,533	0.909	0	495,030	-495,030	-1,311,829
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-1,163,877
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-1,029,375
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-907,100
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-795,942
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-694,889
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-603,022
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-519,507
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-443,584
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-374,563
11	315,770	108,042	207,728	0.350	110,676	37,868	72,808	-301,756
12	347,347	108,042	239,305	0.319	110,676	34,426	76,250	-225,506
13	382,082	108,042	274,040	0.290	110,676	31,296	79,380	-146,126
14	420,290	108,042	312,248	0.263	110,676	28,451	82,225	-63,901
15	462,319	108,042	354,277	0.239	110,676	25,864	84,811	20,910
16	508,551	108,042	400,509	0.218	110,676	23,513	87,163	108,072
17	559,407	108,042	451,365	0.198	110,676	21,376	89,300	197,372
18	615,347	108,042	507,305	0.180	110,676	19,432	91,243	288,616
19	676,882	108,042	568,840	0.164	110,676	17,666	93,010	381,626
20	744,570	108,042	636,528	0.149	110,676	16,060	94,616	476,241
21	819,027	108,042	710,985	0.135	110,676	14,600	96,076	572,317
	Sum				2,720,348	2,148,031	572,317	

NPV = 572,317

B/C = 1.27

Economic Cost	80% subsidy		
4,083,994	816,799		
2,722,665	544,533		
Saving from residential establishments	Saving from non-residential establishments(10 % increase)	Total savings	
142920	144144	287064	

Appendix 5.1-7: Economic Analysis of KETO SHP with 80% subsidy and 20% increase in economic establishments from the 11th year

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	816,799	-816,799	1	0	816,799	-816,799	-816,799
1	0	544,533	-544,533	0.909	0	495,030	-495,030	-1,311,829
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-1,163,877
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-1,029,375
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-907,100
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-795,942
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-694,889
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-603,022
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-519,507
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-443,584
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-374,563
11	373,183	108,042	265,141	0.350	130,798	37,868	92,930	-281,633
12	410,502	108,042	302,460	0.319	130,798	34,426	96,373	-185,260
13	451,552	108,042	343,510	0.290	130,798	31,296	99,503	-85,758
14	496,707	108,042	388,665	0.263	130,798	28,451	102,348	16,590
15	546,378	108,042	438,336	0.239	130,798	25,864	104,934	121,524
16	601,015	108,042	492,973	0.218	130,798	23,513	107,285	228,809
17	661,117	108,042	553,075	0.198	130,798	21,376	109,423	338,232
18	727,228	108,042	619,186	0.180	130,798	19,432	111,366	449,598
19	799,951	108,042	691,909	0.164	130,798	17,666	113,133	562,731
20	879,946	108,042	771,904	0.149	130,798	16,060	114,739	677,470
21	967,941	108,042	859,899	0.135	130,798	14,600	116,199	793,668
	Sum				2,941,700	2,148,031	793,668	

NPV = 793,668
B/C = 1.37

Economic Cost	80% subsidy	
4,083,994	816,799	
2,722,665	544,533	
Saving from residential establishments	Saving from non-residential establishments(20% increase)	Total savings
142920	144144	287064

Appendix 5.1-8: Economic Analysis of KETO SHP with 80% subsidy and 30% increase in economic establishments from the 11th year

Year	Economic Revenue (Birr)	Economic Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	816,799	-816,799	1	0	816,799	-816,799	-816,799
1	0	544,533	-544,533	0.909	0	495,030	-495,030	-1,311,829
2	287,064	108,042	179,022	0.826	237,243	89,291	147,952	-1,163,877
3	287,064	108,042	179,022	0.751	215,675	81,174	134,502	-1,029,375
4	287,064	108,042	179,022	0.683	196,069	73,794	122,274	-907,100
5	287,064	108,042	179,022	0.621	178,244	67,086	111,159	-795,942
6	287,064	108,042	179,022	0.564	162,040	60,987	101,053	-694,889
7	287,064	108,042	179,022	0.513	147,309	55,443	91,867	-603,022
8	287,064	108,042	179,022	0.467	133,917	50,402	83,515	-519,507
9	287,064	108,042	179,022	0.424	121,743	45,820	75,923	-443,584
10	287,064	108,042	179,022	0.386	110,676	41,655	69,021	-374,563
11	373,183	108,042	265,141	0.350	130,798	37,868	92,930	-281,633
12	410,502	108,042	302,460	0.319	130,798	34,426	96,373	-185,260
13	451,552	108,042	343,510	0.290	130,798	31,296	99,503	-85,758
14	496,707	108,042	388,665	0.263	130,798	28,451	102,348	16,590
15	546,378	108,042	438,336	0.239	130,798	25,864	104,934	121,524
16	601,015	108,042	492,973	0.218	130,798	23,513	107,285	228,809
17	661,117	108,042	553,075	0.198	130,798	21,376	109,423	338,232
18	727,228	108,042	619,186	0.180	130,798	19,432	111,366	449,598
19	799,951	108,042	691,909	0.164	130,798	17,666	113,133	562,731
20	879,946	108,042	771,904	0.149	130,798	16,060	114,739	677,470
21	967,941	108,042	859,899	0.135	130,798	14,600	116,199	793,668
	Sum				2,941,700	2,148,031	793,668	

NPV 793,668
B/C 1.37

Economic Cost	80% subsidy	
4,083,994	816,799	
2,722,665	544,533	
Saving from residential establishments	Saving from non-residential establishments(30% increase)	Total savings
142920	144144	287064

KETO HYDROPOWER-FINAMCIAL ANALYSIS

Appendix 3.1-1: Energy sells and the corresponding revenues with different given tariffs for KETO

No	Energy Sells (MWH)	Revenue (Birr) (tariff=0.518Birr/kwh)	Revenue (Birr) (tariff=0.95Birr/kwh)
1	1220	631,960	1,159,000
2	1350	699,300	1,282,500
3	1455	753,690	1,382,250
4	1526	790,468	1,449,700
5	1615	836,570	1,534,250
6	1638	848,484	1,556,100
7	1662	860,916	1,578,900
8	1685	872,830	1,600,750
9	1704	882,672	1,618,800
10	1721	891,478	1,634,950
11	1738	900,284	1,651,100
12	1756	909,608	1,668,200
13	1776	919,968	1,687,200
14	1796	930,328	1,706,200
15	1818	941,724	1,727,100
16	1838	952,084	1,746,100
17	1838	952,084	1,746,100
18	1838	952,084	1,746,100
19	1838	952,084	1,746,100
20	1838	952,084	1,746,100

Appendix 3.1-2: Energy sells and the corresponding revenues with different values of capacity utilization and tariff for KETO

No	Energy Sells (forecasted) (MWH)	Energy Sells by 10% increase from 11th year (MWH)	Energy Sells by 20% increase from 11th year (MWH)	Energy Sells by 30% increase from 11th year (MWH)	Energy Sells by 40% increase from 11th year (MWH)	Energy Sells by 50% increase from 11th year (MWH)	5% increase in tariff from the 11th year(Birr/kwh)	Revenue by 5% increase in tariff & 10% in energy sell	Energy Sales by 20% increase from 11th year (MWH)	10% increase in tariff from the 11th year(Birr/kwh)	Revenue by 10% increase in tariff & 20% in energy sell	Revenue by 10% increase in energy sell (tariff 0.518Birr/kwh)	Revenue by 20% increase in energy sell (tariff 0.518Birr/kwh)	Revenue by 30% increase in energy sell (tariff 0.518Birr/kwh)	Revenue by 40% increase in energy sell (tariff 0.518Birr/kwh)	Revenue by 50% increase in energy sell (tariff 0.518Birr/kwh)
1	1220	1220	1220	1220	1220	1220	0.518	631,960	1220	0.518	631,960	631,960	631,960	631,960	631,960	631,960
2	1350	1350	1350	1350	1350	1350	0.518	699,300	1350	0.518	699,300	699,300	699,300	699,300	699,300	699,300
3	1455	1455	1455	1455	1455	1455	0.518	753,690	1455	0.518	753,690	753,690	753,690	753,690	753,690	753,690
4	1526	1526	1526	1526	1526	1526	0.518	790,468	1526	0.518	790,468	790,468	790,468	790,468	790,468	790,468
5	1615	1615	1615	1615	1615	1615	0.518	836,570	1615	0.518	836,570	836,570	836,570	836,570	836,570	836,570
6	1638	1638	1638	1638	1638	1638	0.518	848,484	1638	0.518	848,484	848,484	848,484	848,484	848,484	848,484
7	1662	1662	1662	1662	1662	1662	0.518	860,916	1662	0.518	860,916	860,916	860,916	860,916	860,916	860,916
8	1685	1685	1685	1685	1685	1685	0.518	872,830	1685	0.518	872,830	872,830	872,830	872,830	872,830	872,830
9	1704	1704	1704	1704	1704	1704	0.518	882,672	1704	0.518	882,672	882,672	882,672	882,672	882,672	882,672
10	1721	1721	1721	1721	1721	1721	0.518	891,478	1721	0.518	891,478	891,478	891,478	891,478	891,478	891,478
11	1738	1912	2086	2259	2433	2607	0.544	1,039,828	2086	0.570	1,188,375	990,312	1,080,341	1,170,369	1,260,398	1,350,426
12	1756	1932	2107	2283	2458	2634	0.571	1,103,127	2107	0.627	1,320,751	1,000,569	1,091,530	1,182,490	1,273,451	1,364,412
13	1776	1954	2131	2309	2486	2664	0.600	1,171,476	2131	0.689	1,469,373	1,011,965	1,103,962	1,195,958	1,287,955	1,379,952
14	1796	1976	2155	2335	2514	2694	0.630	1,243,901	2155	0.758	1,634,512	1,023,361	1,116,394	1,209,426	1,302,459	1,395,492
15	1818	2000	2182	2363	2545	2727	0.661	1,322,095	2182	0.834	1,819,987	1,035,896	1,130,069	1,224,241	1,318,414	1,412,586
16	1838	2022	2206	2389	2573	2757	0.694	1,403,472	2206	0.918	2,024,010	1,047,292	1,142,501	1,237,709	1,332,918	1,428,126
17	1838	2022	2206	2389	2573	2757	0.729	1,473,646	2206	1.009	2,226,411	1,047,292	1,142,501	1,237,709	1,332,918	1,428,126
18	1838	2022	2206	2389	2573	2757	0.765	1,547,328	2206	1.110	2,449,052	1,047,292	1,142,501	1,237,709	1,332,918	1,428,126
19	1838	2022	2206	2389	2573	2757	0.804	1,624,694	2206	1.221	2,693,957	1,047,292	1,142,501	1,237,709	1,332,918	1,428,126
20	1838	2022	2206	2389	2573	2757	0.844	1,705,929	2206	1.344	2,963,353	1,047,292	1,142,501	1,237,709	1,332,918	1,428,126

Appendix 3.1-3: Energy Sell with 90% utilization factor starting from the 11th year and the corresponding revenues at different feed-in tariffs for KETO

No	Energy Sales (MWH)	Revenue (Birr) [rate:0.518Birr/kwh]	Revenue (Birr) [10 % increase in tariff from 11th year]	Revenue (Birr) [rate: 0.6Birr/kwh]	Revenue (Birr) [rate: 0.7Birr/kwh]	Revenue (Birr) [rate: 0.8Birr/kwh]	Revenue (Birr) [rate: 1Birr/kwh]	Revenue (Birr) [rate: 1.1Birr/kwh]
1	1220	631,960	631,960	631,960	631,960	631,960	631,960	631,960
2	1350	699,300	699,300	699,300	699,300	699,300	699,300	699,300
3	1455	753,690	753,690	753,690	753,690	753,690	753,690	753,690
4	1526	790,468	790,468	790,468	790,468	790,468	790,468	790,468
5	1615	836,570	836,570	836,570	836,570	836,570	836,570	836,570
6	1638	848,484	848,484	848,484	848,484	848,484	848,484	848,484
7	1662	860,916	860,916	860,916	860,916	860,916	860,916	860,916
8	1685	872,830	872,830	872,830	872,830	872,830	872,830	872,830
9	1704	882,672	882,672	882,672	882,672	882,672	882,672	882,672
10	1721	891,478	891,478	891,478	891,478	891,478	891,478	891,478
11	3154	1,633,772	1,797,149	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
12	3154	1,633,772	1,976,864	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
13	3154	1,633,772	2,174,551	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
14	3154	1,633,772	2,392,006	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
15	3154	1,633,772	2,631,206	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
16	3154	1,633,772	2,894,327	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
17	3154	1,633,772	3,183,759	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
18	3154	1,633,772	3,502,135	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
19	3154	1,633,772	3,852,349	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400
20	3154	1,633,772	4,237,584	1,892,400	2,207,800	2,523,200	3,154,000	3,469,400

Energy Sell with 90% UF=400kw*365days*24hr/day*0.9=3154MWh: Assume a max. energy sell of 3154MWH

Appendix 3.1-4: Financial Analysis of KETO SHP at Initial Condition Considering 1year of Construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	10,804,220	-10,804,220	1	0	10,804,220	-10,804,220	-10,804,220
1	631,960	162,063	469,897	0.909	574,509	147,330	427,179	-10,377,041
2	699,300	162,063	537,237	0.826	577,934	133,936	443,998	-9,933,043
3	753,690	162,063	591,627	0.751	566,258	121,760	444,498	-9,488,545
4	790,470	162,063	628,407	0.683	539,902	110,691	429,210	-9,059,335
5	836,570	162,063	674,507	0.621	519,444	100,628	418,816	-8,640,519
6	848,480	162,063	686,417	0.564	478,945	91,480	387,465	-8,253,055
7	860,920	162,063	698,857	0.513	441,788	83,164	358,624	-7,894,430
8	872,830	162,063	710,767	0.467	407,182	75,604	331,578	-7,562,852
9	882,670	162,063	720,607	0.424	374,338	68,731	305,608	-7,257,245
10	891,480	162,063	729,417	0.386	343,704	62,482	281,222	-6,976,023
11	900,280	162,063	738,217	0.350	315,543	56,802	258,741	-6,717,282
12	909,610	162,063	747,547	0.319	289,830	51,638	238,192	-6,479,091
13	919,970	162,063	757,907	0.290	266,483	46,944	219,539	-6,259,552
14	930,330	162,063	768,267	0.263	244,985	42,676	202,309	-6,057,243
15	941,720	162,063	779,657	0.239	225,440	38,797	186,644	-5,870,600
16	952,080	162,063	790,017	0.218	207,200	35,270	171,931	-5,698,669
17	952,080	162,063	790,017	0.198	188,364	32,063	156,301	-5,542,368
18	952,080	162,063	790,017	0.180	171,240	29,148	142,092	-5,400,277
19	952,080	162,063	790,017	0.164	155,673	26,499	129,174	-5,271,103
20	952,080	162,063	790,017	0.149	141,521	24,090	117,431	-5,153,672
	Sum				7,030,282	12,183,954	-5,153,672	

NPV = -5,153,672
B/C = 0.58

Appendix 4.1-1: Financial Analysis of KETO SHP at Initial Condition Considering 2years of Construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	900,284	162,063	738,221	0.319	286,858	51,638	235,220	-6,695,943
13	909,608	162,063	747,545	0.290	263,481	46,944	216,537	-6,479,406
14	919,968	162,063	757,905	0.263	242,256	42,676	199,580	-6,279,826
15	930,328	162,063	768,265	0.239	222,713	38,797	183,916	-6,095,909
16	941,724	162,063	779,661	0.218	204,947	35,270	169,677	-5,926,232
17	952,084	162,063	790,021	0.198	188,365	32,063	156,301	-5,769,931
18	952,084	162,063	790,021	0.180	171,241	29,149	142,092	-5,627,839
19	952,084	162,063	790,021	0.164	155,673	26,499	129,175	-5,498,664
20	952,084	162,063	790,021	0.149	141,521	24,090	117,432	-5,381,232
21	952,084	162,063	790,021	0.135	128,656	21,900	106,756	-5,274,476
	Sum				6,391,168	11,665,645	-5,274,476	

Net Present Value (NPV)= -5,274,476

Benefit to Cost Ratio=discounted revenue/discounted cost=0.55

B/C = 0.55

Appendix 4.1-2: Financial Analysis of KETO SHP: calculation of IRR

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=2.4% per annum(for IRR)	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	6,482,530	-6,482,530	1.000	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.977	0	4,220,400	-4,220,400	-10,702,930
2	631,960	162,063	469,897	0.954	602,684	154,555	448,129	-10,254,802
3	699,300	162,063	537,237	0.931	651,274	150,933	500,341	-9,754,461
4	753,690	162,063	591,627	0.909	685,477	147,395	538,082	-9,216,379
5	790,468	162,063	628,405	0.888	702,077	143,941	558,136	-8,658,243
6	836,570	162,063	674,507	0.867	725,609	140,567	585,042	-8,073,202
7	848,484	162,063	686,421	0.847	718,694	137,273	581,421	-7,491,781
8	860,916	162,063	698,853	0.827	712,133	134,055	578,078	-6,913,703
9	872,830	162,063	710,767	0.808	705,066	130,913	574,153	-6,339,550
10	882,672	162,063	720,609	0.789	696,305	127,845	568,460	-5,771,090
11	891,478	162,063	729,415	0.770	686,770	124,849	561,921	-5,209,169
12	900,284	162,063	738,221	0.752	677,298	121,923	555,376	-4,653,793
13	909,608	162,063	747,545	0.735	668,274	119,065	549,209	-4,104,584
14	919,968	162,063	757,905	0.717	660,045	116,275	543,770	-3,560,814
15	930,328	162,063	768,265	0.701	651,834	113,549	538,284	-3,022,529
16	941,724	162,063	779,661	0.684	644,354	110,888	533,466	-2,489,064
17	952,084	162,063	790,021	0.668	636,174	108,289	527,885	-1,961,178
18	952,084	162,063	790,021	0.653	621,264	105,751	515,513	-1,445,666
19	952,084	162,063	790,021	0.637	606,703	103,273	503,430	-942,235
20	952,084	162,063	790,021	0.622	592,483	100,852	491,631	-450,604
21	952,084	162,063	790,021	0.608	578,597	98,488	480,109	29,505
	Sum				13,223,115	13,193,610	29,505	

NPV=29,4920 (can be approxiamated as NPV=0, as compared to the big values of NPV in million)

B/C=1

Appendix 4.1-3: Financial Analysis of KETO SHP at with increase in tariff to 0.95Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	1,159,000	162,063	996,937	0.826	957,851	133,937	823,915	-9,587,424
3	1,282,500	162,063	1,120,437	0.751	963,561	121,761	841,801	-8,745,624
4	1,382,250	162,063	1,220,187	0.683	944,095	110,691	833,404	-7,912,220
5	1,449,700	162,063	1,287,637	0.621	900,150	100,629	799,521	-7,112,699
6	1,534,250	162,063	1,372,187	0.564	866,044	91,481	774,564	-6,338,135
7	1,556,100	162,063	1,394,037	0.513	798,525	83,164	715,361	-5,622,774
8	1,578,900	162,063	1,416,837	0.467	736,569	75,604	660,965	-4,961,809
9	1,600,750	162,063	1,438,687	0.424	678,874	68,731	610,144	-4,351,666
10	1,618,800	162,063	1,456,737	0.386	624,117	62,482	561,635	-3,790,030
11	1,634,950	162,063	1,472,887	0.350	573,040	56,802	516,238	-3,273,793
12	1,651,100	162,063	1,489,037	0.319	526,091	51,638	474,453	-2,799,340
13	1,668,200	162,063	1,506,137	0.290	483,218	46,944	436,274	-2,363,066
14	1,687,200	162,063	1,525,137	0.263	444,292	42,676	401,616	-1,961,449
15	1,706,200	162,063	1,544,137	0.239	408,451	38,797	369,654	-1,591,795
16	1,727,100	162,063	1,565,037	0.218	375,867	35,270	340,598	-1,251,198
17	1,746,100	162,063	1,584,037	0.198	345,457	32,063	313,393	-937,805
18	1,746,100	162,063	1,584,037	0.180	314,051	29,149	284,903	-652,902
19	1,746,100	162,063	1,584,037	0.164	285,501	26,499	259,003	-393,899
20	1,746,100	162,063	1,584,037	0.149	259,547	24,090	235,457	-158,442
21	1,746,100	162,063	1,584,037	0.135	235,951	21,900	214,052	55,610
	Sum				11,721,255	11,665,645	55,610	

NPV = 55,610
B/C = 1.00

Appendix 4.1-4: Financial Analysis of KETO SHP with 10% increase in energy utilization starting from the 11th year

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	990,312	162,063	828,249	0.319	315,544	51,638	263,906	-6,667,257
13	1,000,569	162,063	838,506	0.290	289,829	46,944	242,885	-6,424,372
14	1,011,965	162,063	849,902	0.263	266,482	42,676	223,806	-6,200,566
15	1,023,361	162,063	861,298	0.239	244,984	38,797	206,188	-5,994,378
16	1,035,896	162,063	873,833	0.218	225,441	35,270	190,172	-5,804,207
17	1,047,292	162,063	885,229	0.198	207,201	32,063	175,138	-5,629,069
18	1,047,292	162,063	885,229	0.180	188,365	29,149	159,216	-5,469,853
19	1,047,292	162,063	885,229	0.164	171,241	26,499	144,742	-5,325,111
20	1,047,292	162,063	885,229	0.149	155,673	24,090	131,584	-5,193,527
21	1,047,292	162,063	885,229	0.135	141,521	21,900	119,622	-5,073,905
					6,591,739	11,665,645	-5,073,905	

NPV = -5,073,905
B/C = 0.57
IRR = 3.0%

Appendix 4.1-5: Financial Analysis of KETO SHP with 20% increase in energy utilization starting from the 11th year

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	1,080,341	162,063	918,278	0.319	344,230	51,638	292,592	-6,638,571
13	1,091,530	162,063	929,466	0.290	316,177	46,944	269,233	-6,369,338
14	1,103,962	162,063	941,898	0.263	290,708	42,676	248,031	-6,121,306
15	1,116,394	162,063	954,330	0.239	267,256	38,797	228,459	-5,892,847
16	1,130,069	162,063	968,006	0.218	245,936	35,270	210,666	-5,682,181
17	1,142,501	162,063	980,438	0.198	226,038	32,063	193,974	-5,488,207
18	1,142,501	162,063	980,438	0.180	205,489	29,149	176,340	-5,311,867
19	1,142,501	162,063	980,438	0.164	186,808	26,499	160,309	-5,151,557
20	1,142,501	162,063	980,438	0.149	169,825	24,090	145,736	-5,005,821
21	1,142,501	162,063	980,438	0.135	154,387	21,900	132,487	-4,873,334
	Sum				6,792,310	11,665,645	-4,873,334	

NPV = -4,873,334
B/C = 0.58
IRR = 3.4%

Appendix 4.1-6: Financial Analysis of KETO SHP with 30% increase in energy utilization starting from the 11th year

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	1,170,369	162,063	1,008,306	0.319	372,916	51,638	321,277	-6,609,885
13	1,182,490	162,063	1,020,427	0.290	342,525	46,944	295,581	-6,314,304
14	1,195,958	162,063	1,033,895	0.263	314,933	42,676	272,257	-6,042,047
15	1,209,426	162,063	1,047,363	0.239	289,527	38,797	250,730	-5,791,316
16	1,224,241	162,063	1,062,178	0.218	266,431	35,270	231,161	-5,560,156
17	1,237,709	162,063	1,075,646	0.198	244,874	32,063	212,811	-5,347,345
18	1,237,709	162,063	1,075,646	0.180	222,613	29,149	193,464	-5,153,880
19	1,237,709	162,063	1,075,646	0.164	202,375	26,499	175,877	-4,978,004
20	1,237,709	162,063	1,075,646	0.149	183,978	24,090	159,888	-4,818,116
21	1,237,709	162,063	1,075,646	0.135	167,252	21,900	145,353	-4,672,763
	Sum				6,992,882	11,665,645	-4,672,763	

NPV = -4,672,763
B/C = 0.60
IRR = 3.90%

Appendix 4.1-7: Financial Analysis of Keto SHP with 40% increase in energy utilization starting from the 11th year

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	1,260,398	162,063	1,098,334	0.319	401,602	51,638	349,963	-6,581,199
13	1,273,451	162,063	1,111,388	0.290	368,873	46,944	321,929	-6,259,270
14	1,287,955	162,063	1,125,892	0.263	339,159	42,676	296,483	-5,962,787
15	1,302,459	162,063	1,140,396	0.239	311,798	38,797	273,002	-5,689,786
16	1,318,414	162,063	1,156,350	0.218	286,925	35,270	251,656	-5,438,130
17	1,332,918	162,063	1,170,854	0.198	263,711	32,063	231,647	-5,206,483
18	1,332,918	162,063	1,170,854	0.180	239,737	29,149	210,588	-4,995,894
19	1,332,918	162,063	1,170,854	0.164	217,943	26,499	191,444	-4,804,450
20	1,332,918	162,063	1,170,854	0.149	198,130	24,090	174,040	-4,630,410
21	1,332,918	162,063	1,170,854	0.135	180,118	21,900	158,218	-4,472,192
	Sum				7,193,453	11,665,645	-4,472,192	

NPV = -4,472,192
B/C = 0.62
IRR = 4.30%

Appendix 4.1-8: Financial Analysis of KETO SHP with 50% increase in energy utilization starting from the 11th year

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	1,350,426	162,063	1,188,363	0.319	430,287	51,638	378,649	-6,552,514
13	1,364,412	162,063	1,202,349	0.290	395,222	46,944	348,278	-6,204,236
14	1,379,952	162,063	1,217,889	0.263	363,384	42,676	320,708	-5,883,528
15	1,395,492	162,063	1,233,429	0.239	334,070	38,797	295,273	-5,588,255
16	1,412,586	162,063	1,250,523	0.218	307,420	35,270	272,150	-5,316,105
17	1,428,126	162,063	1,266,063	0.198	282,547	32,063	250,484	-5,065,621
18	1,428,126	162,063	1,266,063	0.180	256,861	29,149	227,713	-4,837,908
19	1,428,126	162,063	1,266,063	0.164	233,510	26,499	207,011	-4,630,897
20	1,428,126	162,063	1,266,063	0.149	212,282	24,090	188,192	-4,442,705
21	1,428,126	162,063	1,266,063	0.135	192,983	21,900	171,084	-4,271,621
	Sum				7,394,024	11,665,645	-4,271,621	

NPV = -4,271,621
B/C = 0.63
IRR = 4.7%

Appendix 4.1-9: Financial Analysis of Keto SHP with 90% UF and feed-in tariff of 0.6Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	1,892,400	162,063	1,730,337	0.319	602,977	51,638	551,339	-6,379,824
13	1,892,400	162,063	1,730,337	0.290	548,161	46,944	501,217	-5,878,607
14	1,892,400	162,063	1,730,337	0.263	498,328	42,676	455,652	-5,422,955
15	1,892,400	162,063	1,730,337	0.239	453,026	38,797	414,229	-5,008,726
16	1,892,400	162,063	1,730,337	0.218	411,841	35,270	376,572	-4,632,155
17	1,892,400	162,063	1,730,337	0.198	374,401	32,063	342,338	-4,289,817
18	1,892,400	162,063	1,730,337	0.180	340,365	29,149	311,216	-3,978,601
19	1,892,400	162,063	1,730,337	0.164	309,423	26,499	282,924	-3,695,677
20	1,892,400	162,063	1,730,337	0.149	281,293	24,090	257,204	-3,438,473
21	1,892,400	162,063	1,730,337	0.135	255,721	21,900	233,821	-3,204,652
	Sum				8,460,993	11,665,645	-3,204,652	

NPV = -3,204,652
B/C = 0.73
IRR = 6.40

Appendix 4.1-10: Financial Analysis of Keto SHP with 90% UF and feed-in tariff of 0.7Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	2,207,800	162,063	2,045,737	0.319	703,473	51,638	651,835	-6,279,328
13	2,207,800	162,063	2,045,737	0.290	639,521	46,944	592,577	-5,686,751
14	2,207,800	162,063	2,045,737	0.263	581,383	42,676	538,706	-5,148,044
15	2,207,800	162,063	2,045,737	0.239	528,530	38,797	489,733	-4,658,311
16	2,207,800	162,063	2,045,737	0.218	480,482	35,270	445,212	-4,213,099
17	2,207,800	162,063	2,045,737	0.198	436,801	32,063	404,738	-3,808,361
18	2,207,800	162,063	2,045,737	0.180	397,092	29,149	367,944	-3,440,417
19	2,207,800	162,063	2,045,737	0.164	360,993	26,499	334,494	-3,105,923
20	2,207,800	162,063	2,045,737	0.149	328,175	24,090	304,086	-2,801,837
21	2,207,800	162,063	2,045,737	0.135	298,341	21,900	276,442	-2,525,396
	Sum				9,140,249	11,665,645	-2,525,396	

NPV = -2,525,396
B/C = 0.78
IRR = 7.4

Appendix 4.1-11: Financial Analysis of KETO SHP with 90% UF and feed-in tariff of 0.8Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	2,523,200	162,063	2,361,137	0.319	803,969	51,638	752,331	-6,178,832
13	2,523,200	162,063	2,361,137	0.290	730,881	46,944	683,937	-5,494,894
14	2,523,200	162,063	2,361,137	0.263	664,437	42,676	621,761	-4,873,133
15	2,523,200	162,063	2,361,137	0.239	604,034	38,797	565,237	-4,307,896
16	2,523,200	162,063	2,361,137	0.218	549,122	35,270	513,852	-3,794,044
17	2,523,200	162,063	2,361,137	0.198	499,202	32,063	467,138	-3,326,905
18	2,523,200	162,063	2,361,137	0.180	453,820	29,149	424,671	-2,902,234
19	2,523,200	162,063	2,361,137	0.164	412,563	26,499	386,065	-2,516,170
20	2,523,200	162,063	2,361,137	0.149	375,058	24,090	350,968	-2,165,202
21	2,523,200	162,063	2,361,137	0.135	340,961	21,900	319,062	-1,846,140
	Sum				9,819,505	11,665,645	-1,846,140	

NPV = -1,846,140
B/C = 0.84
IRR = 8.2

Appendix 4.1-12: Financial Analysis of Keto SHP with 90% UF and feed-in tariff of 1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	3,154,000	162,063	2,991,937	0.319	1,004,962	51,638	953,323	-5,977,839
13	3,154,000	162,063	2,991,937	0.290	913,601	46,944	866,657	-5,111,182
14	3,154,000	162,063	2,991,937	0.263	830,547	42,676	787,870	-4,323,311
15	3,154,000	162,063	2,991,937	0.239	755,043	38,797	716,246	-3,607,065
16	3,154,000	162,063	2,991,937	0.218	686,402	35,270	651,133	-2,955,933
17	3,154,000	162,063	2,991,937	0.198	624,002	32,063	591,939	-2,363,994
18	3,154,000	162,063	2,991,937	0.180	567,275	29,149	538,126	-1,825,868
19	3,154,000	162,063	2,991,937	0.164	515,704	26,499	489,206	-1,336,662
20	3,154,000	162,063	2,991,937	0.149	468,822	24,090	444,732	-891,930
21	3,154,000	162,063	2,991,937	0.135	426,202	21,900	404,302	-487,628
	Sum				11,178,017	11,665,645	-487,628	

NPV = -487,628
B/C = 0.96
IRR = 9.6

Appendix 4.1-13: Financial Analysis of Keto SHP with 90% UF and feed-in tariff of 1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,482,530	-6,482,530	1	0	6,482,530	-6,482,530	-6,482,530
1	0	4,321,690	-4,321,690	0.909	0	3,928,809	-3,928,809	-10,411,339
2	631,960	162,063	469,897	0.826	522,281	133,937	388,344	-10,022,995
3	699,300	162,063	537,237	0.751	525,394	121,761	403,634	-9,619,361
4	753,690	162,063	591,627	0.683	514,780	110,691	404,089	-9,215,272
5	790,468	162,063	628,405	0.621	490,818	100,629	390,190	-8,825,082
6	836,570	162,063	674,507	0.564	472,222	91,481	380,741	-8,444,341
7	848,484	162,063	686,421	0.513	435,406	83,164	352,242	-8,092,098
8	860,916	162,063	698,853	0.467	401,624	75,604	326,020	-7,766,078
9	872,830	162,063	710,767	0.424	370,165	68,731	301,434	-7,464,644
10	882,672	162,063	720,609	0.386	340,308	62,482	277,826	-7,186,818
11	891,478	162,063	729,415	0.350	312,458	56,802	255,655	-6,931,162
12	3,469,400	162,063	3,307,337	0.319	1,105,458	51,638	1,053,819	-5,877,343
13	3,469,400	162,063	3,307,337	0.290	1,004,962	46,944	958,018	-4,919,325
14	3,469,400	162,063	3,307,337	0.263	913,601	42,676	870,925	-4,048,400
15	3,469,400	162,063	3,307,337	0.239	830,547	38,797	791,750	-3,256,650
16	3,469,400	162,063	3,307,337	0.218	755,043	35,270	719,773	-2,536,877
17	3,469,400	162,063	3,307,337	0.198	686,402	32,063	654,339	-1,882,538
18	3,469,400	162,063	3,307,337	0.180	624,002	29,149	594,854	-1,287,685
19	3,469,400	162,063	3,307,337	0.164	567,275	26,499	540,776	-746,909
20	3,469,400	162,063	3,307,337	0.149	515,704	24,090	491,615	-255,294
21	3,469,400	162,063	3,307,337	0.135	468,822	21,900	446,922	191,628
	Sum				11,857,273	11,665,645	191,628	

NPV = 191,628
B/C = 1.02
IRR = 10.2

Appendix 4.1-14: Financial Analysis of Keto SHP with 90% Load factor and tariff with 10% increase from the 11th year, O&M cost 1%Capital & 15% subsidy

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	5,510,151	-5,510,151	1	0	5,510,151	-5,510,151	-5,510,151
1	0	3,673,437	-3,673,437	0.909	0	3,339,488	-3,339,488	-8,849,638
2	631,960	108,042	523,918	0.826	522,281	89,291	432,990	-8,416,648
3	699,300	108,042	591,258	0.751	525,394	81,174	444,221	-7,972,428
4	753,690	108,042	645,648	0.683	514,780	73,794	440,986	-7,531,441
5	790,468	108,042	682,426	0.621	490,818	67,086	423,733	-7,107,709
6	836,570	108,042	728,528	0.564	472,222	60,987	411,235	-6,696,474
7	848,484	108,042	740,442	0.513	435,406	55,443	379,964	-6,316,510
8	860,916	108,042	752,874	0.467	401,624	50,402	351,221	-5,965,289
9	872,830	108,042	764,788	0.424	370,165	45,820	324,345	-5,640,944
10	882,672	108,042	774,630	0.386	340,308	41,655	298,653	-5,342,291
11	891,478	108,042	783,436	0.350	312,458	37,868	274,589	-5,067,701
12	1,797,149	108,042	1,689,107	0.319	572,627	34,426	538,202	-4,529,500
13	1,976,864	108,042	1,868,822	0.290	572,627	31,296	541,331	-3,988,169
14	2,174,551	108,042	2,066,508	0.263	572,627	28,451	544,176	-3,443,992
15	2,392,006	108,042	2,283,963	0.239	572,627	25,864	546,763	-2,897,230
16	2,631,206	108,042	2,523,164	0.218	572,627	23,513	549,114	-2,348,116
17	2,894,327	108,042	2,786,285	0.198	572,627	21,376	551,252	-1,796,864
18	3,183,759	108,042	3,075,717	0.180	572,627	19,432	553,195	-1,243,669
19	3,502,135	108,042	3,394,093	0.164	572,627	17,666	554,961	-688,708
20	3,852,349	108,042	3,744,307	0.149	572,627	16,060	556,567	-132,141
21	4,237,584	108,042	4,129,542	0.135	572,627	14,600	558,027	425,887
	Sum				10,111,729	9,685,842	425,887	

Net Present Value (NPV)= 425,887
B/C 1.04
IRR 10.4

Year	Capital Cost	Subsidized Cost(10% of capital cost subidized)	Subsidized Cost(15% of capital cost subidized)
0	6,482,530	5,834,277	5,510,151
1	4,321,690	3,889,521	3,673,437

MOGOR HYDROPOWER-FINANCIAL ANALYSIS

Energy sells with different given tariffs

No	Energy Sales (MWH)	Revenue (Birr) (tariff=0.518Birr/kwh)
1	582	301,476
2	665	344,470
3	749	387,982
4	835	432,530
5	1000	518,000
6	1043	540,274
7	1090	564,620
8	1139	590,002
9	1183	612,794
10	1222	632,996
11	1247	645,946
12	1269	657,342
13	1282	664,076
14	1299	672,882
15	1316	681,688
16	1331	689,458
17	1331	689,458
18	1331	689,458
19	1331	689,458
20	1331	689,458

Appendix 3.4-2: Energy sells with different values of capacity utilization

No	Energy Sales (MWH)	Energy Sales by 10% increase from 11th year (MWH)	Energy Sales by 20% increase from 11th year (MWH)	Energy Sales by 30% increase from 11th year (MWH)	Energy Sales by 40% increase from 11th year (MWH)	Energy Sales by 50% increase from 11th year (MWH)	Revenue by 10% increase in energy sell(Birr)	Revenue by 20% increase in energy sell(Birr)	Revenue by 30% increase in energy sell(Birr)	Revenue by 40% increase in energy sell(Birr)	Revenue by 50% increase in energy sell(Birr)
1	582	582	582	582	582	582	301,476	301,476	301,476	301,476	301,476
2	665	665	665	665	665	665	344,470	344,470	344,470	344,470	344,470
3	749	749	749	749	749	749	387,982	387,982	387,982	387,982	387,982
4	835	835	835	835	835	835	432,530	432,530	432,530	432,530	432,530
5	1000	1000	1000	1000	1000	1000	518,000	518,000	518,000	518,000	518,000
6	1043	1043	1043	1043	1043	1043	540,274	540,274	540,274	540,274	540,274
7	1090	1090	1090	1090	1090	1090	564,620	564,620	564,620	564,620	564,620
8	1139	1139	1139	1139	1139	1139	590,002	590,002	590,002	590,002	590,002
9	1183	1183	1183	1183	1183	1183	612,794	612,794	612,794	612,794	612,794
10	1222	1222	1222	1222	1222	1222	632,996	632,996	632,996	632,996	632,996
11	1247	1372	1414	1414	1414	1414	710,541	732,452	732,452	732,452	732,452
12	1269	1396	1414	1414	1414	1414	723,076	732,452	732,452	732,452	732,452
13	1282	1410	1414	1414	1414	1414	730,484	732,452	732,452	732,452	732,452
14	1299	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452
15	1316	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452
16	1331	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452
17	1331	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452
18	1331	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452
19	1331	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452
20	1331	1414	1414	1414	1414	1414	732,452	732,452	732,452	732,452	732,452

The max. energy sell at ideal condition=170kw*365days*24hr/day=1489MWh. Therefore, limit all values of energy sell under this value. Lets assume max. energy sell with 95% UF as 1414MWh

From the above table we observe that the revenue for 20%, 30%, 40%, and 50% increase in capital utilization are all the same. This is because of high energy demand. With 10% increase in capital tilization all the supply will be consumed.

Appendix 3.4-3: Energy Sell with 90% UF starting from the 11th year and the corresponding revenues at different feed-in tariffs

No	Energy Sales (MWH)	Revenue (Birr) [rate:0.518Birr /kwh]	Revenue (Birr) [rate: 0.6Birr/kwh]	Revenue (Birr) [rate: 0.7Birr/kwh]	Revenue (Birr) [rate: 0.8Birr/kwh]	Revenue (Birr) [rate: 1Birr/kwh]	Revenue (Birr) [rate: 1.1Birr/kwh]
1	582	301,476	301,476	301,476	301,476	301,476	301,476
2	665	344,470	344,470	344,470	344,470	344,470	344,470
3	749	387,982	387,982	387,982	387,982	387,982	387,982
4	835	432,530	432,530	432,530	432,530	432,530	432,530
5	1000	518,000	518,000	518,000	518,000	518,000	518,000
6	1043	540,274	540,274	540,274	540,274	540,274	540,274
7	1090	564,620	564,620	564,620	564,620	564,620	564,620
8	1139	590,002	590,002	590,002	590,002	590,002	590,002
9	1183	612,794	612,794	612,794	612,794	612,794	612,794
10	1222	632,996	632,996	632,996	632,996	632,996	632,996
11	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
12	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
13	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
14	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
15	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
16	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
17	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
18	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
19	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000
20	1,340	694,120	804,000	938,000	1,072,000	1,340,000	1,474,000

Energy Sell with 90% UF=170kw*365days*24hr/day*0.9=1340MWh

Appendix 3.4-4: Financial Analysis of Mogor SHP at Initial Condition considering 1year of construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	7,233,220	-7,233,220	1	0	7,233,220	-7,233,220	-7,233,220
1	301,476	108,500	192,976	0.909	274,069	98,636	175,433	-7,057,787
2	344,470	108,500	235,970	0.826	284,686	89,669	195,017	-6,862,771
3	387,982	108,500	279,482	0.751	291,497	81,518	209,979	-6,652,792
4	432,530	108,500	324,030	0.683	295,424	74,107	221,317	-6,431,475
5	518,000	108,500	409,500	0.621	321,637	67,370	254,267	-6,177,208
6	540,274	108,500	431,774	0.564	304,971	61,245	243,725	-5,933,482
7	564,620	108,500	456,120	0.513	289,739	55,678	234,062	-5,699,421
8	590,002	108,500	481,502	0.467	275,240	50,616	224,624	-5,474,797
9	612,794	108,500	504,294	0.424	259,884	46,015	213,870	-5,260,927
10	632,996	108,500	524,496	0.386	244,047	41,831	202,216	-5,058,711
11	645,946	108,500	537,446	0.350	226,400	38,029	188,372	-4,870,339
12	657,342	108,500	548,842	0.319	209,449	34,571	174,878	-4,695,461
13	664,076	108,500	555,576	0.290	192,359	31,429	160,931	-4,534,531
14	672,882	108,500	564,382	0.263	177,191	28,571	148,619	-4,385,911
15	681,688	108,500	573,188	0.239	163,191	25,974	137,217	-4,248,695
16	689,458	108,500	580,958	0.218	150,046	23,613	126,433	-4,122,261
17	689,458	108,500	580,958	0.198	136,406	21,466	114,939	-4,007,322
18	689,458	108,500	580,958	0.180	124,005	19,515	104,490	-3,902,831
19	689,458	108,500	580,958	0.164	112,732	17,741	94,991	-3,807,840
20	689,458	108,500	580,958	0.149	102,484	16,128	86,356	-3,721,484
	Sum				4,435,457	8,156,942	-3,721,484	

NPV = -3,721,484
B/C = 0.54

Appendix 4.4-1: Financial Analysis of MOGOR SHP at Initial Condition considering 2years of construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	645,946	108,500	537,446	0.319	205,818	34,571	171,247	-4,822,120
13	657,342	108,500	548,842	0.290	190,409	31,429	158,980	-4,663,140
14	664,076	108,500	555,576	0.263	174,872	28,571	146,301	-4,516,840
15	672,882	108,500	564,382	0.239	161,083	25,974	135,109	-4,381,731
16	681,688	108,500	573,188	0.218	148,355	23,613	124,742	-4,256,989
17	689,458	108,500	580,958	0.198	136,406	21,466	114,939	-4,142,049
18	689,458	108,500	580,958	0.180	124,005	19,515	104,490	-4,037,559
19	689,458	108,500	580,958	0.164	112,732	17,741	94,991	-3,942,568
20	689,458	108,500	580,958	0.149	102,484	16,128	86,356	-3,856,212
21	689,458	108,500	580,958	0.135	93,167	14,662	78,505	-3,777,707
	Sum				4,032,234	7,809,941	-3,777,707	

NPV = -3,777,707
B/C = 0.52

Appendix 4.4-2: Financial Analysis of MOGOR SHP at Initial Condition: calculation of IRR

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=2.3 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.978	0	2,828,240	-2,828,240	-7,168,170
2	301,476	108,500	192,976	0.956	288,072	103,676	184,396	-6,983,774
3	344,470	108,500	235,970	0.934	321,754	101,345	220,409	-6,763,365
4	387,982	108,500	279,482	0.913	354,249	99,067	255,183	-6,508,182
5	432,530	108,500	324,030	0.893	386,045	96,839	289,206	-6,218,976
6	518,000	108,500	409,500	0.872	451,935	94,662	357,273	-5,861,703
7	540,274	108,500	431,774	0.853	460,770	92,534	368,237	-5,493,467
8	564,620	108,500	456,120	0.834	470,708	90,453	380,254	-5,113,213
9	590,002	108,500	481,502	0.815	480,809	88,420	392,390	-4,720,823
10	612,794	108,500	504,294	0.797	488,155	86,432	401,724	-4,319,099
11	632,996	108,500	524,496	0.779	492,912	84,489	408,423	-3,910,676
12	645,946	108,500	537,446	0.761	491,687	82,589	409,098	-3,501,578
13	657,342	108,500	548,842	0.744	489,112	80,732	408,380	-3,093,199
14	664,076	108,500	555,576	0.727	483,013	78,917	404,096	-2,689,103
15	672,882	108,500	564,382	0.711	478,415	77,143	401,272	-2,287,831
16	681,688	108,500	573,188	0.695	473,779	75,408	398,370	-1,889,461
17	689,458	108,500	580,958	0.679	468,406	73,713	394,693	-1,494,768
18	689,458	108,500	580,958	0.664	457,874	72,056	385,819	-1,108,949
19	689,458	108,500	580,958	0.649	447,580	70,436	377,144	-731,805
20	689,458	108,500	580,958	0.635	437,517	68,852	368,665	-363,140
21	689,458	108,500	580,958	0.620	427,681	67,304	360,376	-2,763
	Sum				8,850,473	8,853,237	-2,763	

NPV = -2,763
B/C = 1.00
IRR = 2.30%

appendix 4.4-3: Financial Analysis of MOGOR SHP with 10% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	710,541	108,500	602,041	0.319	226,400	34,571	191,829	-4,801,538
13	723,076	108,500	614,576	0.290	209,449	31,429	178,021	-4,623,518
14	730,484	108,500	621,984	0.263	192,359	28,571	163,788	-4,459,730
15	732,452	108,500	623,952	0.239	175,343	25,974	149,369	-4,310,361
16	732,452	108,500	623,952	0.218	159,403	23,613	135,790	-4,174,571
17	732,452	108,500	623,952	0.198	144,912	21,466	123,446	-4,051,125
18	732,452	108,500	623,952	0.180	131,738	19,515	112,223	-3,938,902
19	732,452	108,500	623,952	0.164	119,762	17,741	102,021	-3,836,881
20	732,452	108,500	623,952	0.149	108,874	16,128	92,746	-3,744,134
21	732,452	108,500	623,952	0.135	98,977	14,662	84,315	-3,659,819
	Sum				4,150,122	7,809,941	-3,659,819	

NPV = -3,659,819
B/C = 0.53
IRR = 2.7%

Appendix 4.4-4: Financial Analysis of MOGOR SHP with 20% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	732,452	108,500	623,952	0.319	233,382	34,571	198,810	-4,794,557
13	732,452	108,500	623,952	0.290	212,165	31,429	180,737	-4,613,820
14	732,452	108,500	623,952	0.263	192,878	28,571	164,306	-4,449,514
15	732,452	108,500	623,952	0.239	175,343	25,974	149,369	-4,300,145
16	732,452	108,500	623,952	0.218	159,403	23,613	135,790	-4,164,355
17	732,452	108,500	623,952	0.198	144,912	21,466	123,446	-4,040,909
18	732,452	108,500	623,952	0.180	131,738	19,515	112,223	-3,928,686
19	732,452	108,500	623,952	0.164	119,762	17,741	102,021	-3,826,665
20	732,452	108,500	623,952	0.149	108,874	16,128	92,746	-3,733,918
21	732,452	108,500	623,952	0.135	98,977	14,662	84,315	-3,649,603
	Sum				4,160,337	7,809,941	-3,649,603	

NPV = -3,649,603
B/C = 0.53
IRR = 2.7%

Appendix 4.4-5: Financial Analysis of MOGOR SHP with 90% UF and feed-in tariff of 0.6Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	804,000	108,500	695,500	0.319	256,179	34,571	221,608	-4,771,759
13	804,000	108,500	695,500	0.290	232,890	31,429	201,462	-4,570,298
14	804,000	108,500	695,500	0.263	211,718	28,571	183,147	-4,387,151
15	804,000	108,500	695,500	0.239	192,471	25,974	166,497	-4,220,654
16	804,000	108,500	695,500	0.218	174,974	23,613	151,361	-4,069,293
17	804,000	108,500	695,500	0.198	159,067	21,466	137,601	-3,931,692
18	804,000	108,500	695,500	0.180	144,606	19,515	125,092	-3,806,600
19	804,000	108,500	695,500	0.164	131,460	17,741	113,720	-3,692,880
20	804,000	108,500	695,500	0.149	119,509	16,128	103,382	-3,589,498
21	804,000	108,500	695,500	0.135	108,645	14,662	93,983	-3,495,515
	Sum				4,314,425	7,809,941	-3,495,515	

NPV = -3,495,515
B/C = 0.55
IRR = 3.3%

Appendix 4.4-6: Financial Analysis of MOGOR SHP with 90% UF and feed-in tariff of 0.7Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	938,000	108,500	829,500	0.319	298,876	34,571	264,304	-4,729,063
13	938,000	108,500	829,500	0.290	271,705	31,429	240,277	-4,488,786
14	938,000	108,500	829,500	0.263	247,005	28,571	218,433	-4,270,353
15	938,000	108,500	829,500	0.239	224,550	25,974	198,576	-4,071,777
16	938,000	108,500	829,500	0.218	204,136	23,613	180,523	-3,891,254
17	938,000	108,500	829,500	0.198	185,578	21,466	164,112	-3,727,142
18	938,000	108,500	829,500	0.180	168,708	19,515	149,193	-3,577,949
19	938,000	108,500	829,500	0.164	153,370	17,741	135,630	-3,442,319
20	938,000	108,500	829,500	0.149	139,428	16,128	123,300	-3,319,019
21	938,000	108,500	829,500	0.135	126,752	14,662	112,091	-3,206,928
	Sum				4,603,012	7,809,941	-3,206,928	

NPV = -3,206,928
B/C = 0.59
IRR = 4.2%

Appendix 4.4-7: Financial Analysis of MOGOR SHP with 90% UF and feed-in tariff of 0.8Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	$I=I_{n-1}+H_n$
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	1,072,000	108,500	963,500	0.319	341,572	34,571	307,001	-4,686,366
13	1,072,000	108,500	963,500	0.290	310,520	31,429	279,092	-4,407,275
14	1,072,000	108,500	963,500	0.263	282,291	28,571	253,720	-4,153,555
15	1,072,000	108,500	963,500	0.239	256,628	25,974	230,654	-3,922,901
16	1,072,000	108,500	963,500	0.218	233,298	23,613	209,686	-3,713,215
17	1,072,000	108,500	963,500	0.198	212,089	21,466	190,623	-3,522,592
18	1,072,000	108,500	963,500	0.180	192,809	19,515	173,294	-3,349,298
19	1,072,000	108,500	963,500	0.164	175,281	17,741	157,540	-3,191,758
20	1,072,000	108,500	963,500	0.149	159,346	16,128	143,218	-3,048,540
21	1,072,000	108,500	963,500	0.135	144,860	14,662	130,198	-2,918,341
	Sum				4,891,599	7,809,941	-2,918,341	

NPV = -2,918,341
B/C = 0.63
IRR = 5.0%

Appendix 4.4-8: Financial Analysis of MOGOR SHP with 90% UF and feed-in tariff of 1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	1,340,000	108,500	1,231,500	0.319	426,965	34,571	392,394	-4,600,973
13	1,340,000	108,500	1,231,500	0.290	388,150	31,429	356,722	-4,244,252
14	1,340,000	108,500	1,231,500	0.263	352,864	28,571	324,292	-3,919,959
15	1,340,000	108,500	1,231,500	0.239	320,785	25,974	294,811	-3,625,148
16	1,340,000	108,500	1,231,500	0.218	291,623	23,613	268,010	-3,357,137
17	1,340,000	108,500	1,231,500	0.198	265,112	21,466	243,646	-3,113,492
18	1,340,000	108,500	1,231,500	0.180	241,011	19,515	221,496	-2,891,996
19	1,340,000	108,500	1,231,500	0.164	219,101	17,741	201,360	-2,690,636
20	1,340,000	108,500	1,231,500	0.149	199,182	16,128	183,055	-2,507,581
21	1,340,000	108,500	1,231,500	0.135	181,075	14,662	166,413	-2,341,168
	Sum				5,468,773	7,809,941	-2,341,168	

NPV = -2,341,168
B/C = 0.70
IRR = 6.3%

Appendix 4.4-9: Financial Analysis of MOGOR SHP with 90% UF and feed-in tariff of 1.1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,339,930	-4,339,930	1	0	4,339,930	-4,339,930	-4,339,930
1	0	2,893,290	-2,893,290	0.909	0	2,630,264	-2,630,264	-6,970,194
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-6,810,709
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-6,633,422
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-6,442,532
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-6,241,334
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-6,010,182
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-5,788,614
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-5,575,831
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-5,371,627
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-5,177,200
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-4,993,367
12	1,474,000	108,500	1,365,500	0.319	469,662	34,571	435,090	-4,558,277
13	1,474,000	108,500	1,365,500	0.290	426,965	31,429	395,537	-4,162,740
14	1,474,000	108,500	1,365,500	0.263	388,150	28,571	359,579	-3,803,161
15	1,474,000	108,500	1,365,500	0.239	352,864	25,974	326,890	-3,476,271
16	1,474,000	108,500	1,365,500	0.218	320,785	23,613	297,173	-3,179,099
17	1,474,000	108,500	1,365,500	0.198	291,623	21,466	270,157	-2,908,942
18	1,474,000	108,500	1,365,500	0.180	265,112	19,515	245,597	-2,663,345
19	1,474,000	108,500	1,365,500	0.164	241,011	17,741	223,270	-2,440,074
20	1,474,000	108,500	1,365,500	0.149	219,101	16,128	202,973	-2,237,102
21	1,474,000	108,500	1,365,500	0.135	199,182	14,662	184,521	-2,052,581
	Sum				5,757,360	7,809,941	-2,052,581	

NPV = -2,052,581
B/C = 0.74
IRR = 6.9%

Appendix 4.4-10: Financial Analysis of MOGOR SHP with 90% UF, feed-in tariff of 1.1Birr/kwh and 30% subsiidy

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	3,037,951	-3,037,951	1	0	3,037,951	-3,037,951	-3,037,951
1	0	2,025,303	-2,025,303	0.909	0	1,841,185	-1,841,185	-4,879,136
2	301,476	108,500	192,976	0.826	249,154	89,669	159,484	-4,719,651
3	344,470	108,500	235,970	0.751	258,805	81,518	177,288	-4,542,363
4	387,982	108,500	279,482	0.683	264,997	74,107	190,890	-4,351,474
5	432,530	108,500	324,030	0.621	268,567	67,370	201,197	-4,150,276
6	518,000	108,500	409,500	0.564	292,397	61,245	231,152	-3,919,124
7	540,274	108,500	431,774	0.513	277,246	55,678	221,568	-3,697,556
8	564,620	108,500	456,120	0.467	263,399	50,616	212,783	-3,484,773
9	590,002	108,500	481,502	0.424	250,218	46,015	204,204	-3,280,569
10	612,794	108,500	504,294	0.386	236,259	41,831	194,427	-3,086,142
11	632,996	108,500	524,496	0.350	221,861	38,029	183,833	-2,902,309
12	1,474,000	108,500	1,365,500	0.319	469,662	34,571	435,090	-2,467,219
13	1,474,000	108,500	1,365,500	0.290	426,965	31,429	395,537	-2,071,682
14	1,474,000	108,500	1,365,500	0.263	388,150	28,571	359,579	-1,712,103
15	1,474,000	108,500	1,365,500	0.239	352,864	25,974	326,890	-1,385,213
16	1,474,000	108,500	1,365,500	0.218	320,785	23,613	297,173	-1,088,041
17	1,474,000	108,500	1,365,500	0.198	291,623	21,466	270,157	-817,884
18	1,474,000	108,500	1,365,500	0.180	265,112	19,515	245,597	-572,287
19	1,474,000	108,500	1,365,500	0.164	241,011	17,741	223,270	-349,016
20	1,474,000	108,500	1,365,500	0.149	219,101	16,128	202,973	-146,044
21	1,474,000	108,500	1,365,500	0.135	199,182	14,662	184,521	38,477
	Sum				5,757,360	5,718,883	38,477	

NPV = 38,477
B/C = 1.01
IRR = 10.1%

Year	Capital Cost	Subsidized Cost(30% capital cost subsidized)
0	4,339,930	3,037,951
1	2,893,290	2,025,303

WENI HYDROPOWER-FINANCIAL ANALYSIS

Appendix 3.3-1: Energy sells with different given tariffs

No	Energy Sales (MWH)	Revenue (Birr) (tariff=0.518Birr/kwh)
1	584	302,512
2	617	319,606
3	640	331,520
4	666	344,988
5	691	357,938
6	704	364,672
7	717	371,406
8	728	377,104
9	739	382,802
10	747	386,946
11	756	391,608
12	766	396,788
13	771	399,378
14	780	404,040
15	786	407,148
16	790	409,220
17	790	409,220
18	790	409,220
19	790	409,220
20	790	409,220

Appendix 3.3-2: Energy sells and the corresponding revenues with different values of capacity utilization

No	Energy Sales (MWH)	Energy Sales by 10% increase from 11th year (MWH)	Energy Sales by 20% increase from 11th year (MWH)	Energy Sales by 30% increase from 11th year (MWH)	Energy Sales by 40% increase from 11th year (MWH)	Energy Sales by 50% increase from 11th year (MWH)	Revenue by 10% increase in energy sell(Birr)	Revenue by 20% increase in energy sell(Birr)	Revenue by 30% increase in energy sell(Birr)	Revenue by 40% increase in energy sell(Birr)	Revenue by 50% increase in energy sell(Birr)
1	584	584	584	584	584	584	302,512	302,512	302,512	302,512	302,512
2	617	617	617	617	617	617	319,606	319,606	319,606	319,606	319,606
3	640	640	640	640	640	640	331,520	331,520	331,520	331,520	331,520
4	666	666	666	666	666	666	344,988	344,988	344,988	344,988	344,988
5	691	691	691	691	691	691	357,938	357,938	357,938	357,938	357,938
6	704	704	704	704	704	704	364,672	364,672	364,672	364,672	364,672
7	717	717	717	717	717	717	371,406	371,406	371,406	371,406	371,406
8	728	728	728	728	728	728	377,104	377,104	377,104	377,104	377,104
9	739	739	739	739	739	739	382,802	382,802	382,802	382,802	382,802
10	747	747	747	747	747	747	386,946	386,946	386,946	386,946	386,946
11	756	832	907	983	999	999	430,769	469,930	509,090	517,482	517,482
12	766	843	919	996	999	999	436,467	476,146	515,824	517,482	517,482
13	771	848	925	999	999	999	439,316	479,254	517,482	517,482	517,482
14	780	858	936	999	999	999	444,444	484,848	517,482	517,482	517,482
15	786	865	943	999	999	999	447,863	488,578	517,482	517,482	517,482
16	790	869	948	999	999	999	450,142	491,064	517,482	517,482	517,482
17	790	869	948	999	999	999	450,142	491,064	517,482	517,482	517,482
18	790	869	948	999	999	999	450,142	491,064	517,482	517,482	517,482
19	790	869	948	999	999	999	450,142	491,064	517,482	517,482	517,482
20	790	869	948	999	999	999	450,142	491,064	517,482	517,482	517,482

Note: the max. energy sell at ideal condition=120kw*365days*24hr/day=1051MWh. Therefore, limit all values of energy sell under this value. Lets assume max. energy sell with 95% UF as 999MWh

Appendix 3.3-3: Energy Sell with 90% UF starting from the 11th year and the corresponding revenues at different feed-in tariffs

No	Energy Sales (MWH)	Revenue (Birr) [rate:0.518Birr /kwh]	Revenue (Birr) [rate: 0.6Birr/kwh]	Revenue (Birr) [rate: 0.7Birr/kwh]	Revenue (Birr) [rate: 0.8Birr/kwh]	Revenue (Birr) [rate: 1Birr/kwh]	Revenue (Birr) [rate: 1.1Birr/kwh]
1	584	302,512	302,512	302,512	302,512	302,512	302,512
2	617	319,606	319,606	319,606	319,606	319,606	319,606
3	640	331,520	331,520	331,520	331,520	331,520	331,520
4	666	344,988	344,988	344,988	344,988	344,988	344,988
5	691	357,938	357,938	357,938	357,938	357,938	357,938
6	704	364,672	364,672	364,672	364,672	364,672	364,672
7	717	371,406	371,406	371,406	371,406	371,406	371,406
8	728	377,104	377,104	377,104	377,104	377,104	377,104
9	739	382,802	382,802	382,802	382,802	382,802	382,802
10	747	386,946	386,946	386,946	386,946	386,946	386,946
11	946	490,028	567,600	662,200	756,800	946,000	1,040,600
12	946	490,028	567,600	662,200	756,800	946,000	1,040,600
13	946	490,028	567,600	662,200	756,800	946,000	1,040,600
14	946	490,028	567,600	662,200	756,800	946,000	1,040,600
15	946	490,028	567,600	662,200	756,800	946,000	1,040,600
16	946	490,028	567,600	662,200	756,800	946,000	1,040,600
17	946	490,028	567,600	662,200	756,800	946,000	1,040,600
18	946	490,028	567,600	662,200	756,800	946,000	1,040,600
19	946	490,028	567,600	662,200	756,800	946,000	1,040,600
20	946	490,028	567,600	662,200	756,800	946,000	1,040,600

Energy Sell with 90% UF=120kw*365days*24hr/day*0.9=946MWh

Appendix 3.3-4: Financial Analysis of WENI SHP at Initial Condition considering 1year of construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	6,695,600	-6,695,600	1	0	6,695,600	-6,695,600	-6,695,600
1	302,512	100,434	202,078	0.909	275,011	91,304	183,707	-6,511,893
2	319,606	100,434	219,172	0.826	264,137	83,003	181,134	-6,330,759
3	331,520	100,434	231,086	0.751	249,076	75,458	173,618	-6,157,141
4	344,988	100,434	244,554	0.683	235,631	68,598	167,034	-5,990,107
5	357,938	100,434	257,504	0.621	222,251	62,362	159,890	-5,830,217
6	364,672	100,434	264,238	0.564	205,848	56,692	149,155	-5,681,062
7	371,406	100,434	270,972	0.513	190,590	51,539	139,051	-5,542,010
8	377,104	100,434	276,670	0.467	175,922	46,853	129,069	-5,412,942
9	382,802	100,434	282,368	0.424	162,345	42,594	119,752	-5,293,190
10	386,946	100,434	286,512	0.386	149,184	38,722	110,463	-5,182,727
11	391,608	100,434	291,174	0.350	137,256	35,202	102,055	-5,080,672
12	396,788	100,434	296,354	0.319	126,429	32,001	94,428	-4,986,245
13	399,378	100,434	298,944	0.290	115,686	29,092	86,593	-4,899,652
14	404,040	100,434	303,606	0.263	106,396	26,447	79,949	-4,819,703
15	407,148	100,434	306,714	0.239	97,468	24,043	73,425	-4,746,278
16	409,220	100,434	308,786	0.218	89,058	21,857	67,201	-4,679,077
17	409,220	100,434	308,786	0.198	80,962	19,870	61,092	-4,617,985
18	409,220	100,434	308,786	0.180	73,602	18,064	55,538	-4,562,447
19	409,220	100,434	308,786	0.164	66,911	16,422	50,489	-4,511,958
20	409,220	100,434	308,786	0.149	60,828	14,929	45,899	-4,466,059
	Sum				3,084,592	7,550,651	-4,466,059	

NPV = -4,466,059
B/C = 0.41

Appendix 4.3-1: Financial Analysis of WENI SHP at Initial Condition considering 2years of construction

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909090909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826446281	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751314801	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683013455	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.620921323	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.56447393	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513158118	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.46650738	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424097618	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.385543289	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350493899	135,622	35,202	100,421	-5,076,785
12	391,608	100,434	291,174	0.318630818	124,778	32,001	92,777	-4,984,008
13	396,788	100,434	296,354	0.28966438	114,935	29,092	85,843	-4,898,165
14	399,378	100,434	298,944	0.263331254	105,169	26,447	78,721	-4,819,443
15	404,040	100,434	303,606	0.239392049	96,724	24,043	72,681	-4,746,762
16	407,148	100,434	306,714	0.217629136	88,607	21,857	66,750	-4,680,012
17	409,220	100,434	308,786	0.197844669	80,962	19,870	61,092	-4,618,921
18	409,220	100,434	308,786	0.17985879	73,602	18,064	55,538	-4,563,383
19	409,220	100,434	308,786	0.163507991	66,911	16,422	50,489	-4,512,894
20	409,220	100,434	308,786	0.148643628	60,828	14,929	45,899	-4,466,995
21	409,220	100,434	308,786	0.135130571	55,298	13,572	41,726	-4,425,268
	Sum				2,804,175	7,229,443	-4,425,268	

NPV = -4,425,268
B/C = 0.39

Appendix 4.3-2: Financial Analysis of WENI SHP at Initial Condition: calculation of IRR

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=-1.5% per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	1.015228426	0	2,719,025	-2,719,025	-6,736,385
2	302,512	100,434	202,078	1.030688758	311,796	103,516	208,280	-6,528,106
3	319,606	100,434	219,172	1.046384526	334,431	105,093	229,338	-6,298,768
4	331,520	100,434	231,086	1.062319315	352,180	106,693	245,487	-6,053,281
5	344,988	100,434	244,554	1.078496767	372,068	108,318	263,751	-5,789,530
6	357,938	100,434	257,504	1.094920576	391,914	109,967	281,946	-5,507,583
7	364,672	100,434	264,238	1.111594493	405,367	111,642	293,726	-5,213,858
8	371,406	100,434	270,972	1.128522328	419,140	113,342	305,798	-4,908,060
9	377,104	100,434	276,670	1.145707947	432,051	115,068	316,983	-4,591,077
10	382,802	100,434	282,368	1.163155276	445,258	116,820	328,438	-4,262,639
11	386,946	100,434	286,512	1.180868301	456,932	118,599	338,333	-3,924,306
12	391,608	100,434	291,174	1.198851067	469,480	120,405	349,074	-3,575,232
13	396,788	100,434	296,354	1.217107682	482,934	122,239	360,695	-3,214,537
14	399,378	100,434	298,944	1.235642317	493,488	124,101	369,388	-2,845,149
15	404,040	100,434	303,606	1.254459205	506,852	125,990	380,861	-2,464,288
16	407,148	100,434	306,714	1.273562644	518,528	127,909	390,619	-2,073,668
17	409,220	100,434	308,786	1.292956999	529,104	129,857	399,247	-1,674,421
18	409,220	100,434	308,786	1.3126467	537,161	131,834	405,327	-1,269,095
19	409,220	100,434	308,786	1.332636244	545,341	133,842	411,499	-857,595
20	409,220	100,434	308,786	1.352930196	553,646	135,880	417,766	-439,829
21	409,220	100,434	308,786	1.373533194	562,077	137,949	424,128	-15,701
	Sum				9,119,749	9,135,451	-15,701	

NPV = -15,701
B/C = 1.00
IRR = -1.50%

Appendix 4.3-3: Financial Analysis of WENI SHP with 10% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	430,769	100,434	330,335	0.319	137,256	32,001	105,255	-4,971,530
13	436,467	100,434	336,033	0.290	126,429	29,092	97,337	-4,874,193
14	439,316	100,434	338,882	0.263	115,686	26,447	89,238	-4,784,955
15	444,444	100,434	344,010	0.239	106,396	24,043	82,353	-4,702,602
16	447,863	100,434	347,429	0.218	97,468	21,857	75,611	-4,626,991
17	450,142	100,434	349,708	0.198	89,058	19,870	69,188	-4,557,803
18	450,142	100,434	349,708	0.180	80,962	18,064	62,898	-4,494,905
19	450,142	100,434	349,708	0.164	73,602	16,422	57,180	-4,437,725
20	450,142	100,434	349,708	0.149	66,911	14,929	51,982	-4,385,743
21	450,142	100,434	349,708	0.135	60,828	13,572	47,256	-4,338,487
	Sum				2,890,956	7,229,443	-4,338,487	

NPV = -4,338,487
B/C = 0.40
IRR = -0.9%

Appendix 4.3-4: Financial Analysis of WENI SHP with 20% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	469,930	100,434	369,496	0.319	149,734	32,001	117,733	-4,959,052
13	476,146	100,434	375,712	0.290	137,922	29,092	108,830	-4,850,222
14	479,254	100,434	378,820	0.263	126,202	26,447	99,755	-4,750,467
15	484,848	100,434	384,414	0.239	116,069	24,043	92,026	-4,658,441
16	488,578	100,434	388,144	0.218	106,329	21,857	84,471	-4,573,970
17	491,064	100,434	390,630	0.198	97,154	19,870	77,284	-4,496,686
18	491,064	100,434	390,630	0.180	88,322	18,064	70,258	-4,426,427
19	491,064	100,434	390,630	0.164	80,293	16,422	63,871	-4,362,556
20	491,064	100,434	390,630	0.149	72,994	14,929	58,065	-4,304,492
21	491,064	100,434	390,630	0.135	66,358	13,572	52,786	-4,251,706
	Sum				2,977,737	7,229,443	-4,251,706	

NPV = -4,251,706
B/C = 0.41
IRR = -0.40%

Appendix 4.3-5: Financial Analysis of WENI SHP with 30% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	509,090	100,434	408,656	0.319	162,212	32,001	130,211	-4,946,574
13	515,824	100,434	415,390	0.290	149,416	29,092	120,324	-4,826,250
14	517,482	100,434	417,048	0.263	136,269	26,447	109,822	-4,716,429
15	517,482	100,434	417,048	0.239	123,881	24,043	99,838	-4,616,591
16	517,482	100,434	417,048	0.218	112,619	21,857	90,762	-4,525,829
17	517,482	100,434	417,048	0.198	102,381	19,870	82,511	-4,443,318
18	517,482	100,434	417,048	0.180	93,074	18,064	75,010	-4,368,308
19	517,482	100,434	417,048	0.164	84,612	16,422	68,191	-4,300,118
20	517,482	100,434	417,048	0.149	76,920	14,929	61,992	-4,238,126
21	517,482	100,434	417,048	0.135	69,928	13,572	56,356	-4,181,770
	Sum				3,047,673	7,229,443	-4,181,770	

NPV = -4,181,770
B/C = 0.42
IRR = 0.00%

Appendix 4.3-6: Financial Analysis of WENI SHP with 40% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	517,482	100,434	417,048	0.319	164,886	32,001	132,884	-4,943,900
13	517,482	100,434	417,048	0.290	149,896	29,092	120,804	-4,823,096
14	517,482	100,434	417,048	0.263	136,269	26,447	109,822	-4,713,275
15	517,482	100,434	417,048	0.239	123,881	24,043	99,838	-4,613,437
16	517,482	100,434	417,048	0.218	112,619	21,857	90,762	-4,522,675
17	517,482	100,434	417,048	0.198	102,381	19,870	82,511	-4,440,164
18	517,482	100,434	417,048	0.180	93,074	18,064	75,010	-4,365,154
19	517,482	100,434	417,048	0.164	84,612	16,422	68,191	-4,296,964
20	517,482	100,434	417,048	0.149	76,920	14,929	61,992	-4,234,972
21	517,482	100,434	417,048	0.135	69,928	13,572	56,356	-4,178,616
	Sum				3,050,827	7,229,443	-4,178,616	

NPV = -4,178,616
B/C = 0.42
IRR = 0.05%

Appendix 4.3-7: Financial Analysis of WENI SHP with 50% increase in capacity utilization and tariff unchanged

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	517,482	100,434	417,048	0.319	164,886	32,001	132,884	-4,943,900
13	517,482	100,434	417,048	0.290	149,896	29,092	120,804	-4,823,096
14	517,482	100,434	417,048	0.263	136,269	26,447	109,822	-4,713,275
15	517,482	100,434	417,048	0.239	123,881	24,043	99,838	-4,613,437
16	517,482	100,434	417,048	0.218	112,619	21,857	90,762	-4,522,675
17	517,482	100,434	417,048	0.198	102,381	19,870	82,511	-4,440,164
18	517,482	100,434	417,048	0.180	93,074	18,064	75,010	-4,365,154
19	517,482	100,434	417,048	0.164	84,612	16,422	68,191	-4,296,964
20	517,482	100,434	417,048	0.149	76,920	14,929	61,992	-4,234,972
21	517,482	100,434	417,048	0.135	69,928	13,572	56,356	-4,178,616
	Sum				3,050,827	7,229,443	-4,178,616	

NPV = -4,178,616
B/C = 0.42
IRR = 0.05%

Appendix 4.3-8: Financial Analysis of WENI SHP with 90% UF and feed-in tariff of 0.6Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	567,600	100,434	467,166	0.319	180,855	32,001	148,853	-4,927,931
13	567,600	100,434	467,166	0.290	164,414	29,092	135,321	-4,792,610
14	567,600	100,434	467,166	0.263	149,467	26,447	123,019	-4,669,590
15	567,600	100,434	467,166	0.239	135,879	24,043	111,836	-4,557,755
16	567,600	100,434	467,166	0.218	123,526	21,857	101,669	-4,456,086
17	567,600	100,434	467,166	0.198	112,297	19,870	92,426	-4,363,659
18	567,600	100,434	467,166	0.180	102,088	18,064	84,024	-4,279,636
19	567,600	100,434	467,166	0.164	92,807	16,422	76,385	-4,203,250
20	567,600	100,434	467,166	0.149	84,370	14,929	69,441	-4,133,809
21	567,600	100,434	467,166	0.135	76,700	13,572	63,128	-4,070,680
	Sum				3,158,762	7,229,443	-4,070,680	

NPV = -4,070,680
B/C = 0.44
IRR = 0.6%

Appendix 4.3-9: Financial Analysis of WENI SHP with 90% UF and feed-in tariff of 0.7Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	662,200	100,434	561,766	0.319	210,997	32,001	178,996	-4,897,789
13	662,200	100,434	561,766	0.290	191,816	29,092	162,724	-4,735,065
14	662,200	100,434	561,766	0.263	174,378	26,447	147,931	-4,587,135
15	662,200	100,434	561,766	0.239	158,525	24,043	134,482	-4,452,652
16	662,200	100,434	561,766	0.218	144,114	21,857	122,257	-4,330,396
17	662,200	100,434	561,766	0.198	131,013	19,870	111,142	-4,219,253
18	662,200	100,434	561,766	0.180	119,102	18,064	101,039	-4,118,215
19	662,200	100,434	561,766	0.164	108,275	16,422	91,853	-4,026,361
20	662,200	100,434	561,766	0.149	98,432	14,929	83,503	-3,942,859
21	662,200	100,434	561,766	0.135	89,483	13,572	75,912	-3,866,947
	Sum				3,362,496	7,229,443	-3,866,947	

NPV = -3,866,947
B/C = 0.47
IRR = 1.5%

Appendix 4.3-10: Financial Analysis of WENI SHP with 90% UF and feed-in tariff of 0.8Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	756,800	100,434	656,366	0.319	241,140	32,001	209,138	-4,867,646
13	756,800	100,434	656,366	0.290	219,218	29,092	190,126	-4,677,520
14	756,800	100,434	656,366	0.263	199,289	26,447	172,842	-4,504,679
15	756,800	100,434	656,366	0.239	181,172	24,043	157,129	-4,347,550
16	756,800	100,434	656,366	0.218	164,702	21,857	142,844	-4,204,706
17	756,800	100,434	656,366	0.198	149,729	19,870	129,859	-4,074,847
18	756,800	100,434	656,366	0.180	136,117	18,064	118,053	-3,956,794
19	756,800	100,434	656,366	0.164	123,743	16,422	107,321	-3,849,473
20	756,800	100,434	656,366	0.149	112,493	14,929	97,565	-3,751,908
21	756,800	100,434	656,366	0.135	102,267	13,572	88,695	-3,663,213
	Sum				3,566,230	7,229,443	-3,663,213	

NPV = -3,663,213
B/C = 0.49
IRR = 2.4%

Appendix 4.3-11: Financial Analysis of WENI SHP with 90% UF and feed-in tariff of 1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	946,000	100,434	845,566	0.319	301,425	32,001	269,423	-4,807,361
13	946,000	100,434	845,566	0.290	274,023	29,092	244,930	-4,562,431
14	946,000	100,434	845,566	0.263	249,111	26,447	222,664	-4,339,767
15	946,000	100,434	845,566	0.239	226,465	24,043	202,422	-4,137,345
16	946,000	100,434	845,566	0.218	205,877	21,857	184,020	-3,953,325
17	946,000	100,434	845,566	0.198	187,161	19,870	167,291	-3,786,035
18	946,000	100,434	845,566	0.180	170,146	18,064	152,082	-3,633,952
19	946,000	100,434	845,566	0.164	154,679	16,422	138,257	-3,495,695
20	946,000	100,434	845,566	0.149	140,617	14,929	125,688	-3,370,007
21	946,000	100,434	845,566	0.135	127,834	13,572	114,262	-3,255,746
	Sum				3,973,697	7,229,443	-3,255,746	

NPV = -3,255,746
B/C = 0.55
IRR = 3.8%

Appendix 4.3-12: Financial Analysis of WENI SHP with 90% UF and feed-in tariff of 1.1Birr/kwh

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	4,017,360	-4,017,360	1	0	4,017,360	-4,017,360	-4,017,360
1	0	2,678,240	-2,678,240	0.909	0	2,434,764	-2,434,764	-6,452,124
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-6,285,117
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-6,120,450
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-5,962,615
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-5,810,766
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-5,665,412
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-5,529,816
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-5,403,406
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-5,286,071
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-5,177,205
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-5,076,785
12	1,040,600	100,434	940,166	0.319	331,567	32,001	299,566	-4,777,219
13	1,040,600	100,434	940,166	0.290	301,425	29,092	272,333	-4,504,886
14	1,040,600	100,434	940,166	0.263	274,023	26,447	247,575	-4,257,311
15	1,040,600	100,434	940,166	0.239	249,111	24,043	225,068	-4,032,243
16	1,040,600	100,434	940,166	0.218	226,465	21,857	204,608	-3,827,635
17	1,040,600	100,434	940,166	0.198	205,877	19,870	186,007	-3,641,629
18	1,040,600	100,434	940,166	0.180	187,161	18,064	169,097	-3,472,531
19	1,040,600	100,434	940,166	0.164	170,146	16,422	153,725	-3,318,807
20	1,040,600	100,434	940,166	0.149	154,679	14,929	139,750	-3,179,057
21	1,040,600	100,434	940,166	0.135	140,617	13,572	127,045	-3,052,012
	Sum				4,177,431	7,229,443	-3,052,012	

NPV = -3,052,012
B/C = 0.58
IRR = 4.4%

Appendix 4.3-13: Financial Analysis of WENI SHP with 90% UF, feed-in tariff of 1.1Birr/kwh and 5o% subsidy

Year	Revenue (Birr)	Cost (Birr)	Net Cash flow (Birr)	Discount Rate at i=10 % per annum	Discounted Revenue (Birr)	Discounted Cost (Birr)	Discounted Net Cash flow (Birr)	Cummulative Cash Flow (Birr)
A	B	C	D(B-C)	$E=1/(1+i)^n$	F=B*E	G=C*E	H=F-G	I=In-1+Hn
0	0	2,008,680	-2,008,680	1	0	2,008,680	-2,008,680	-2,008,680
1	0	1,339,120	-1,339,120	0.909	0	1,217,382	-1,217,382	-3,226,062
2	302,512	100,434	202,078	0.826	250,010	83,003	167,007	-3,059,055
3	319,606	100,434	219,172	0.751	240,125	75,458	164,667	-2,894,388
4	331,520	100,434	231,086	0.683	226,433	68,598	157,835	-2,736,553
5	344,988	100,434	244,554	0.621	214,210	62,362	151,849	-2,584,704
6	357,938	100,434	257,504	0.564	202,047	56,692	145,354	-2,439,350
7	364,672	100,434	264,238	0.513	187,134	51,539	135,596	-2,303,754
8	371,406	100,434	270,972	0.467	173,264	46,853	126,410	-2,177,344
9	377,104	100,434	276,670	0.424	159,929	42,594	117,335	-2,060,009
10	382,802	100,434	282,368	0.386	147,587	38,722	108,865	-1,951,144
11	386,946	100,434	286,512	0.350	135,622	35,202	100,421	-1,850,723
12	1,040,600	100,434	940,166	0.319	331,567	32,001	299,566	-1,551,157
13	1,040,600	100,434	940,166	0.290	301,425	29,092	272,333	-1,278,824
14	1,040,600	100,434	940,166	0.263	274,023	26,447	247,575	-1,031,249
15	1,040,600	100,434	940,166	0.239	249,111	24,043	225,068	-806,181
16	1,040,600	100,434	940,166	0.218	226,465	21,857	204,608	-601,574
17	1,040,600	100,434	940,166	0.198	205,877	19,870	186,007	-415,567
18	1,040,600	100,434	940,166	0.180	187,161	18,064	169,097	-246,470
19	1,040,600	100,434	940,166	0.164	170,146	16,422	153,725	-92,745
20	1,040,600	100,434	940,166	0.149	154,679	14,929	139,750	47,005
21	1,040,600	100,434	940,166	0.135	140,617	13,572	127,045	174,050
	Sum				4,177,431	4,003,381	174,050	

NPV = 174,050
B/C = 1.04
IRR = 10.5%

Year	Capital Cost	Subsidized Cost(50% capital cost subsidized
0	4,017,360	2,008,680
1	2,678,240	1,339,120